# REPORT OF THE COMMISSIONER.

## A.—GENERAL CONSIDERATIONS.

### 1.—INTRODUCTORY REMARKS.

In the report herewith presented will be found an account of the operations of the United States Fish Commission during the year ending December 31, 1881.

In entering upon a second decade a few changes in methods of administration have been made, some of which were rendered necessary by the expansion of the work, while others have been suggested by the experience of the first ten years. Some idea of the extent of the correspondence may be obtained from the accompanying table prepared by Mr. C. W. Smiley, in charge of the archives, showing the number of letters written each month from 1871 to 1881, inclusive. The number received was much greater. Probably one-half of the latter were answered by printed circulars or by furnishing publications of the Commission.

The table may be of interest, also, as showing the increase of correspondence with succeeding years and steady expansion of the work. The decrease of the letters in 1876, the year of the International or Centennial Exhibition in Philadelphia, was due to the cessation of field-work caused by the necessary occupation of the time of the Commissioner, for the greater part of the year, in connection with the Government participation on the occasion in question.

*Number of letters written monthly in the office of the United States Fish Commission 1871-1881, inclusive.*

| Months. | 1871. | 1872. | 1873. | 1874. | 1875. | 1876. | 1877. | 1878. | 1879. | 1880. | 1881. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January | ..... | 34 | 109 | 137 | 166 | 72 | 156 | 244 | 223 | 366 | 365 |
| February | ..... | 65 | 102 | 82 | 115 | 69 | 151 | 132 | 219 | 492 | 396 |
| March | 19 | 41 | 94 | 138 | 204 | 106 | 121 | 252 | 241 | 631 | 412 |
| April | 32 | 27 | 104 | 247 | 182 | 67 | 176 | 401 | 269 | 411 | 471 |
| May | 41 | 44 | 113 | 173 | 217 | 74 | 278 | 334 | 337 | 415 | 440 |
| June | 36 | 48 | 86 | 133 | 103 | 61 | 187 | 310 | 339 | 515 | 511 |
| July | 31 | 97 | 65 | 129 | 275 | 102 | 307 | 173 | 275 | 486 | 555 |
| August | 7 | 46 | 98 | 180 | 187 | 61 | 300 | 218 | 261 | 331 | 670 |
| September | 7 | 45 | 137 | 133 | 232 | 117 | 200 | 334 | 360 | 283 | 447 |
| October | 16 | 26 | 82 | 167 | 220 | 11 | 107 | 228 | 268 | 305 | 367 |
| November | 41 | 86 | 102 | 132 | 221 | 16 | 232 | 221 | 238 | 410 | 441 |
| December | 42 | 88 | 116 | 166 | 114 | 58 | 276 | 268 | 295 | 422 | 590 |
| Total | 272 | 647 | 1,208 | 1,822 | 2,235 | 814 | 2,491 | 3,115 | 3,325 | 5,067 | 5,673 |

Up to the present year, or for eleven years, all the office and administrative work of the Commission was carried on in the private resi-

dence of the Commissioner, built by him with special reference to the same, and for the use of which compensation was neither asked nor received. The accommodation thus furnished proving too contracted, an appropriation for rent of offices was for the first time made in 1881, and upon the vacant lot adjacent to the Commissioner's residence a suitable building was erected by the owner, Mr. J. O. Wilson, and occupied by the Commission in the latter part of the year. This, however, has not in any way obviated the necessity of the continued employment of the office rooms in the Commissioner's own residence.

The most noteworthy features of the year have been the following:

1. The production and distribution of German carp on a much larger scale than heretofore, in spite of the flood of February 12, which threatened to sweep away all the breeding fish.

2. The construction of an additional carp pond.

3. The construction of a car suitable for distributing fish of all kinds, and an entire change in the methods of fish transportation.

4. An entire change in the policy of distributing fish in public waters, whereby, instead of depositing a few fish in a great many localities, a great many fish have this year been introduced in fewer localities.

5. An unprecedentedly large yield of shad and consequent increase in the distribution of fry.

6. A flood in the McCloud River sweeping away all the works at that station, and which resulted in a decrease of production and distribution of California salmon and of California trout.

7. Extended experiments upon the hatching of cod at Wood's Holl in winter, and of Spanish mackerel at Cherrystone in summer.

8. The exportation of young carp, the eggs of California and land-locked salmon, and of the whitefish, to foreign countries.

9. Important investigations into the embryology and food of fishes, and upon the retardation of the development of the eggs of shad.

10. The inauguration of experiments looking to the artificial propagation of the oyster.

11. The further investigation of the new tile-fish grounds, and the publication of instructions for the use of the cod gill-net, which had been previously introduced in the ocean fisheries upon the recommendation of the Fish Commission.

12. The collection, arrangement, and distribution to educational institutions of a series of marine invertebrates.

13. The preparation of plans and specifications for an ocean steamer, an appropriation of $103,000 for the construction of a vessel for deep-sea research having been made by Congress.

14. The securing, with money raised by private subscription, of a large tract of land on Wood's Holl Harbor upon which to establish a station for the artificial propagation of sea-fishes, such as cod, &c., and also for general biological research.

15. The establishment, by act of Congress, of an annual Bulletin of

500 pages, to be issued in numbers as well as in a bound volume, and to contain important information gathered by the Commission.

16. The leasing of a building for the offices of the Fish Commission.

17. The importation from England of living turbot and sole for the purpose of stocking the waters of the United States.

Full information upon all these topics will be found under the proper headings.

## 2.—PRINCIPAL STATIONS OF THE UNITED STATES FISH COMMISSION.

A brief statement of the principal localities at which the work of the Commission was conducted during this year is here given as prefatory to a fuller discussion under each head.

### A.—INVESTIGATION AND RESEARCH.

1. *Gloucester.*—Since Gloucester was made the summer station of 1878, quarters have, until the present year, been maintained there under lease, at Fort Wharf, for the use of the Commission. This was considered an important point, as being one of the principal fishing ports of the Atlantic Coast, where much information in regard to the fisheries and many valuable specimens could be obtained from fishing vessels. In June of the present year Messrs. Burns & Co., having purchased the premises, took forcible possession of the Fish Commission quarters, although the lease under which the rooms were held did not expire until January, 1882. The Attorney-General, the honorable Wayne MacVeagh, instructed the district attorney for Massachusetts, Judge G. P. Sanger, to take any necessary steps for maintaining the rights of the United States, but to avoid litigation it was thought best to abandon the station, although it had been intended to make it one of the principal points for hatching codfish and mackerel on an extensive scale. Since that time, however, Capt. S. J. Martin has made weekly reports of the arrival of fishing vessels and the general features of the fisheries, together with daily records of ocean and atmospheric temperatures.

2. *Wood's Holl.*—The summer investigations by the Commission have formed an important feature during nearly every year of its history, having been conducted in its successive years at the following places: 1871. Wood's Holl, Mass.; 1872. Eastport, Me.; 1873. Portland, Me.; 1874. Noank, Conn.; 1875. Wood's Holl, Mass.; 1876. Intermitted on account of the engagement of the Commissioner at the Centennial Exhibition in Philadelphia; 1877. Salem, Mass., and Halifax, Nova Scotia; 1878. Gloucester, Mass.; 1879. Provincetown, Mass.; 1880. Newport, R. I.; 1881. Wood's Holl, Mass.

The Commissioner was in attendance at this station from July 8 to October 4. From this point dredging trips were made by the steamer Fish Hawk to the Gulf Stream and other regions of the North Atlantic.

3. *Saint Jerome.*—This station, located near the mouth of the Potomac River, was established during the previous year by Mr. T. B. Fer-

guson, as Commissioner of Fisheries for the State of Maryland, for the purpose of conducting experiments in regard to the artificial propagation of oysters, &c. This year the United States Commissioner joined with the Maryland Commissioner, and the operations were under their general auspices, but under the special direction of Mr. Ferguson.

B.—PROPAGATION OF SALMONIDÆ.

4. *Grand Lake Stream on the Schoodic Lakes.*—The station at this place, situated not very far from Calais, Me., was inaugurated in 1875, and has proved very successful in furnishing a supply of the eggs of the land-locked salmon.

5. *Bucksport, Me.*—This station, located near Bucksport, and adjacent to the mouth of the Penobscot River, has been in operation since 1871 for the taking and hatching of eggs of the Penobscot or Atlantic salmon, under the direction of Mr. Charles G. Atkins.

6. *Northville.*—A fish-hatching station was established at Northville, in 1868, by the late Mr. N. W. Clark. Since 1874 the United States Fish Commission has made use of it, and since 1880 has held it under lease. At this station whitefish, lake trout, brook trout, California trout, &c., are hatched.

7. *McCloud River Salmon Station.*—This station, not far from Mount Shasta, and on a tributary of Pitt River, one of the principal branches of the Sacramento, has been in successful operation since 1872, and has turned out 70,000,000 eggs, largely increasing the local supply of the Sacramento River, as well as furnishing eggs for shipment to the East, and to foreign countries.

8. *McCloud River Trout Station.*—This is located a few miles from the salmon station, and was established in 1879 for the taking of eggs of the California mountain trout.

C.—PROPAGATION OF SHAD.

9. *Battery Island.*—Work at this station, near Havre de Grace, Md., was carried on from May 15 to June 13, under the direction of Mr. Frank N. Clark, for the taking and hatching of eggs of the shad, and for conducting some important experiments connected with the retardation of the development of the eggs.

10. *North East River, Maryland.*—This station, a few miles from Battery Island, near the mouth of the Susquehanna, was operated from May 5 to June 5, inclusive, by the steamer Fish Hawk, for taking and hatching the eggs of shad, this vessel having been transferred from Avoca upon the completion of the season there.

11. *Central Station.*—The Centennial exhibits, which had been stored in the Armory building in Washington for several years, were this year in part removed to the new Museum building, and by authority of Congress the space thus vacated was fitted up as a central hatching and distributing station. It is abundantly supplied with water, and from

its location, adjacent to the Baltimore and Potomac Railroad tracks, is very convenient as a shipping depot for fish and eggs. During the year permission has been obtained from the District Commissioners to extend a side track from the railroad, along the southern side of the building. It will also be used for investigations upon fish and eggs in relation to many practical and biological questions.

12. *Washington navy-yard.*—This station was occupied temporarily, as in some former years, from May 4 to June 25, inclusive, for the hatching of shad-eggs, which were collected at the fisheries on the Potomac and brought thither by a steam launch.

13. *Potomac River barges.*—Two of the barges, one fitted as quarters and the other containing facilities for hatching, were transferred from Havre de Grace and anchored in Gunston Bay, about 20 miles below Washington. This temporary shad-hatching station was most successful, and was under the immediate direction of Mr. Marshall McDonald from April 20 to May 30, inclusive.

14. *Avoca, N. C.*—This was a temporary station occupied from April 12 to April 30 by the steamer Fish Hawk, Lieut. Z. L. Tanner, U. S. N., commanding, for the taking and hatching of the eggs of shad.

### D.—Propagation of Carp.

15. *Carp ponds at Monument Lot.*—These ponds have been maintained during the present year for the propagation of carp under the superintendence of Mr. Rud. Hessel. The number of carp produced was larger than in any previous year. A new pond has also been constructed during the present year.

16. *Carp ponds at the Washington Arsenal.*—These ponds were maintained as heretofore for the propagation of the scale and mirror carp, and were under the charge of Mr. Elliott Jones, of the Ordnance Department, United States Army, until the latter part of May, when, through his transfer to another field of duty, the Commission was deprived of his services. The General of the Army, however, kindly instructed General Ayres, the commandant of the artillery station in the Arsenal Grounds, to protect the ponds and their contents from disturbance and depredation.

## 3.—Assistance rendered to the Commission.

The act of Congress establishing the Commission directs the Executive Departments of the Government to render all necessary and practicable aid in carrying out its mission; and, as in previous years, it is my very agreeable duty to report the cordial manner in which this has been done. The most noteworthy occasions for this service have been as follows:

Treasury Department—*Secretary's Office.*—June 1, Thomas J. Hobbs was designated to disburse the appropriation for "fish hatching

establishments, 1881–1882, $10,000," and on the 15th of November he was instructed to disburse the appropriation for the new steamer.

*Bureau of Revenue Marine.*—In the latter part of October a consignment of turbot and sole arrived from Europe, and in order to facilitate their immediate transportation to a place of deposit, the revenue steamer Grant, under Captain Fengar, was placed at the disposal of the Commission by order of the Secretary of the Treasury.

*Light-House Board.*—By instruction of the Board in previous years, many light-house keepers have continued to furnish satisfactory records of ocean temperature. November 25 the Board directed that these temperatures should also be taken at three new places in Chesapeake Bay. May 11 the Board granted the use of a building in the buoy shed at Wood's Holl for the summer. June 15 the Board granted a three months' leave of absence to Ephraim Edwards in order that he might act as fog pilot of the steamer Fish Hawk during its stay at Wood's Holl. In March General O. E. Babcock rendered important services to the steamer Fish Hawk in navigating Albemarle Sound. At the request of the Fish Commission, the Light-House Board, in the latter part of August, had the entrance to Saint Jerome's Creek properly marked with buoys.

*Coast Survey.*—On many occasions during the year Capt. C. P. Patterson, Superintendent of the Coast Survey, responded to requests for charts of Wood's Holl, Chesapeake Bay, Atlantic coast, as well as for copies of the Coast Pilot.

WAR DEPARTMENT.—June 16 the Adjutant-General of the Army announced that instructions had been given by General Hancock to the chief quartermaster of the Washington Arsenal to take charge of the carp ponds at that point.

*Engineer Bureau.*—In November Col. W. P. Craighill, United States engineer, Baltimore, ordered important improvements at Battery Island, such as providing a landing place for the seine; the preparation of a breakwater; laying the foundation of the hatching house; the filling of the island; and the sheathing of the basin with boards. The Ordnance Department remitted a charge for rifles and ammunition used in 1878 at McCloud River Station, the property having been lost in the flood of this year, and issued an order for duplicating the same.

*Signal Office.*—On many occasions during the year, the Chief Signal Officer has furnished thermometers for light-house keepers to use in taking ocean temperatures. April 27 General Hazen furnished a complete set of recording and self-registering meteorological instruments for use at Havre de Grace, and on June 27 sent Sergeant Seybooth to Havre de Grace to inaugurate the observations. During operations at Wood's Holl he furnished a series of weather reports, and gave special notice of apprehended hurricanes and storms on the coast, which were of great importance to the steamer Fish Hawk in arranging for trips to the Gulf Stream. He also authorized the stretching of telephone wires along the signal service poles at Wood's Holl.

THE NAVY DEPARTMENT.—From its first organization the United States Fish Commission has been more closely related to the Navy Department than to any other branch of the Government, and the facilities extended by it, in compliance with the law as well as in accordance with the kindly feeling of the Secretaries and of the chiefs of bureaus, have been of the utmost importance. This aid has been shown in the detail of several steamers, fully manned and equipped, for service; the loan of launches; the execution of work and of repairs at the navy-yards, and in many other ways.

The experiences of 1881 have been in the same general direction; the most important occasion being the loan of two steam launches, one a Herreshoff, No. 62, and the other a naval launch, No. 55, both rendering admirable service in their respective avocations; this, of course, in addition to furnishing officers and men to the Fish Hawk, the Lookout, and the launches.

The United States steamer Despatch being under orders for service in the West Indies was likely to be delayed unseasonably by waiting for the completion of repairs on her steam launch. In this emergency it gave me great pleasure to accede to a request from the chief of the Bureau of Construction and Repair to supply the Despatch with the Fish Hawk's launch and take the other in exchange when completed, as both were of the same character. No inconvenience resulted to either vessel by the exchange.

POST-OFFICE DEPARTMENT.—At various times during the year Mr. W. L. Nicholson, the topographer of the Department, furnished post-route maps.

INTERIOR DEPARTMENT.—The Commissioner of Patents has furnished copies of specifications of patents relating to the fisheries and fishery apparatus.

DEPARTMENT OF JUSTICE.—The Attorney-General, Hon. Wayne MacVeagh, instructed the district attorney of Massachusetts to advise with the Commissioner with reference to the interests at Gloucester and also to the acquisition of land at Wood's Holl.

COMMISSIONER OF PUBLIC BUILDINGS AND GROUNDS.—May 20, Col. A. F. Rockwell furnished the Commission with a quantity of iron fencing to be used at the carp ponds.

DISTRICT COMMISSIONERS.—The District Commissioners, May 31, issued a permit for extending a railroad track from the Baltimore and Potomac line to the Armory. Major Brock, Chief of Police, gave directions for removing squatters from the river front near the carp ponds. Dr. Smith Townshend, health officer, has furnished each month reports of the inspection of fresh fish for the District of Columbia.

RAILROADS.—At the close of this report will be found a list of railroads that have granted the privilege of carrying fish in their baggage cars during the year, in continuance of a custom which had been established for several years. The Fish Commission car having been com-

pleted in the spring, some special arrangements with reference to its rate of transportation were called for. On May 20 Mr. Isaac Hinckley, president of the Philadelphia, Wilmington and Baltimore road, offered the rate of 20 cents a mile for car and five messengers. This was shortly afterwards acceded to by the Pennsylvania Railroad, the Baltimore and Ohio, the Chicago, Burlington and Quincy, the Boston and Albany, the Cincinnati, Hamilton and Dayton, the Flint and Pere Marquette, the Illinois Central, the Louisville and Nashville, the New York, New Haven and Hartford, the Old Colony, the Pittsburgh, Fort Wayne and Chicago, the Terre Haute and Indianapolis, and the Vandalia line. The Union and Central Pacific railroads offered the rate of $370 for moving the car from Council Bluffs to San Francisco.

STEAMSHIPS.—The North German Lloyd steamer Donau, sailing in January, took out 20,000 land-locked salmon for Germany. December 20 the steamer for Panama took a can of carp for Arthur Morell at San José. In December the steamship Oder took 350,000 whitefish eggs for Germany.

WESTERN UNION TELEGRAPH COMPANY.—January 28 the operators of the Western Union were instructed to receive and transmit at Government rates, without prepayment, the messages on official business from the messengers of the Fish Commission.

FOREIGN COUNTRIES.—Of courtesies extended to the Commission by individuals or establishments in foreign countries, the following may be enumerated:

GERMANY—(*Saibling.*)—On the 23d of January an invoice of 60,000 saibling eggs (*Salmo salvelinus*) arrived from Burgomaster Schuster, of Freiburg, Germany, with a loss of but 5,000 eggs. The particulars of their treatment on arrival will be found on page XLV.

FRANCE—(*Gourami.*)—In August an effort was made by Monsieur L. Carbonnier to send a pair of live gourami to the United States, consigned to Mr. E. G. Blackford. Unfortunately, one died on the passage and the other a short time after reaching this country. Further reference to this experiment will be found on page LII.

ENGLAND—(*Turbot and sole.*)—In October Mr. C. L. Jackson, of Bolton, England, started 70 live soles and 35 turbot for the United States, in charge of A. Wilson Armistead. Of these, 67 soles and 29 turbot died on the passage, and there arrived, October 26, 3 soles and 6 turbot. These were taken charge of by Mr. Blackford, Mr. Mather, and Mr. Phillips, who deposited them off Long Island, nearly opposite the Hotel Brighton, on the day of their arrival. Further particulars of this will be found on page LIII.

## 4.—COURTESIES EXTENDED BY THE COMMISSION TO FOREIGN COUNTRIES.

During the present year, as in previous ones, considerable numbers of salmon, whitefish, and trout eggs have been sent abroad in exchange

for such species as it is considered desirable to import into the United States. These shipments have been generally successful, though sometimes attended with loss. This year, in addition, carp have been sent to a considerable number of countries.

GERMANY.—The whitefish eggs which were forwarded December 25, 1880, per steamer Donau, to the *Deutsche Fischerei-Verein*, of which Herr von Behr is the president, arrived in good condition on January 10 of the present year. On the 19th of March, 20,000 land-locked salmon eggs were forwarded to the *Verein* by the same steamer, and again, on the 8th of October, 350,000 eggs of California salmon, also by the Donau. The California salmon eggs reached Germany in good condition, and were hatched partly at Freiburg and partly in Hungary, the latter finding their final destination in the Danube.

On the 17th of December 20,000 eggs of lake trout were forwarded by the steamer Maine to Herr von Behr.

On the 26th of December there were shipped per steamer Oder, from New York, 300,000 whitefish eggs for the *Deutsche Fischerei-Verein*, and 12,000 whitefish eggs for G. L. Ebrecht, Geestemunde, near Bremen.

There were also forwarded on the same date and by the same steamer 20,000 lake-trout eggs for F. Busse, at Geestemunde, and 12,000 brook-trout eggs for G. L. Ebrecht. Mr. Busse has furnished us on previous occasions with collections of fishes from Germany from which to make plaster casts. Mr. Ebrecht has signified his intention of forwarding blue and golden carp in return for these eggs.

FRANCE.—On the 19th of March there were forwarded per steamer Donau, via Bremen, 20,000 salmon eggs, consigned to the *Société d'Acclimatation*. On the 25th of April the *Société* acknowledged their receipt in excellent condition, and stated that those sent in the previous year were doing well.

At the request of the secretary, M. Raveret-Wattel, there was forwarded, February 21, through the Bureau of International Exchanges a sample of Frank N. Clark's self-picking apparatus for the *Société d'Acclimatation*.

ENGLAND.—Correspondence was entered into early in the year with Hon. W. Oldham Chambers, honorary secretary, in reference to his obtaining from the Commission a consignment of eggs of the California salmon, the California trout, and the land-locked salmon. The floods in the McCloud River and the reduced number of land-locked salmon eggs, however, prevented any sending during the present year.

SCOTLAND.—On the 9th of November 25 leather carp were delivered in New York to A. Wilson Armistead, of Douglas Hall, near Dalbeattie, Scotland. After a very stormy voyage, he was able on the 22d of December to announce their safe arrival. He also took home with him 30 or 40 large black bass.

BELGIUM.—Correspondence has been maintained during the year

with Thomas Wilson, United States consul at Ghent, looking to the introduction of the American catfish into Belgium.

ECUADOR.—In May of the present year thirty carp were forwarded to E. G. Blackford, New York, who delivered them to Frederick Wesson, of 75 William street, for shipment to Ecuador. On the 21st of May they were forwarded per steamer Colon. On the 23d of August Mr. Wesson was able to announce that six of the carp had safely arrived and had been deposited in a lake on the estate of Señor Jijon, near Quito, although not until numerous difficulties had been overcome.

COSTA RICA.—In November Hon. William Hunter, of the State Department, made application in behalf of Arthur Morrell, United States consul in Costa Rica, for a can of living carp. These were forwarded to New York December 15, and left on the steamer of December 20 for Aspinwall, consigned to Mr. Morrell, at San José, Costa Rica. Dr. Bransford, of the Navy, was a passenger on the steamer, and kindly undertook to give them the necessary supervision on the voyage.

MEXICO.—Early in the year Maj. Gen. O. E. C. Ord took with him a supply of carp to the city of Mexico. News was received from him, March 10, of their safe arrival.

CANADA.—As on one or two previous occasions, carp were this year sent to Samuel Wilmot, superintendent of fisheries, Newcastle, Ontario. On December 31 he reported that they reached him in good condition.

## 5.—FISHERY EXHIBITIONS.

Last year a full account was given of the participation of the United States in the International Fishery Exhibition at Berlin, and of the safe return of the collections. These were in due time installed in the National Museum so far as practicable. On February 18, Congress passed a bill, which had been introduced by the Hon. J. G. Carlisle, to admit free of duty the vase which was awarded to the United States Fish Commissioner. On the 28th of February this bill was signed by the President and became a law. On the 30th of March the Hon. James G. Blaine, Secretary of State, transmitted the various medals and diplomas which had been awarded to the American Exhibitors. These were forwarded to the proper persons. During the year there was held a fishery exhibition at Norfolk, England, and another was announced for Edinburgh, Scotland, in 1882, in both of which the United States Commission was asked to participate, but it was necessary to decline the invitations.

## 6.—FISH COMMISSION BULLETIN.

On the 14th of February Congress, by joint resolution (House resolution No. 372), authorized the publication annually of a Bulletin of 500 pages, to contain the announcements of new observations, discov-

eries, and applications of fish-culture and fisheries. The following is a copy of the resolution:

JOINT RESOLUTION authorizing the Public Printer to print reports of the United States Fish Commissioner upon new discoveries in regard to fish-culture.

*Resolved by the Senate and House of Representatives of the United States of America in Congress assembled*, That the Public Printer be, and he hereby is, instructed to print and stereotype, from time to time, any matter furnished him by the United States Commissioner of Fish and Fisheries relative to new observations, discoveries, and applications connected with fish-culture and the fisheries, to be capable of being distributed in parts, and the whole to form an annual volume or bulletin not exceeding five hundred pages. The extra edition of said work shall consist of five thousand copies, of which two thousand five hundred shall be for the use of the House of Representatives, one thousand for the use of the Senate, and one thousand five hundred for the use of the Commissioner of Fish and Fisheries.

This Bulletin was introduced by an article of 16 pages, accompanied by 12 plates, upon the use of gill-nets in the cod-fishery, by Capt. J. W. Collins. Of this paper 1,500 extra copies were also published and distributed in pamphlet form. There were 109 different articles published in this Bulletin, among the more important of which were the following: Observations on the food of young whitefish, by Prof. S. A. Forbes; Notes on the development of stickleback, Spanish mackerel, shad, hippocampus, and silver gar, oysters, &c., by John A. Ryder; Notes on the cod, mackerel, and other fishes of Gloucester, by S. J. Martin; Notes on the life-history of the eel, by G. Brown Goode; Carangoid fisheries of the United States, by G. Brown Goode; The winter haddock fishery, by Goode and Collins; Changes in the fisheries of the Great Lakes, from 1870–'80, by C. W. Smiley; Notes on whitefish-hatching apparatus, by Frank N. Clark; Description of new species of fish, by Jordan and Gilbert; and A discussion on the disease among salmon in English waters, by Professor Huxley and S. Walpole.

## 7.—THE PROPOSED STEAMER ALBATROSS.

The steamer Fish Hawk, of the construction and performances of which a full account has been given in the present and preceding Reports, was built to serve as a floating station for hatching the eggs of shad and other fish, experience having shown that many important stations need to be occupied only for a short time, without the necessity of a permanent establishment. Thus, by means of a vessel like the Fish Hawk, work can be begun at the South in the winter or early spring, and the vessel moved, as the season advances, to more northerly points, carrying with it, of course, all its outfit and equipment, and

able to commence operations immediately on arriving at a suitable anchorage.

Provision having thus been made to utilize all possible opportunities for the propagation of food-fishes, by the establishing of movable as well as of permanent stations, the United States Fish Commission has endeavored to extend its sphere of operations in other directions, so as to render its work more and more useful to the country.

It is well known that the interests of the nation are closely identified with the prosperity of its fisheries, their extension and development furnishing a stimulus to all the industries connected with the waters. While supplying occupation to a large number of persons, the amount of the fish product is increased and the cost diminished.

In this connection may also be considered the increase in the number of persons accustomed to the use of boats and vessels, and furnishing in time of need the material for supplying the vessels of the United States Navy.

Referring to the next section of the present Report for the details of desirable research and for a presentation of the importance of constructing a suitable vessel for carrying on the work, I have to announce the approbation of Congress, as shown in an appropriation of $103,000 for the construction of a suitable steamer to be built for the use of the Fish Commission.

No Department having been designated to overlook its construction, the Secretary of the Treasury was asked to place the work under the direction of the Light-House Board, which had so ably supervised the building of the Fish Hawk. This having been granted, Mr. Charles W. Copeland was selected by the Board to prepare the necessary plans and specifications, so as to carry out the needs of the Commission. In this he had the assistance of Lieut. Z. L. Tanner, commander of the Fish Hawk, who was able to indicate important points to be provided for in connection with scientific work, as also of Engineer G. W. Baird.

The estimates of the cost of the vessel upon which the appropriation was based were made in the year 1880, but it was not until October, 1881, that it become possible to issue advertisements for proposals. By that time the price of iron and of labor had advanced very materially, and the appropriation was found to be inadequate, the bids for an iron steamer being severally as follows:

| | |
|---|---|
| H. A. Ramsey & Co., of Baltimore | $129,500 |
| Pusey & Jones, of Wilmington, Del | 130,800 |
| Harlan & Hollingsworth, of Wilmington, Del | 137,000 |

These figures being all far beyond the amount of the appropriation, it became necessary either to prepare plans for a smaller vessel or to defer further action until an additional appropriation could be made by Congress. The latter alternative was considered preferable.

## B.—INQUIRY INTO THE HISTORY AND STATISTICS OF FOOD-FISHES.

### 8.—PROPOSED INVESTIGATIONS INTO THE OFFSHORE FISHERY GROUNDS OF THE UNITED STATES.

Among the most important objects of a Government fishery commission is that of investigating the known fishing-grounds of a country, to determine accurately their extension and character, so as to define the circumstances and conditions under which the pursuit of the various species of fish can be prosecuted at the various seasons of the year, and also to ascertain what natural bait most attractive to the fish can be secured on the ground, and what can be most advantageously brought from a distance. This involves, also, the question of the methods of fishing most appropriate to the different localities.

A second object of such a commission should be the discovery and definition of new fishing-grounds, or such as had been previously unknown to the fishermen. Such undoubtedly exist, and from time to time are accidentally brought to light, some becoming of national importance. Incidental to this is the inquiry into the hitherto unknown winter abode of many of our valuable summer fishes, which are absent from our shores for several months of the year, as is the case with the mackerel, menhaden, bluefish, and many other species. An important corollary is to relieve the United States fishermen from their dependence upon the Canadian waters, either for fish or for bait; so that, even with the utmost probable development of the fishery marine of this country, it may find ample occupation in the waters directly off from our own coast, from Maine to Florida.

One general result of such stimulation and development will, of course, be found in a great increase in the number of sea-going fishing-vessels and the training of their crews to maritime adventure. Norway is the only country in Europe in which the Government has come to the aid of the fishermen in any notable degree, and the result of a moderate amount of attention by the State is shown by the immense development of the fishing industry. It is well known that Norway is supported by her fisheries to a greater extent than any other country, and that her exports constitute a great source of the fish supply of the world, her cod and herring being exported in immense quantities, not only over the whole of Europe, but even to the West Indies, and to Central and South America. The Loffoden Islands are the great winter spawning-grounds of the cod in the North Atlantic of Europe; and here, for four or five months of each year, the fishing industry is prosecuted to its utmost extent, the product being greater than that of America, including both the British provinces and the United States.

The Norwegian Government has for many years sustained a scientific commission for the purpose of studying carefully all possible methods

of protecting and developing her fisheries, and with distinguished success. It has, however, not been satisfied with its labors in the known grounds, but has for several years had a large steamer engaged in a thorough search for additional fishing-grounds, and although the Norwegian seas have been traversed by her fishing-vessels for hundreds of years, each year some new locality is discovered, made known and occupied, including the previously unknown summer abode of her winter fish.

This problem, so far as the offshores of the United States is concerned, is one that is eminently worthy of the attention of the United States Fish Commission and the support of Congress in its attempt to solve it. At present the principal grounds visited by the fishermen of the United States, excepting for mackerel, are found between latitudes 41° N. and 46° N., a breadth of only about five degrees, but extending eastward beyond the eastern edge of the Grand Banks. The special objects of search over these grounds are the cod and halibut; but the incessant prosecution of the business in one locality tends to diminish the supply and to lead to the inquiry for other banks not yet ascertained. A systematic investigation of the fishing-grounds will result in determining the exact depths at which the fish can be taken at different seasons of the year and the regions where this industry can be most profitably pursued.

Another, even more important, branch of the subject, is that of finding entirely new localities not previously explored. A notable instance of what may be done in this respect is seen in the case of the tile-fish, a species already mentioned. A few of these were accidentally taken by a Gloucester fishing-vessel in 1879, and like all strange fishes brought into that port, were delivered to an agent of the Fish Commission, who transmitted them to Washington. Here they were carefully investigated and found to constitute a very desirable as well as new genus and species of food-fish, and one entirely worthy of future attention. In September, 1880, the Fish Hawk proceeded to the locality where these fish were taken, about 75 miles south of Newport, and discovered that this was in the western edge of the Gulf Stream. On putting down the trawl-net the sea-bottom was found to be rich in animal life, beyond any previous experience of the Commission, the mass and variety being perfectly startling, and a large number of new species being readily secured in a short time. The quantity of crabs, shell-fish, &c., serving as food for fishes, was incalculable. The fishing-lines were then brought into requisition and the tile-fish found in abundance proportional to that of its food. The fish were then traced, in three successive trips of the vessel, along an extent of 60 miles, where they appeared to be as abundant as codfish on their banks, and were taken with even greater facility with the hook. The flesh was found to be most palatable, and to be capable of preservation by salting or drying, in the same way as the cod. A fish, therefore, which two years ago was entirely un-

known, even to the fishermen, now bids fair, when its distribution is better ascertained, to constitute a most important object of pursuit by the fishermen, and to have the especial advantage of occurring farther to the south than the localities in which the cod and halibut are abundant, and yet to be equally accessible from any part of the coast. It is extremely desirable therefore that this inquiry be prosecuted so as to ascertain exactly over what degrees of latitude the tile-fish occurs. A similar research in the waters to the south and southeast of New England will, in all probability, show much more accessible localities for the halibut and cod, especially in the winter season.

There is also a large field for investigation into new fishing-grounds off the coast of the Southern States; several fishes, such as the sea bass, the red snappers, &c., occurring there in great abundance, while a few localities only are known.

In time these investigations should be continued into the Gulf of Mexico (where there are vast possibilities of fisheries not yet developed), as well as on the Pacific coast of the United States. Here scarcely anything has been done, or is known, beyond the general fact that valuable stores of food-fishes exist in the sea, though the best fishing-grounds are not yet indicated.

An incidental result of winter explorations off the middle and southern coast of the United States, will be, in all probability, the discovery of the present winter grounds of certain fishes that are abundant near the shores only in the summer, but which are absent for from four to six months in entirely unknown winter quarters. These are especially the mackerel, the bluefish, the menhaden, the swordfish, the horse-mackerel, the shad, the salmon, the Spanish mackerel, &c. In all probability they are found in the same region with the tile-fish, as the researches of last summer showed that the food of all the fishes mentioned occurs in an inexhaustible quantity in the locality just indicated.

Norway has a very small area of ocean in which to prosecute her fisheries, compared with the United States, and a systematic investigation on the American side will undoubtedly produce results of greater comparative importance.

In the earlier years of the American fisheries and in the greater abundance of inshore fishes, with a comparatively slight demand in consequence of the small population of the country, and the difficulties of transporting the fish, it was quite possible to obtain within easy reach of our coast fish enough to meet all the requirements. Now, with a population of fifty millions of people, the great decline of the inshore fisheries, and the ability not only to transport fresh fish to any distance inland, without deterioration, but with also the growing demand for salted, dried, and canned fish, it is of the utmost importance that every facility be furnished to the fishermen in the prosecution of their business. The diminution of inshore fishing is particularly noticeable in the case of the halibut. This fish was formerly taken

with great ease in small boats all along the New England coast, and at first was considered of very little value, fish weighing a hundred pounds and over being caught and thrown back into the water as refuse, and classed in the same category with sharks, skates, and rays. Within a comparatively few years, however, the halibut has appreciated in value, and is now one of the principal objects of pursuit by the New England fishermen. The yield of this fish to Gloucester alone in 1879 amounted to over eleven millions of pounds.

In later years it has been necessary to follow the halibut into deeper and deeper waters, so that while twenty years ago it might be taken in water of 10 to 50 fathoms, it is now seldom caught in less than 100 fathoms, and deeper waters are gradually traversed up to 300 fathoms. The increasing depth renders it constantly more difficult for the fishermen to prosecute their labors, and makes it more important that new localities be discovered.

An important result of the research herein proposed will be the release in a greater or less degree from that dependence upon Canadian waters for fish and bait, for which the United States is now paying at the rate of $800,000 a year for twelve years, extending from 1873 to 1885. It is to be hoped that before the expiration of this period, and the meeting of a new commission, we will be in a position to decline any negotiations whatever for privileges much inferior in value to those possessed on our coast without any question of interference on the part of others. It is confidently believed that, in the discovery of new fishing banks and grounds, at a comparatively moderate distance from the coast, from Cape Cod to Florida, a large increase of the fishing fleet may be looked for, and that vessels from the ports of Jacksonville, Fernandina, Savannah, Charleston, Wilmington, Norfolk, &c., will find ample occupation throughout the year. That this will result in a great increase of the fishery marine is unquestionable; and in the continued diminution of the number and crews of merchant vessels of the United States, the question of securing and maintaining an ample sea-faring population, is one of no small moment to the political economist. The magnitude of the present industry is shown by the fact that the fishing fleet of Gloucester alone, consists of 385 vessels of above 5 tons, manned by 4,375 individuals, in large part consisting of men from Nova Scotia and New Brunswick. More southern crews will probably be more or less entirely American in their composition. The catch of these 385 vessels in 1880 is estimated at 129,620 barrels, or 25,924,000 pounds, of mackerel; 9,000,000 pounds of halibut, and 57,758,000 of salt cod, or other salt fish—an aggregate of 92,682,000 pounds, and this exclusive of a large quantity of other fish sold fresh. The total number of trips to secure the above-mentioned quantity of fish consisted of 1,430 to the George's Banks, 249 to the Grand and Western Banks for cod, and 261 to the same for halibut, a total of 1,940 trips. The necessity of new grounds for halibut is shown

by the fact that the number of this fish taken in 1879 was 11,336,716 pounds, a decrease of 2,336,716 pounds, or 20 per cent. in a single year.

An important consideration in connection with this problem of the expected fishing-grounds is the great increase in the demand for fish, consequent upon the success of the American display at the International Fishery Exposition at Berlin in 1880, as will be seen in another portion of this report. The American success was everything that could be desired, the display of this country being placed unhesitatingly at the very head of all others, although but a short time was allowed for its preparation. The quality and character of the American prepared fish attracted also deserved attention, and already engagements and contracts have been entered into between parties in Europe and the United States involving interests likely before long to amount to millions of dollars.

It may not be amiss, in this connection, to refer to the fact that the introduction by the United States Fish Commission to the American fishermen of the Norwegian system of taking codfish by means of gill-nets, with glass floats, has already become of the utmost value. Heretofore in the capture of codfish the question of bait has been the most important, ample opportunities frequently occurring for taking cod which cannot be utilized for the want of suitable bait. This rendered it necessary to resort to the British provinces for the purpose of obtaining it, and has caused almost entirely the recent difficulties between the fishermen of the two countries, which have been the subject of repeated diplomatic correspondence between the United States and Great Britain. When gill-nets can be used bait is unnecessary, and it is probable that within a few years three-fourths of the fish taken will be by gill-nets, and bait used only in localities where the net is not applicable.

The preliminary research by which the locality and relationships of the tile-fish were ascertained was prosecuted by the Fish Hawk, the fish-hatching steamer connected with the service of the United States Fish Commission. This vessel, in an interval of enforced inaction in her special work, made three trips to the edge of the Gulf Stream during the months of September and October, each time being but twelve hours on the ground. Not intended as a sea-going steamer, of course, it was not proper to run any risks, and it was simply on the occasion of a spell of settled weather that the vessel could run out one night to the grounds, spend a single day there, and return the next night, on each occasion being absent only thirty-six hours. To do the work properly requires a steamer that can remain off the coast in any weather, winter or summer. Such a vessel has been planned by Mr. C. W. Copeland, the naval constructor of the Light-House Board, in which are embodied all the requirements for a staunch sea-going vessel, as small as the service will permit, and able to do any work of this kind, and at the same time perfectly fitted for the hydrographic service of either the Coast

Survey or the Navy Department, to either of which branches of the service it can be transferred when no longer needed for the Fish Commission. The length of keel proposed is about 200 feet. Under the law of Congress she would be furnished by the Navy Department with officers and crew, otherwise not employed, so that the expense to the country will be little beyond that of construction, the vessel, of course, being available either in an emergency or permanently for the service of the Government in any Department other than that for which especially constructed. Provided with sails, such a vessel will be able to dispense with a large expenditure of coal. There is at present nothing of the kind belonging to the United States service, either in the Navy or Coast Survey, and her construction would furnish an important addition to the naval resources of the United States.

The method of research, in the interest of the fisheries, upon the proposed steamer, will consist in the use of the most approved apparatus for determinations of temperature, depths, and currents, and for collecting objects from the sea-bottom, from the surface, and for the depths midway; also in securing samples of the water at the different depths, for chemical and microscopical investigation. The temperature investigations will be of very great importance, as the distribution and migrations of fish are influenced by the variation of temperature in the waters inhabited by them.

An important problem for solution on such a vessel is the determination of the reasons why the menhaden, within the last few years, have almost entirely abandoned the coast of Maine, and indeed the whole region to the north of Cape Cod. Upon this fishery in the Gulf of Maine depends the livelihood of some two thousand men, and the success of an investment of between one and two million dollars. If this change in the habit of the fish is likely to be permanent, the sooner the fact is ascertained the better, that the industry may be transferred to some other quarter, since now its prosecution is attended with no other result than that of serious loss to those who are concerned in it. There is no question that the cause is a physical one and capable of determination.

A similar problem is that relating to the disappearance of mackerel in the Gulf of Saint Lawrence. It was for the privilege of participating in this fishery that the United States recently paid the onerous Halifax award. If we can determine the probability of a continued absence of fish from the Gulf before the next convention to consider the value of the Canadian fisheries to the United States, it will greatly simplify the impending negotiations.

Many other similar questions may be solved by the results of a thorough scientific inquiry, and it is not impossible that we may hope to establish general principles by which the fishermen each year may know at what points to meet the incoming schools of mackerel and menhaden, and save weeks of fruitless search for them.

As incidental to the economical inquiry, but of very great interest to the naturalist, will be the collecting of objects of natural history in large quantity otherwise unattainable. The investigations already made by the inshore explorations of the United States Fish Commission have added greatly to our knowledge of the biology of the sea, and enabled the Smithsonian Institution to distribute to the principal museums and universities of the country duplicate series of objects of great educational value to them.

With the larger field of investigation which will be accessible to a sea-going steamer, this material will be vastly increased, both in quantity and variety. This is shown by the fact that during the three days, or thirty-six hours in all, spent by the Fish Hawk on the tile-fish grounds, no less than 175 different species of shells were collected, of which more than one-fourth were entirely new to science.

The scientific aspect of deep-sea research is one that has occupied the attention of the principal nations of Europe, the British Government having a few years ago sent out one of her finest frigates on a three years' voyage in the seas of all parts of the globe, the results of which proved to be of very great interest and importance.

## 9.—THE FISHERY CENSUS OF 1880.

In pursuance of the arrangements made in 1879 with General F. A. Walker, Superintendent of the Tenth Census, particulars of which have been given in the two preceding reports, work upon the fishery division of the census was continued during the year 1881, under the general supervision of Mr. G. Brown Goode.

The plan of operations pursued has been published as an appendix to the Fish Commission Report of 1880, by the close of which year nearly all of the investigations were completed. The gathering of material from the eastern side of Buzzard's Bay, from the north shore of Long Island Sound, from the Pacific coast, from the shad and alewife rivers, and from the lobster, crab, and whale fisheries, extended into 1881, but was mostly finished in the early part of the year. The preparation of material for the press, which had advanced very satisfactorily in 1880, was pushed forward with vigor in 1881.

The following publications have been made:

1. On the 24th of May a bulletin (Census No. 176) was issued under the direction of Mr. Goode. This contained four tables giving statistics of the fisheries of California, Oregon, Washington, and Alaska. It included the cod, salmon, whale, seal, fur-seal, and shore fisheries, and also the marine salt industry. The tables show the number of men, boats, vessels, and other apparatus employed, and the quantity and value of the products, for the sections considered. These figures were compiled from the returns of David S. Jordan, James G. Swan, and T. H. Bean.

2. The second instalment of results appeared in Census Bulletin 261,

dated September 1, giving the statistics of the fisheries of the Great Lakes, from the material collected by Mr. Ludwig Kumlien. This series of sixteen tables relates to the various kinds of food-fishes which are taken from those lakes, such as whitefish, trout, herring, sturgeon, pike, &c., as well as the caviar, isinglass, and oil prepared in that region.

3. A larger bulletin (Census No. 278) covering 47 pages quarto was issued under date of November 22, 1881. It was prepared by Mr. R. Edward Earll, and contained the statistics of the fisheries of Maine. He incorporated with his own researches those of Mr. C. G. Atkins, Mr. W. A. Wilcox, and Capt. J. W. Collins. These figures relate to the cod, hake, haddock, pollock, cusk, mackerel, herring, lobster, and clam fisheries, and show the quantity and value of the fresh, dried, pickled, smoked, and canned products. The production of oil and dried sounds is also considered.

4. Under date of December 1, the statistics of the fisheries of Virginia were published in Census Bulletin No. 281. These were prepared by Col. Marshall McDonald, and include the fisheries for shad, herring, sturgeon, Spanish mackerel, bluefish, gray and salmon trout, sheepshead, crabs, clams, terrapin, and oysters, and the manufacture of oil and fertilizers from menhaden.

5. A monograph entitled "The Oyster Industry," by Mr. Ernest Ingersoll, was issued in the latter part of this year. It covers 250 quarto pages, and contains 13 plates.

Under the direction of Mr. C. W. Smiley, a series of 1,419 tables were completed and turned over to the Census Office for publication. These related to the imports and exports of fish in the United States from 1731 to the present time. This material was drawn from the State papers and other early records of the colonies and of the nation, and, since its organization, from the publications of the Bureau of Statistics of the Treasury Department.

A large amount of material ready for press, which could not be printed and issued during this year by the Census Office, was held over till another year.

## 10.—OCEAN TEMPERATURES.

The arrangement made with the Light-House Board in 1878, whereby the keepers of the light-houses at selected points upon the Atlantic coast have observed and recorded temperatures of the sea, has been continued during the present year, with instruments furnished for the most part by the United States Signal Office.

The points selected, as will be seen by the accompanying list, are those most favorably situated for obtaining the mean ocean temperatures along the coast. The work is done by the keepers without extra compensation, and too much credit cannot be given to them for performing this duty, in addition to that connected more directly with the Light-House Service. Their records have been of the utmost possible impor-

tance in throwing a flood of light upon many important problems in reference to the movements and migrations of our food-fishes.

The following is a list of the light-houses (with their keepers) at which temperatures have been observed during a portion or all of the present year:

*List of light-houses on the Atlantic coast at which ocean temperatures have been taken during the year* 1881, *together with the number of monthly reports made at each one.*

Petit Manan light-house, Petit Manan Island:
George L. Upton, Millbridge, Me ..... 11
Mount Desert light-house, Mount Desert Rock:
Amos B. Newman, Tremont, Me ..... 12
Matinicus Rock light-house, Penobscot Bay:
William G. Grant, Matinicus, Me ..... 12
Seguin light-house, Seguin Island, Kennebec River:
Thomas Day, Hunnewell's Point, Me ..... 12
Boone Island light-house:
Alfred J. Leavitt, box 808, Portsmouth, N. H ..... 12
Minot's Ledge light-house, Cohasset Rocks, Boston Bay:
Frank F. Martin, Cohasset, Mass ..... 12
Race Point light-house, Cape Cod Bay:
Heman F. Smith, Provincetown, Mass ..... 12
Pollock Rip light-station, entrance to Vineyard Sound:
Joseph Allen, jr., South Yarmouth, Mass ..... 8
Nantucket New South Shoal light-station, Davis New South Shoal:
Andrew J. Sandsbury, Nantucket, Mass ..... 12
Cross Rip light-station, Vineyard Sound:
James F. Chase, jr., Nantucket, Mass ..... 6
Buoy Depot, Government wharf, office inspector second division:
Benjamin J. Edwards, Wood's Holl, Mass ..... 12
Vineyard Sound light-station, Sow and Pigs Rocks:
William H. Doane, 13 Milk street, New Bedford, Mass ..... 11
Brenton's Reef light-station, off Brenton's Reef and Newport Harbor:
Charles D. Marsh, Newport, R. I ..... 12
Block Island light-house, southeast end of Block Island:
H. W. Clark, Block Island, R. I ..... 12
Bartlett's Reef light-station, Long Island Sound:
Daniel G. Tinker, New London, Conn ..... 12
Stratford Shoals light-house, Middle Ground, Long Island Sound:
James G. Scott, Port Jefferson, N. Y ..... 12
Fire Island light-house, south side of Long Island:
Seth R. Hubbard, Fire Island, N. Y ..... 12
Sandy Hook light-house, entrance to New York Bay:
James Cosgrove, 128 Rutledge street, Brooklyn, N. Y ..... 12
Absecom light-house, Absecom Inlet:
A. G. Wolfe, Atlantic City, N. J ..... 12
Five Fathom Bank light-station, off Delaware Bay:
Capt. John Reeves, Cape May City, N. J ..... 12
Fourteen-Foot Bank light-station, Delaware Bay:
John Lund, Wilmington, Del ..... 10
Winter-Quarter Shoal light-station, Chincoteague Island:
C. Lindermann, Chincoteague Island, Accomack County, Virginia ..... 12

## 11.—BIOLOGICAL RESEARCH.

The necessity of studying carefully the circumstances under which the development of the egg of the shad, salmon, &c., takes place, and the practical bearing of definite facts on this subject, induced the Commission to add, during the year, to its working force, Mr. John A. Ryder, a prominent member of the Academy of National Sciences of Philadelphia. This gentleman having given much attention to the microscopic work connected with the development of eggs of fishes and other animals, was able to render very important assistance. His labors during the year had relation more particularly to the eggs of the whitefish, the shad, the flounder, the white perch, the California salmon, the Penobscot salmon, and other species. On many of these subjects he prepared elaborate memoirs, some of which have already been published by the Commission in its Bulletin for 1881, and others will be published in the Appendix of the present Report.

Mr. Ryder's inquiry extended into the phenomena of the development of shad eggs on trays covered with wet flannel, as suggested by Colonel McDonald. The results of this research have promised to largely revolutionize the entire method of transporting eggs from the river stations to the hatching-houses.

## 12.—THE INTRODUCTION OF COD GILL-NETS.

The introduction of gill-nets in the shore cod-fisheries during the winter of 1880–'81 created a general and widespread interest among those concerned in fishing. The use of these nets was first suggested by the Commission in the winter of 1878–'79, but those first tried were not sufficiently strong for the capture of the large cod that frequent our coast in winter. This experiment has been described in an article by Mr. R. E. Earll, on the cod-fisheries of Cape Ann, published in the Report of the United States Fish Commission for 1878. He says: "The method of catching cod with gill-nets, though so successfully used by

the fishermen of Norway, has never been adopted by the fishermen of our coast. Knowing the profits derived from the use of these nets by those foreign fishermen, Professor Baird, who is ever anxious to introduce among the Americans any methods that will result to their advantage in the prosecution of the fisheries, decided to make experiments with them at Cape Ann, with a view to their introduction among our shore cod-fishermen. Accordingly he secured from parties in Norway a set of these nets and forwarded them to Gloucester to be thoroughly tested by the employés of the Commission at that place. They reached the hatchery when the pasture school was on the shore, and were set on the favorite fishing grounds a number of times. But the strength of the twine had probably been affected in transit, and the nets proved far too frail. The strong tide and rough water caused them to catch among the rocks, where they were badly damaged; while numerous holes indicated clearly that large fish had torn their way through the nets, only such being retained as had become completely rolled up in the twine. The nets were always taken from the water in bad order, but the capture of 800 pounds on one occasion, even under the circumstances, seemed to indicate that nets of sufficient strength might be used to good advantage, at least on the smooth fishing grounds along the coast."

Having made the preliminary trials with the nets, and demonstrated that with reasonably fair chances a good catch might be obtained with them, the offer to lend the nets to any responsible fisherman who would give them a fair and thorough trial was made. The manner of setting them was also explained to any persons who applied for information.

But fishermen are somewhat conservative, and do not hurriedly adopt new ideas about catching fish. They know that they can ill afford to waste time or money on questionable ventures. Whatever was the cause it appears that none of the fishermen showed a desire either that winter or the next to try the gill-nets.

When Captain Collins left for the Berlin International Fishery Exhibition in 1880 he received special instructions to study, from a practical standpoint, the Norwegian methods of using these nets, so that our fishermen might be provided with all the information that could be obtained. On his return he embodied the facts in a report on the methods of catching cod in Norway; giving, also, an account of the methods that have been tried by our fishermen, as these differ in some respects from those of the Norwegians. This has been published in the Fish Commission Bulletin for 1881.

Although the fruits of the work done by the Commission in 1878 did not immediately appear, the seed that was thus sown was destined in time to bear its legitimate fruit.

The difficulty of procuring a supply of bait is a source of great trouble to the shore fishermen, and its cost, even when it is obtainable, is so great that oftentimes the fishermen hesitate to invest, fearing that it

may result in loss rather than gain. Such was the feeling of Capt. George H. Martin, master of the Northern Eagle, of Gloucester, during the fall of 1880. For several years he had been engaged in the shore cod-fishery during the winter, but the prospect of getting sperling (small herring that are used for bait) appeared so uncertain that he hesitated about fitting out. His father, an employé of the Commission, and also an old fisherman, suggested gill-nets as a means of solving the problem. Together with several of his crew he visited the station of the Commission at Gloucester and examined the nets.

Before starting out on his first trip, he conferred with Capt. J. W. Collins, who had studied the Norwegian methods at Berlin. This resulted in his devising a plan whereby one man is enabled here to accomplish nearly the same amount of work as six in Norway. This new method is called "under-running," and is found to be an improvement. Nets of 10-inch mesh are set the same as herring nets, being suspended by hollow glass balls or floats at any required depth. They are usually left out several days at a time, the fishermen under-running them each morning, and taking out the fish that have been caught in the meshes during the night. None are caught except at night. The first trials proved successful, the Northern Eagle taking 4,000, 6,000, and 7,000 pounds, respectively, on her first three trips with nets, in spite of the weather being unfavorable. The nets first used, part of which had been lent by the Commission, were found too weak to resist the struggles of the larger cod, some of which weigh as much as 75 or 80 pounds each. The average weight of those taken in the nets is 23 pounds. Stronger nets were soon obtained, and their number was increased. At present the Northern Eagle carries 8 dories, each with a single man, who is provided with a gang of three nets, making a total of twenty-four nets for the crew. The nets are each 50 fathoms long and three fathoms deep, knit of salmon twine. Unexampled success has resulted from the use of these new nets. On a trip ending January 11th, 35,000 pounds of cod were taken by the crew of the Northern Eagle, 8,000 pounds of which were obtained in a single morning. Two other vessels, which were absent the same length of time, fishing at the same place, but in the old way, got only 4,000 and 5,000 pounds, respectively. Later, another trip was made by the same vessel, which was even more successful, when 35,000 pounds of cod were caught in four days' fishing, 18,000 pounds being taken in one day. The catch was three times as large as that of the trawlers fishing on the same ground.

At first the nets met with the same opposition from the trawlers that trawls had from the hand-line fishermen, when they were introduced, some thirty years ago. Although at first inclined to inveigh against "building a fence" to prevent the fish from reaching the trawls, &c., the fishermen soon began to realize its advantages. Whenever in port, the deck of the Northern Eagle would be crowded with fishermen anxious to learn about this new method of fishing. Letters from all along the

coast were received by the Boston net factories inquiring about the cod gill-nets. Allusion has been made to the difficulty of obtaining bait for the shore fisheries, its cost, &c. As an instance of this, the average bait bill of a vessel in the Gloucester shore fleet for the month of December, 1880, may be stated at $150, and the bait bill of the schooner Phantom for fifteen days was $380. This, added to the loss of time in seeking bait (often one-third), was a serious drawback. But the bait question is a still more important one to the bank fishermen, who have generally been obliged to seek it in the ports of the British Provinces. Great stress has been laid by the inhabitants of the provinces on the importance of this privilege to our fishermen.

Gill-nets have been used in the Norwegian cod fisheries for nearly two hundred years, and with good success. M. Friele, in an account of the fisheries of Norway, in 1877, says they are "quite indispensable when the cod does not bite," while, according to Mr. Hermann Baars, *Die Fischerei Industrie Norwegens*, Bergen, 1873, "the fatter the fish the less it is attracted by the bait, and during spawning season it scarcely ever takes the hook at all. For this reason the well-to-do fisherman is usually provided with nets as well as trawls. These nets are held upright in the water by means of floats of hollow glass, the invention of Merchant Christopher Faye, of Bergen. Sometimes, however, wood or cork is used. The glass floats are almost exclusively in use in all the Loffoden Islands." The importance of the use of gill-nets in the Norwegian cod-fisheries is shown in the following extracts from the official report of the superintendent, Niels Juel (first lieutenant in the navy), for 1878, giving the statistics, &c., of the Loffoden Island fisheries:

"The percentage of fishermen using different apparatus was as follows: 58 per cent. used nets; 32 per cent. used lines; 10 per cent. used deep-bait. There was an increase from last year of 2,542 in the number of net fishermen. There was an average of 3,725 boats employed, of which 2,154 boats, carrying 13,168 men, were engaged in fishing with gill-nets. The total catch for 1878 was 24,660,000 cod in number, of which upwards of 14,000,000 of the largest were caught with nets."

The net-fishing has since increased, according to Mr. Hermann Baars, who says: "In 1879 the following enumeration was made: 2,532 boats, with crews numbering 14,322 men, fitted out for the net-fishery." He further says that "usually the boats fishing with nets obtain the greatest net receipts, since these often sell 10,000 to 12,000 fish, 10 to 12 barrels of oil, and 10 barrels of roe, valued at 2,500 marks ($595.24), and at least 400 marks ($95.24) to each man. A net yield of 350 marks a head is considered by the trawl-line fishermen very satisfactory." These remarkable results are obtained by fishing in open boats in the dead of winter north of the arctic circle. What may we not hope for under more favorable circumstances? Of this Mr. Baars says: "But it must be remembered that the stormy weather, which often lasts for weeks at

a time in the winter months at this region, often renders it impossible for the fishermen to go out to sea. As a rule, fishing cannot be carried on more than two days in a week."

## 13.—THE VALUE OF FISH AS FOOD.

In a previous Report reference was made to the results of a series of elaborate chemical investigations by Prof. W. O. Atwater, of Middletown, Conn., into the absolute and comparative value of fish as food. This work has been continued during the year on an increased scale, and it is expected that his next report will contain some additional data of much interest.

## 14.—WORK DONE AT WOOD'S HOLL, MASS., IN 1881.

*Advantages as a permanent sea-coast station of the United States Fish Commission.*—From the inception of the work of the Commission in 1871 it has been the custom to select some station on the sea-coast from which to prosecute the researches required by Congress into the scientific and economical problems connected with the sea and its inhabitants; the stations, as already indicated, covering the coast from the Bay of Fundy to Long Island Sound. In this way the peculiarities of the inshores have been well determined and the geographical distribution of the fishes, mollusks, crustacea, radiates, &c., properly marked out. In addition to the discovery of a great many new species, much light has been thrown upon the whole subject of marine zoology generally.

It is not to be supposed that everything in this connection has been learned; but the broad features have been determined, and the minor details can be safely left to local and special researches.

The acquisition of a sea-going steamer in the Fish Hawk, and the hope of obtaining a still more serviceable vessel, rendered it expedient to fix upon some point for permanent occupation where the necessary facilities for the maritime work of the Commission could be obtained. The southern side of New England was considered better than the eastern, as permitting investigation for a longer period and presenting a much richer fauna. The best conditions for the propagation of marine fishes were also found on the southern coast of New England, as fish are in greater variety, and, so far as the winter hatching is concerned, the cold is less severe, and other circumstances generally were more favorable.

By the use of a suitable fishing smack, the fish can be brought in alive and penned up until they are ready to yield their eggs, and in this way will be exposed to much less danger from destruction by cold than proved to be the case at Gloucester.

After a careful consideration of the subject, the choice was found to lie between Newport and Wood's Holl. Newport has a great many advantages in its accessibility, and in the very great desire manifested by its citizens to secure the presence of the United States Fish Com-

mission. A number of gentlemen, of whom Mr. J. M. K. Southwick was spokesman, offered to furnish the requisite buildings, and also the use of a suitable wharf, and otherwise to encourage the selection of the station. The Navy Department also gave the Commission a provisional invitation to establish itself on the northern end of Coasters' Harbor Island, which was not required for the purposes of the training school.

The great difficulty in the way of Newport, however, was found to be in the comparative impurity of the water, Narragansett Bay receiving the drainage of a number of large cities, such as Newport, Fall River, Bristol, Providence, &c., and also having extensive mud bottoms and flats. The experience of the year 1880 showed that the abounding impurities would settle as a sediment upon the eggs of the fishes to be hatched and materially impair their development, as was found to be the case at Gloucester.

A totally different condition of things was found at Wood's Holl, where the water is exceptionally pure and free from sediment, and where the sudden tide rushing through the Wood's Holl passage keeps the water in a state of healthy oxygenation especially favorable for biological research. The entire lack of sewage, owing to the remoteness of large cities, and the absence of large rivers tending to reduce the salinity of the water, constitute a strong argument in its favor, and this station was finally fixed upon for the purpose in question.

The quarters occupied by the Commission at Wood's Holl, furnished by the courtesy of the Light-House Board, are too scanty for the expected work of the Commission in the future, and measures were immediately instituted to obtain foothold on the Great Harbor. Here a point of land constituting the neck of the upper harbor was fixed upon as a suitable location, affording the advantage of pure and very deep water, accessible to vessels of quite unusual draught, and immediately adjacent to the rapid tide of the passage.

Negotiations were opened with the owners of the ground, Messrs. Isaiah Spindel & Co., and a provisional agreement made as to the price and conditions of the purchase, the details of which will be given in the next Report.

*Work of the year* 1881 *at Wood's Holl.*—Pending the permanent establishment of the Commission at Wood's Holl, as explained in the preceding section, that station was selected for the work of 1881, and, by the renewed courtesy of the Light-House Board, the old quarters on the Light-House wharf were secured and fitted for occupation.

As the Government wharf was unable to furnish a berth for the steamer Fish Hawk, the private wharf of Isaiah Spindel & Co. was leased for the purpose. The requisite accommodations for board and lodging for the party were obtained with considerable difficulty, but finally the necessary arrangements were completed.

I reached the station on the 8th of July, being joined soon after by the remainder of the party.

As in previous years, Professor Verrill, of Yale College, had charge of the work connected with the marine invertebrates, and Dr. Tarleton H. Bean of the fishes, in this being assisted by Mr. Peter Parker. Other assistants were Prof. L. A. Lee, of Bowdoin College, Mr. Sanderson Smith, Mr. James H. Emerton, and others. Capt. H. C. Chester had general charge of the buildings, assisted by Vinal N. Edwards, of Wood's Holl.

During the summer the usual branches of research were prosecuted under the direction of the several chiefs, and a great deal of valuable information collected, some of which will be furnished in the form of monographic papers, and the rest presented in the pages of the Reports of the Commission or in the Fishery Division of the United States Census of 1880.

One of the most practical results of the work of the season was the investigation into the area of distribution and the economical qualities of the *tile-fish*. This species was first brought to light by the casual capture of some specimens in 1879 by Captain Kirby, of Gloucester, Mass., who carried them into that city, where they were secured by the Fish Commission, which had a station there at the time. As explained in the previous Report, the ground was investigated by the Fish Hawk in 1880, and a number of specimens captured.

During 1881 special efforts were made to define the limitation and area of this fish. It was found to occur on the edge of the continental plateau, and in abundance equal to that of codfish on the fishing banks. It is confidently believed that a large part of the fish supply of New York and Boston could readily be furnished from this species. Careful tests were made of its qualities as a food-fish, not only on board the vessel and at Wood's Holl, but by distributing them among the New York experts, through Mr. E. G. Blackford. The reports were uniformly favorable; one gentleman characterizing the fish as having hard meat and sweet and juicy as any game fish he ever met with; another ranking it above sheeps-head, as being more juicy and better flavored.

The work accomplished by the Fish Hawk, to which a great deal of the success of the summer was due, will be referred to under a subsequent heading.

The season was closed by my departure on the 4th of October, the Fish Hawk proceeding to Washington with her collections and apparatus, stopping, however, at New Haven to discharge the packages containing specimens for Professor Verrill.

## 15.—EXPLORATIONS OF THE FISH HAWK.

With the exception of the years 1872 and 1876, when the Commissioner was necessarily otherwise occupied, the Navy Department, in compliance with law, has, since 1871, furnished the Commission with a steamer for its summer work. The first detail of this kind was that of a small steam-launch in 1871. In 1873, 1874, and 1875, the steamer

Blue Light, under command of Captain Beardsley, was made use of; in 1877 the Speedwell, under command of Commander Kellogg; the same vessel again in 1878, under command of Captain Beardsley, and again in 1879, under command of Lieut. Z. L. Tanner.

The appropriation by Congress for a special steamer—the Fish Hawk—completed in the spring of 1880, enabled the Commission to dispense with the naval steamer, but it gladly embraced the privilege of calling upon the Department for a detail of officers and crew.

The first service of this vessel, under command of Lieut. Z. L. Tanner, was rendered at Newport in 1880, the Report of which year contains an account of her work on this occasion. The off-shore exploration, however, was limited to two or three trips, the results of which were so interesting as to induce great expectations from the renewal of these labors in 1881.

It will be remembered, as stated in the last Report, that the water deepens very slowly for a considerable distance off the coast, from Cape Cod southward; so that a depth of 100 fathoms is, for the most part, only attainable at a distance, out, of from 75 to 100 miles. This brings us to the edge of the continental plateau; and beyond that there is usually an abrupt declivity, showing rapidly deepening water.

On her expeditions in 1880 the Fish Hawk found that the edge of this slope or declivity was occupied by an extremely rich fauna, both as to species and individuals; indeed, far exceeding in this respect any of the regions nearer the land; and the necessary arrangements were made to renew work in that vicinity during 1881.

On her return to Washington in 1880 she was sent to Point Lookout to obtain a supply of oysters for the oyster-hatching station at Saint Jerome; and the ice forming before she could return, obliged her to winter in the Norfolk navy-yard. Returning, however, from that point in February, she was fitted out with shad-hatching apparatus, and on the 23d of March was ordered to Avoca, a shad-fishing station at the mouth of the Roanoke River in Albemarle Sound. Here she remained until the 30th of April, carrying on her work, and obtaining many courtesies from Dr. W. R. Capehart, the owner of the station. The vessel reached Havre de Grace on the 3d of May, and was occupied until the 5th of June in hatching shad at the head of Chesapeake Bay.

On the 13th of June she again proceeded to Saint Jerome to make experiments in connection with the hatching of Spanish mackerel, but started for Washington on the 20th of June, having left her work at that place in charge of Col. M. McDonald.

The details of her labors in connection with shad and Spanish mackerel will be found in the second division of this Report.

After a short stay at the navy-yard in Washington undergoing repairs, she took on board the apparatus for the deep-sea research, and left for Wood's Holl on the 7th of July, arriving there on the 10th.

From that time until the 4th of October numerous trips were made

to the localities near the Gulf Stream, referred to as having been visited in 1880, and many very interesting results were secured. In the supplementary portion of this Report will be found a popular statement of this work, consisting of the substance of an address by Prof. L. A. Lee, one of the scientific party. A special list of the fishes collected during the season, prepared by Dr. Bean, is also appended.

The steamer arrived at Washington on the 12th of October, and the offer of her services was at once embraced by the Navy Department, in connection with the naval and military celebration at Yorktown, from October 7 to October 20. She was placed by the Secretary of the Navy at the service of the Secretary of War. Having been absent several days, upon returning to Washington, she went into winter quarters at the navy-yard, where she was thoroughly repaired and put in readiness for the work of 1882.

A full description of the vessel and her outfit, together with the details of her work during 1880 and 1881, furnished by her commander, Lieut. Z. L. Tanner, will be found in the Appendix of the present Report.

## C.—THE PROPAGATION OF FOOD-FISHES.

It has already been shown that, while the original object of establishing the United States Fish Commission was the investigation of the alleged decrease of the food-fishes of the United States, during the second year of its existence it was charged by Congress with the added duty of increasing the supply, and of stocking the waters with suitable additional species of economical value. At the present time much the larger part of the expenditure of time and money on the part of the Commission is in the last-mentioned direction.

### 16.—THE METHOD OF DISTRIBUTION OF FISH AND EGGS.

In the beginning of the work of the Commission, in connection with the introduction of food-fishes into new waters, it was entirely possible to cover all the service by placing the fish in cans and employing suitably trained messengers to accompany them to such points of deposit as might have been selected.

All the railroads of the country with scarcely an exception, when applied to, gave instructions to allow the transportation, in baggage-cars, free of extra charge, of the cans containing the young fish, and granted access to the same on the part of the messengers; instructions being given, in many cases, to stop the car at stations near rivers or streams to allow the introduction of the fish therein. This was specially the case with the shad, and where the annual production amounted to but a few millions it became quite possible to accomplish all that was necessary by this means. As, however, the supply of young fish increased, partly in consequence of the increase in the scale of operations and partly from the increase in the supply, caused by the

work of the Commission, this was found to be inadequate, especially as one messenger was unable to carry satisfactorily more than ten or twelve cans, containing from 100,000 to 150,000 fish. The possibility of obtaining a larger number of fish than at first, made it practicable also to test the theory which the Commission has been gradually reaching, that the number of fish likely to survive the attacks of their enemies when planted in a river is increasingly proportionate to the total number introduced, or rather that the expectancy of destruction, in a given locality, is essentially an absolute quantity dependent upon the existing number of minnows and other predaceous fish. Thus, if the expectancy of destruction be estimated at 100,000 young fish, we will have none left to grow up from a deposit of 100,000 fish. If, however, we introduce 200,000 fish, then we may claim a surplus of 100,000. It is highly probable that the larger the number introduced the greater will be the percentage of survivals.

Where we can introduce a car-load of fish instead of a tenth or twentieth of that quantity, our chances of success in stocking waters are probably increased far beyond the difference in the ratio.

When the available supply of young shad increased to an extent of perhaps a million a day, for a number of days in succession, the method of transportation mentioned above proved to be entirely inadequate, and the experiment was made of filling an entire baggage-car with fish cans and forwarding it to destination, accompanied by a suitable number of messengers. This was done was done with the kind assistance of President Hinckley, of the Philadelphia, Wilmington and Baltimore Railroad, and subsequently of the officers of the Baltimore and Ohio Railroad.

It was in time found that even this plan was insufficient, as it was not always possible to obtain the cars, and these were not provided with the necessary facilities for keeping the fish in good condition. It was at length determined either to build a new car, or to adapt an old one of proper character to this express purpose, and an arrangement was finally made with President Hinckley to refit one of the best baggage-cars belonging to his company, and sell it to the Commission, when completed, at cost.

This car was fitted up by Mr. J. H. Ridgway, of Philadelphia, as a refrigerator car, and was provided with living and sleeping rooms at either end for the accommodation of the messengers. It was also supplied with air-brakes, Miller platform, six-wheeled trucks, &c., by means of which it could be moved on passenger trains.

As thus arranged, the car is capable of carrying from one to two millions of fish at a load and five messengers. The details of its construction will be given hereafter.

The car reached Washington from the shops on the 7th of May, and made a trial trip on the 2d of June to Atlanta, Ga., with shad. Owing, however, to the difficulty experienced in changing the trucks at Lynch-

burg, it returned to Washington after depositing the fish in the James River.

On the 15th of June a load of 1,150,000 fish was transported to Maine from the hatchery at Havre de Grace, and introduced successfully into the Kennebec and Mattawamkeag Rivers.

The experience of these trips suggested some additional changes, which were made in the course of the summer; and in the middle of October the car was again used, this time for distributing carp.

In December, it was determined to use the car for transporting a supply of carp to Texas, Arkansas, Louisiana, and Missouri. There were 950 applicants to be supplied in Texas alone. There were placed on board the car forty large cans, each containing one hundred carp, and seven containing one hundred and fifty carp each. There were also placed on board eighteen crates, each containing sixteen small tin pails. As each pail contained twenty carp, each crate would thus contain three hundred and twenty carp. In addition, there were three crates containing four hundred carp each. This made a total of twelve thousand carp. The car was not ready to leave, however, until January 3, 1882, when it was moved by the Pennsylvania Railroad from Washington to Saint Louis, in charge of Colonel Marshal McDonald. The first distributions were made from Saint Louis; after which the car proceeded to Texarkana, from which point applicants in Arkansas were supplied. Similar stops were made at Shreveport, La., Sherman, Tex., Dallas, Tex., Austin, Tex., &c. A full account of this trip, as also of a previous one to Kentucky in November, will be found in the report of Mr. McDonald in the Appendix.

## 17.—SPECIES OF FISH CULTIVATED AND DISTRIBUTED IN 1881.

*a.* **Whitefish** (*Coregonus albus*).

*Northville Station.*—The work at this station, under the charge of Mr. Frank N. Clark, as heretofore, has been prosecuted with increased vigor. A number of improvements have been made in the arrangements for supplying water, and an increased hatching capacity has been obtained. Four new ponds (20 by 83 feet) were constructed during the summer. The total number of whitefish eggs handled during the season of 1881–'82 was 22,500,000, against 14,780,000 for the previous season. The spawn-taking operations were carried on from November 10 to December 5, the points selected being North Bass Island, Middle Bass Island, and Kelley's Island, in Lake Erie. Although the last eggs which reached the hatchery were allowed to remain in the shipping cases for ten days after their arrival, pending the fitting up of additional hatching-jars, there was no increased loss noticeable.

The Chase automatic jar was used in place of the hatching-box in the incubation of the eggs, and experiments were made with a view to obtaining a still more reliable apparatus. The "Improved Shad Hatcher" was found to give a better movement to the eggs, and useful

modifications of this and of the Chase jar were devised by Mr. Clark's assistants. One of these gentlemen, Mr. Seymour Bower, invented a new form of hatching-box which possesses advantages.

The number of whitefish eggs shipped was 2,032,000. Shipments were made to Germany and France, and to the States of California, Connecticut, Iowa, and New Jersey. Over 17,700,000 young fish were released in the waters of the Great Lake system, the deposits being made in Lake Michigan, Lake Huron, the Detroit River, Lake Erie, and Lake Ontario.

*b.* **Brook Trout** (*Salvelinus fontinalis*).

*Northville Station.*—The ponds for brook trout at Northville, Mich., have been greatly enlarged and improved, and four new ones have been added to the three already existing, so that their total area is now 10,674 square feet. About 140,000 eggs were obtained from the trout in the ponds during the spawning season, which lasts from the beginning of November to the middle of January. Shipments of eggs were made to France and to the Druid Hill hatchery in Baltimore; 20,000 young fish were planted in neighboring streams, and 30,000 were shipped East by the Fish Commission car. It is expected that half a million brook-trout eggs will be taken next season.

*c.* **Saibling** (*Salmo salvelinus*).

On January 10, Mr. Schuster, Burgomaster of Freiburg, Germany, announced that he had sent 60,000 saibling eggs by the North German Lloyds steamer Mosel, of January 8, consigned to the United States Fish Commission. These reached New York January 22. Mr. Fred. Mather took charge of them and forwarded them the next day to Mr. A. H. Powers, Plymouth, N. H., which point they reached on the 24th. The entire loss while crossing the ocean and being transported to the hatchery was but 5,000 eggs. Mr. Powers was directed to hatch them and place them in Newfound Lake, located 7 miles from Plymouth. The eggs were all hatched by February 28, with a loss in hatching of 6,515 eggs. Mr. Powers deposited 30,000 fry in Newfound Lake May 18.

Another installment of saibling eggs was announced by Herr Max von dem Borne February 3. These were lost in transit.

*d.* **Lake Trout** (*Cristivomer namaycush*).

*Northville Station.*—While waiting for the whitefish to begin spawning, 57,000 lake-trout eggs were obtained for this station, of which 52,000 were shipped and 1,400 hatched and retained at the hatchery. Of those shipped, 20,000 were forwarded to Germany.

*e.* **The Quinnat or California Salmon** (*Salmo quinnat*).

*The McCloud River Station.*—The work at this place has been under the direction of Mr. Livingston Stone, whose detailed report will be found in the Appendix. The establishment met with a serious disaster on the 3d of February. January had been attended by a rainfall

wholly unprecedented in that region, the total amount for the season being placed at 109.7 inches. During the first days of February the rain continued to fall in torrents, and the McCloud River to rise at the rate of a foot an hour. During the night of February 2 the water rose above the danger-mark, and at half-past two in the morning of February 3 the buildings of the station were swept away. All the improvements which had accumulated since 1872 were thus demolished in a night. The water reached a maximum height of 26 feet 8 inches above its summer level.

At the instance of Senator Booth, of California, an appropriation of $10,000 for rebuilding the station was made by Congress, March 5, and the work of restoration, beginning in May, was completed in September. At the time of the disaster the work was in charge of Mr. Myron Green. Mr. Stone reached the fishery May 19 and superintended the reconstruction, as well as the taking of eggs in the fall, which amounted to 7,500,000. Several millions of these eggs were sent to the commissioners of various States to hatch for local waters, as well as to Canada and New South Wales. Particulars of the distribution are found in the tables appended to this report.

*f.* **Rainbow or California Mountain Trout** (*Salmo irideus*).

*The McCloud River Station.*—This fishery was first operated in July, 1879, and like the salmon station has been continuously under the direction of Mr. L. Stone. It is located near the mouth of Crook's Creek, a tributary of the McCloud River, and about 4 miles distant from Baird Post-office. The station suffered at the time of the flood from a deluge of mud which was precipitated into the ponds, and by which many of the trout were killed.

The region is subject to land slides. The steep hillsides becoming thoroughly saturated with water, whole acres are washed into the valley below. Sometimes the creek is completely dammed up thereby and the water is rendered intensely muddy. To shut off this water from the trout ponds would be as fatal as to admit it, so that the catastrophe to the trout was unavoidable. Many which were not actually killed were seriously injured by mud getting into the gills and producing inflammation. The occurrence of the flood just as the trout were beginning to spawn made the matter still more unfortunate. Only about a thousand trout survived. From these, however, 261,000 eggs were obtained, 179,900 of which were sent to the commissioners of various States to be hatched. During October and November the losses of trout were made up as far as possible by fishing in the river. A new pond was also constructed for the purpose of catching the mud which was brought down by water in the rainy season. The year closed with brighter prospects for the future.

*g.* **Atlantic or Penobscot Salmon** (*Salmo salar.*)

*Penobscot River Station.*—This station, as heretofore, was carried on by the United States conjointly with the States of Maine, Massachusetts,

and Connecticut, and under the continued superintendence of Mr. Charles G. Atkins. Between June 1 and July 2 he purchased from the fishermen 514 salmon, averaging 16½ pounds each. These were placed in the inclosure prepared for them, to await the spawning season in October. An unusual number, 146, died during this interval, most of the deaths occurring, however, in June and July. The first eggs were taken October 26, and, between this date and the 17th of November, 358 fish were manipulated, of which 232 were females and 126 were males. They produced 515 pounds of spawn. The number of eggs was estimated at 2,693,009, or an average of 11,608 eggs from each female. In August and September of this year Mr. Atkins made an important improvement by conducting cold water from a brook through an aqueduct 1,600 feet long. The water previously received from springs near the hatchery attained so high a temperature that in former years the eggs were matured early in December. Under the new arrangement, their development was retarded until the middle of January. The first shipments of eggs were made January 16, 1882, and continued at the convenience of the consignees until March 13, 1882. The total number of eggs shipped was 2,611,500, of which 1,006,500 belonged to the United States. The loss in shipping and hatching out the eggs was very slight, and 2,397,132 were actually planted, as shown by the tables. From the United States quota eggs were sent to New York, Pennsylvania, New Jersey, Minnesota, and Virginia. The full report of Mr. Atkins will be found in the Appendix.

*h.* **Schoodic or Land-locked Salmon** (*Salmo salar*, subs. *sebago*).

*Grand Lake Stream Station.*—Conjointly with the States of Maine, New Hampshire, Massachusetts, and Connecticut, this station was this year again occupied by the United States Fish Commission, under direction of Mr. Atkins, who commenced his work at Grand Lake, September 10, 1881.

Grand Lake is situated upon the western branch of the Saint Croix River, known as Schoodic River. Its water is exceedingly pure, and attains a depth of 100 feet. Its outlet, the Grand Lake Stream, is frequented by this species of salmon in October and November, for the purpose of spawning. As a net can be stretched across this outlet at that time, it is not necessary to hold the fish in confinement for several months, as is the case with the Penobscot salmon.

Hatchery No. 3, which was constructed last year, became the principal scene of operations this year. When originally built it was but 30 feet long. Mr. Atkins has this year added wings, which very largely increase its capacity. The nets were placed across the stream, as usual, about the middle of September. The capture of salmon began October 31. The manipulating of spawning fish continued until its completion of the season, November 19. Six hundred and fifty-three females and three hundred and seventy males, a total of 1,023, were utilized. A total of

947,000 eggs were taken, being an average of 1,525 for each female. Between January 12, 1882, and March 10, 1882, eggs were shipped to the States which were in partnership, and, in behalf of the United States, to New York, New Jersey, Pennsylvania, Vermont, Maryland, Michigan, Iowa, Missouri, Wisconsin, and California; in addition to these 20,000 were sent to Fred. Mather for shipment to Germany. The United States' share of eggs was 311,750. About 215,000 eggs were retained at the hatchery, from which 213,097 young fish were hatched and planted in Grand Lake. The diary of the station, as well as full particulars of the work, have been reported by Mr. Atkins, and will be found in the Appendix. The hatching and distribution of eggs necessarily extends into the following year. This renders it desirable to anticipate dates, to some extent, in this report, in order to show the completion of the work inaugurated in 1881.

*i.* **The Shad** (*Alosa sapidissima*).

As has already been stated on page XVI, six stations were operated for shad work this season, three of these conjointly with the Maryland Commission, the entire yield of which was 70,035,000 young shad. Of this amount 46,518,500 were deposited in the waters near the various hatcheries and 23,516,500 transferred to 18 different States of the Union. This yield of seventy millions was unprecedentedly large, that of 1880 falling a little short of thirty millions, and that of 1879 being less than twenty millions. This increase in production was due, first, to the increased efficiency of the methods and apparatus of the Commission; and, second, to the favorable fishing season both on the Potomac and Susquehanna Rivers.

On the afternoon and evening of May 27, President Garfield made a trip down the Potomac on board the Lookout to witness the shad operations.

The completion of a special car for the operations of the Commission gave facilities, heretofore not enjoyed, for moving a large quantity of shad to distant waters. On the 1st of June a car was loaded at Havre de Grace with one million of shad for the waters of Georgia, but, owing to the break of gauge and the impossibility of obtaining suitable trucks, the fish were deposited in the James River, at Lynchburg. On the 3d of June 1,500,000 fry were placed in the car and consigned to General J. R. Hawley and Dr. W. M. Hudson, for deposit in Connecticut waters. It reached Hartford on June 4, accompanied by General Hawley and Mr. Davidson, the local superintendent, and was moved by special train to Warehouse Point, 13½ miles above Hartford, where the fish were successfully deposited in the Connecticut River. On the 14th of June the car was again loaded, partly from the navy-yard and partly from Havre de Grace, with 1,150,000 shad, consigned to the Maine commissioners, who had secured free freight over the Boston and Maine Rail-

road. The shad were met at Bangor by Mr. E. M. Stillwell, and a part were deposited in the Kennebec and part in the Mattawamkeag Rivers. On the 24th of June there were placed on board the car at the Washington navy-yard 1,140,000 shad, which were taken to Dubuque, Iowa, and deposited in the Mississippi River. The distribution to other States was by the old method of placing the fish in cans to be transferred in the baggage cars of passenger trains under the care of messengers.

*Avoca Station.*—Dr. Capehart having offered to furnish eggs from the spawning shad at his fishery, the Fish Hawk, was ordered, in April, to proceed, with suitable hatching apparatus on board, to Capehart Wharf, on Salmon Creek, North Carolina. The first eggs (66,000 in number) were obtained April 12, but were lost in handling. Eggs were taken nearly every day from that time to April 30, or 5,727,000 in all. From these 1,328,000 fry were hatched and released in local waters on April 29 and 30. Some eggs were also transferred to the North Carolina commissioner, Mr. S. G. Worth, for hatching and deposit in other parts of the State. The season having advanced sufficiently for work farther north, the Fish Hawk was ordered on May 2 to proceed to Havre de Grace.

*Potomac River Barges.*—Simultaneously with that in North Carolina, work was begun the middle of April at Gunston's, on the Potomac River, Col. M. McDonald in charge. The first eggs (125,000 in number) were taken on the 20th of April, and continued to be taken in increasing quantities, the maximum being reached on May 18, at which date 4,870,000 were secured. Over three millions were gathered May 7 and also May 24. The last were taken May 29. These eggs were hatched out with some loss, but supplied a deposit of 26,515,000 fish in the Potomac River, and about six millions sent to other waters. The work closed May 30, at which time Colonel McDonald was transferred to the charge of the navy-yard station at Washington.

*Washington Navy-Yard Station.*—This station was opened May 4 with Frank L. Donnelly in charge, eggs being brought to it from various fishing shores on the river. The first fish were hatched May 10, and 85,000 were transferred to Cumberland, Md., for deposit in the upper waters of the Potomac. From this station instalments of from 100,000 to 200,000 each were sent to Delaware, South Carolina, Maryland, Ohio, and Kentucky. By June 2d, 3,280,000 fry had been produced, at which date the station was turned over to Colonel McDonald. Between June 2d and June 25th, 3,840,000 eggs were received from the gill-netters of the Potomac, which yielded 3,800,000 fry. Colonel McDonald improved the opportunity to experiment in the transportation of eggs upon trays covered with moistened flannel, and reached some very satisfactory results. He succeeded in carrying the eggs forward almost to the point of hatching, while stratified in layers.

The Potomac shad work was completed July 1, and Launch No. 55,

which had been kindly lent by the Navy Department, was returned to the commandant of the yard.

*Battery Island Station.*—Mr. Frank N. Clark was directed to leave the Northville Station in charge of Mr. Seymour Bower and to proceed to Havre de Grace. He arrived at the station about April 15 and immediately commenced preparations for the season's work. No eggs were taken, however, until about the 10th of May. Between that time and June 13 over 15,000,000 eggs were obtained and 13,560,000 hatched, of which number 8,385,000 were released in local waters and 5,175,000 transported to other points. Included in the latter were 3,500,000 which the Pennsylvania commission took charge of and deposited in the headwaters and tributaries of the Susquehanna River. Mr. Clark conducted some extended experiments in retarding the development of the eggs of shad during the season, a report of which will be found in the Appendix. This retardation is considered very desirable as a possible solution of oceanic transportation. Mr. John A. Ryder was also present at the station during several weeks and conducted some important embryological experiments. Several papers from his pen will be found in the Appendix of this volume. On the 17th of June the season closed at Havre de Grace, and Mr. Clark returned to Northville.

*North East River Station.*—The steamer Fish Hawk, upon leaving Avoca, proceeded to the North East River, where it arrived May 3. Lieut. Tanner commenced taking eggs on the 5th of May and continued until the 4th of June with gratifying success. On the 16th of June he directed the removal of the Fish Hawk from the station then occupied to a point near the Battery in order to haul the thousand-fathom seine which had been obtained. On the 29th of May the station was visited by the Commissioners, accompanied by Major Ferguson. Lieut. Tanner obtained in all 15,444,000 eggs. Of the young fish, over 10,000,000 were released in the Susquehanna and about 2,500,000 transported to other waters.

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

The production and distribution of carp has been carried on more extensively this year than in any previous one, the number of applications having also very greatly increased. Over 7,000 applications were filed during the year, 5,758 of which were supplied with from 15 to 20 fish each; the total number of carp thus used was 143,696. There were 1,244 additional applications filed which it was impossible to supply in the year 1881.

*The Monument Station.*—On the 12th of February the ponds in the Monument Lot were visited by a flood considerably exceeding anything that was ever before experienced. The water stood 9 feet above the level of the banks of the ponds, and was 4 feet deep in the guard-house. On this occasion the city was flooded even to Pennsylvania avenue, and the street in front of the Smithsonian grounds was filled with water to

so great a depth as to stop all movement of vehicles. Fortunately, the water was cold enough to drive the carp to the bottom of the ponds close to the mud, so that not very many of the breeding-fish escaped.

March 30 an edition of 1,000 copies of Mr. Rudolph Hessel's paper on the cultivation of carp was ordered from the Public Printer for distribution to persons applying for information. This treatise was reprinted in the London Fishing Gazette.

In April, at the request of the Commissioner, Maj. W. J. Twining, the Engineer Commissioner of the District advertised for bids for constructing an additional carp pond. B. J. Coyle & Co. proved to be the lowest bidders, and the contract was awarded to them April 13. This action was in pursuance of an appropriation by the Forty-sixth Congress, second session, of "$12,000 for the construction of an additional carp pond." Including the one in question there are now 20 acres of water devoted to the cultivation of carp. The grading of the pond was completed December 28.

During the summer, many fish born in 1879 spawned abundantly; indeed, in some cases, fish of 1880 produced an abundance of fry. Superintendent Hessel succeeded in the artificial impregnation of carp, having during June many thousands in his hatching-trays. Some of his young fish, only twelve and fifteen days old, acquired a length of from 3 to 4 inches.

On the 31st of May Mr. George Eckardt arrived from Germany with two cases of carp-eggs. These had been sent by his father, Mr. R. Eckardt, of Lübbinchen, with a view of testing the feasibility of transportation across the ocean. Unfortunately, the eggs were found to be dead and covered with fungus. They were packed in ice, which probably destroyed them, as they are extremely sensitive to cold. On the other hand, without ice the eggs would probably have been hatched prematurely.

In September we were confronted with the problem of distributing an enormous number of carp in small quotas to numerous applicants. An ordinary 10-gallon milk-can had hitherto been found most suitable for their transportation in lots of twenty-five or thirty. This method, however, being expensive and not entirely satisfactory, Colonel McDonald tried the experiment in November of shipping carp in small tin pails. As the result, he found that 20 carp could be inclosed in a tin pail of 6 quarts capacity, when half full of water, and be kept alive two or three days. This led to a radical change in the methods of shipping, and a great saving of expense. Sixteen pails containing 20 carp each were put into a crate and sent by express almost as readily as the single 10 gallon can had been sent. In December the new car was brought into requisition, and being loaded with carp was sent to Missouri and Texas, as has been explained under that heading.

*The Arsenal Ponds.*—On the 4th of June Mr. Elliot Jones reported

the stock of carp in the ponds at the Arsenal the previous autumn to have been as follows:

In the large pond:

15 breeding scale carp, weighing from 2 to 3 pounds each.
1,422 scale carp, of 1879, weighing from 5 to 20 ounces each.

In the small pond:

6 breeding leather carp, weighing from 1 pound 10 ounces to 2 pounds 1 ounce.
242 scale carp, of 1879, weighing 5 ounces each, and
62 mirror carp, of 1879, weighing 5 ounces each.

At this date Mr. Jones was ordered from Washington, and Lieutenant Smith, of the Quartermaster's Department, will hereafter, have charge of these ponds. Richard Lynch, the Arsenal gardener, has the personal oversight of them.

*k.* **Gourami** (*Osphromenus olfax*).

In my last Report I presented several reasons why the gourami would be a desirable species to introduce into the United States, and spoke of the efforts of the *Société d'Acclimatation*, with the aid of a French resident of Saigon, Cochin China, to supply the United States Fish Commission with this fish, as also of the arrangement made with Mr. B. B. Redding to place what might thus be obtained in a lake near San Gabriel, Cal. No result has so far been obtained from this effort.

Monsieur L. Carbonnier, of Paris, having received some specimens from Mauritius, forwarded a pair to the United States through Captain Briand, of the French steamship line, who arrived at New York August 19. Unfortunately one of the fish had died during the passage. The other was delivered to Mr. E. G. Blackford to care for until suitable arrangements could be made. It died, however, early in September, some ten or fifteen days after its arrival.

*l.* **Cod** (*Gadus morrhua*).

*Wood's Holl Station.*—In November, 1880, Capt. H. C. Chester went to Wood's Holl, Mass., with a view of continuing experiments in cod-hatching. Later in the season, Colonel McDonald was directed to take charge of the station and to test some apparatus which he had arranged. He was accompanied by Mr. John A. Ryder, who made some valuable experiments upon the embryology of the cod. Mr. Ryder's report, with numerous illustrations, will be published as an Appendix of the Report for 1882. The experiments were somewhat limited, as only a single lot of spawning-fish was obtained in that locality. In one experiment with 40,000 eggs, Colonel McDonald hatched 25,000 fry. These fish were sent to Annapolis, Md., and deposited in Chesapeake Bay. An account of his operations and of the apparatus which he used will be found in the Appendix. On the 8th of March the station was closed and the apparatus returned to Washington.

m. **The Spanish Mackerel** (*Cybium maculatum*).

*Chesapeake Bay.*—The account of the discovery of spawning-mackerel and the work of hatching them, conducted by Mr. R. E. Earll, was given in full in the last Annual Report. In order to continue the experiments, the Fish Hawk, on the 15th of June, took on board a special outfit for hatching Spanish mackerel. On the 14th it proceeded down the river and arrived at Cherrystone Inlet on the 15th, accompanied by Launch No. 62, which had been ordered from Havre de Grace. The pound-nets of the fishermen were visited, and on the 17th live eggs were taken and placed in hatching-cones. Eggs were also taken on subsequent days, but the hatching was not successful, most of the fish and eggs dying. The particulars of the work of the Fish Hawk will be found in Captain Tanner's report for the year.

On the 29th of June the Fish Hawk left for Washington, turning over the launch, however, to Col. Marshall McDonald, who had arrived to prosecute the experiments still further, with instructions to work out as fully as possible the proper methods without endeavoring to turn out any considerable number of fish during the present season. He was accompanied by Mr. John A. Ryder, who studied the embryology of the fish, and has made a somewhat full report, with four plates, upon "The development of the Spanish mackerel," in the Bulletin of 1881, pages 155–172. On the 26th of July it became necessary to return the borrowed launch to the Navy Department. The work was soon after closed, and Colonel McDonald returned to Washington. A short paper upon his work will appear in the Appendix.

n. **Turbot and Sole** (*Rhombus maximus* and *Solea vulgaris*).

The turbot and sole are generally considered to be the best fish in Europe, commanding a higher price than any other, exclusive of the salmon; and the question is frequently asked as to the intentions of the Commission in regard to introducing and propagating them on the shores of the United States.

By those best qualified to judge, these fish are not considered to possess any marked superiority over corresponding forms of the flat fish found in the United States, which, when properly cooked, are of very great excellence. Many persons, thoroughly familiar with the turbot and sole, who have been present at one of the famous fish dinners given by Mr. Taft, of Point Shirley, Mass., and who have tasted the Northern flat-fish (*Pleuronectes americanus*) and the Southern flounder (*Paralichthys dentatus*), as served by him, stoutly deny any and every claim of superiority in the first-mentioned fish.

Appreciating, however, the interest of the problem, which if solved would simply add to the species of desirable food-fishes in the United States without interfering with the abundance of those belonging to it, the Commission has several times made efforts to introduce both the turbot and the sole into the United States.

The first experiment of importation was made by the United States

Fish Commission in 1878, when Mr. Fred. Mather was instructed to bring over from England thirty specimens collected by Mr. C. L. Jackson, of Bolton, England. During the voyage to Boston most of the fish perished, as it was believed, in consequence of the well-meant but inauspicious action of the boatswain of the Cunard steamer in introducing very cold water, the shock destroying the fish. Only two turbot survived, which were deposited in Massachusetts Bay.

The second experiment, also under Mr. Mather, was made in 1879. This was entirely a failure; the fish all dying, having been injured, it was thought, by the land transportation from Southport to Southampton.

In April, 1880, Captain Mortimer, of the ship Hamilton Fish, brought five sole out of nine sent by Mr. Moore, of the Derby Museum; and these were deposited by Mr. Blackford outside of Sandy Hook.

On the present occasion the Commission again had the important aid of Mr. C. L. Jackson, of Bolton, England, who undertook to collect a number of turbot and sole, and acclimate them in the tanks of the Southport Aquarium. A large number died, but those that survived appeared to be in very good condition, and were shipped from Liverpool on the Cunard steamer Parthia on October 15, in charge of Mr. Armistead. The fish were carried in two oval wooden tanks 5 feet 6 inches long, 4 feet wide, and 2½ feet deep, each tank sub-divided into four spaces, so as to prevent undue agitation during the passage. A cask was set on the top of each, and filled every day with sea-water, and a circulation of the water maintained thereby.

The temperature of the water at Southport on starting was 53½°. During the voyage the range of temperature of the water in the tanks was from 51° to 58°.

Starting with seventy soles and thirty-five turbot, sixty-seven soles and twenty-nine turbot died on the way; three of the former and six of the latter alone surviving.

In response to an application from the Commission, the Secretary of the Treasury directed the collector of customs at New York to have the revenue-steamer Grant in readiness for the immediate transfer. A party of gentlemen interested in the experiment, consisting among others of Mr. E. G. Blackford, Mr. Barnet Phillips, Mr. John Foord, and others, were on board the Grant; and the nine fish were placed in cans and transferred to the ocean in Sheepshead Bay, just opposite the Oriental Hotel, in water about 2 fathoms deep.

It is, of course, impossible to tell what may be the fate of these fish, but the chances are very few that they will ever be heard of again.

After a careful consideration of the whole problem, it is believed that the only chance of successful experiment is to place such fish on arrival in an inclosed basin of tidal water of suitable character, where they can be fed, and guarded against any possible enemies; and where, when ripe, the eggs can be taken and, after artificial impregnation, be hatched out in accordance with the methods adopted for the floating eggs of the sea fish. This is one of the several problems to be solved in connection

with the proposed sea-fish hatching station at Wood's Holl. The facilities there will be excellent for the purpose, and it is hoped that the experiment may be made at the earliest possible moment.

The following report of results, made by Mr. A. Wilson Armistead to Mr. C. L. Jackson, of Bolton, England, will probably be of interest:

It is with sorrow that I have now to inform you of the sad ending of nearly all the fish. However, I do not think it is by any means a lost journey for the Americans. From what I have seen, I feel satisfied the thing can be done. Inclosed you will find an account I have kept, showing changes of temperature, losses, &c., which speaks for itself. You will notice the fish began to die very soon after leaving Liverpool, and when I examined them the first thing noticeable was their sickly appearance, and when examined more closely I could trace scars or bruises which were not observed at the Southport Aquarium.

I am now confident that the fishes must have been injured in their journey down to the landing stage from Liverpool Station, as the jolting about, owing to the bad road, was very severe, and in any future attempt that may be made, I am quite sure that this short part of the journey must be made in some other way. When the largest tank was filled with sea-water, after the carpenter had fixed the cross-pieces, all seemed right until the following day, when the sun's rays falling upon the surface of the water revealed what appeared to be small splinters, very minute, floating about, which had to be got rid of, as they might be bad for the fish by getting lodged in their gills; but I could not discover that any fish had been choked, with but one doubtful exception. This was a large turbot, and appeared as though it had been choked, but I could not find anything in the gills or about the throat to satisfy me.

As to the voyage itself, we had both rough and fine weather. The hole in the largest tank is rather too wide. The water overflowed several times while we had rough weather, and we could only keep it filled up to the cross-pieces. I do not think the fish suffered much by the rolling about of the steamer, unless it be the fish have pressure put upon them when the steamer is heaving upward. I have thought about this a great deal, and have come to the conclusion that the fish do experience a slight pressure, not so great as to injure them, but which, if long continued, might make them sickly. The water was changed every morning, except when the temperature of the sea rose considerably when passing the Gulf Stream currents. You will see that on Monday morning, October 24, when the water in the tanks stood at 51°, in the sea it was 61°, and at 2 p. m. same day it had risen as high as 68°, so I considered it wisest to keep the water I had.

Wood, I fear, is not good for fish to lie upon. I would recommend that the tank be either charred all over inside, or a coating of Portland cement, with about two or three parts sand, which, when well set, to be thoroughly seasoned by placing it in the sea for, say, two or three months; a very thin coating would do. As to procuring the fish, in the first instance, I believe a good deal hinges upon this for making the thing a success. If caught in a trawl-net, I believe that the net should be hauled up at short intervals; this, I expect, would necessitate a trawl-boat to fish expressly for live soles or turbot, and would be more costly, but decidedly more satisfactory. Indeed, I should not like myself to make another venture across the Atlantic unless I could be sure that the fishermen intrusted with the catching of the fish could be relied upon. The best way would be to see them caught one's self.

I do wish I had been in a position to give you a more satisfactory result. Under the circumstances, all that could be has been done. Captain McKay, John Atkins, chief officer, and Mr. Field, the purser, all connected with the steamer, have been very good to me. I am sure they are sorry for the poor result and would like to have seen the experiment successful. I liked Captain McKay very much, and so did all the passengers; and if ever another attempt is made with living fishes, whoever goes out with them I trust may have the same captain.

STEAMER PARTHIA, *October* 26, 1881.

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

Within a few years past special attention has been paid by the Commission to various features connected with the artificial cultivation of the oyster, Major Ferguson having visited France in 1878 to study the details of the business as practiced in that country.

Reference has already been made, in the list of stations of the United States Fish Commission, to Saint Jerome as a station for the artificial cultivation of the oyster. This is located not far from Point Lookout, near the mouth of the Potomac River, and was first established by Major Ferguson while Commissioner of Fisheries of Maryland, and subsequently carried on at the joint expense of the Maryland Commission and the United States Fish Commission. Here it is proposed to establish a system of parks and other arrangements similar to those adopted in France; and, in addition, to test practically the possibilities of the artificial impregnation of the eggs of the oyster and the production of spat at will, a measure not satisfactorily accomplished in Europe.

Lieut. Francis Winslow, of the Navy Department, having been occupied in collecting statistics of the oyster industry for the Census of 1880, continued his labors in the service of the United States Fish Commission by authority of the Secretary of the Navy. His researches will be duly published when they are completed.

By the courtesy of Mr. E. G. Blackford, of New York, a great variety of living oysters of the different breeds was imported from Europe, and placed in the hands of Mr. John A. Ryder for investigation. The special problem was to ascertain how far the European oysters, including the German, French, Portuguese, and English natives, and the green oysters, differed in character from the American; and thus to determine whether processes applicable to the former were suitable for the latter. Some very interesting facts ascertained by Mr. Ryder will be duly made the subject of a report.

p. **The Oregon Clam** (*Glycimeris generosa*).

On the Pacific coast there are several species of bivalve mollusks, coming under the general head of clams, which are of very great value in their localities, and which it has been thought might be profitably introduced to the Atlantic coast.

One of the most important of these is the *Glycimeris generosa*, known by the Indians as the Geoduck, a clam found in California, Oregon, and Washington Territory, and which reaches an enormous size, retaining, however, a great tenderness and delicacy of flesh, much more resembling that of the oyster than of the clam. Correspondence has been entered into with Mr. Henry Hemphill in regard to obtaining and shipping a quantity of these clams for experiment, but it was finally concluded that it would be better to wait the occasion of a return trip of the fish-transportation car of the Commission before attempting a sending.

Several other species of western clams are also under consideration for a similar purpose.

## D.—ABSTRACT OF CONTENTS OF APPENDIX.

### 18.—ANALYSIS.

In the general Appendix to this report will be found a number of separate papers treating upon matters related to the work of the Fish Commission. These are classified under four headings, as follows:

### A.—GENERAL.

The first paper is by Lieut. Z. L. Tanner, and gives a thorough description of the Fish Hawk, illustrated by eighteen plates. This is followed by an account of the Fish Hawk's work during the second year; and, finally, by a list of patents issued in the United States during the year relating to fish and fisheries. The latter is by Dr. R. G. Dyrenforth, chief examiner of the Patent Office.

### B.—FISHERIES.

First under this head is a paper upon the mackerel fishery, by Messrs. Goode, Collins, Earll, and Clark. It embodies all that the Fish Commission has heretofore collected upon the subject, covering some 440 pages, and provided with a special index. An extra edition has been issued, in pamphlet form, for distribution to persons interested in this fishery. Two translations by Dr. Bean furnish the statistics of the Norwegian fisheries for the year 1880. There is a review of the early shad fisheries on the Susquehanna, by Harrison Wright; a reprint from the London Quarterly Review upon the fish-supply of London; and a report, by Charles W. Smiley, upon the extent to which fish-guano is used as a fertilizer in the United States.

### C.—NATURAL HISTORY AND BIOLOGICAL RESEARCH.

Prof. H. E. Webster and Mr. James E. Benedict, of Union College, furnish a report on the worms collected by them at the Fish Commission station at Provincetown in 1879, which is accompanied by eight plates and a special index. Messrs. John A. Ryder, and S. A. Forbes report upon the food of fishes; and Messrs. F. N. Clark, H. J. Rice, and John A. Ryder upon experiments designed to retard the development of shad eggs, with a view to facilitate their transportation.

### D.—PROPAGATION OF FOOD-FISHES.

Under this head will be found detailed and statistical reports upon the work of the United States Fish Commission in propagating and distributing food-fishes, such as shad, whitefish, trout, and several kinds of salmon, by F. N. Clark, Livingston Stone, Charles G. Atkins, and Charles W. Smiley.

## E.—SUPPLEMENT TO REPORT PROPER.

### 19.—ON THE WORK OF THE FISH HAWK AND OF THE UNITED STATES FISH COMMISSION DURING THE YEAR 1881, BY PROF. LESLIE A. LEE, OF BOWDOIN COLLEGE.*

The Fish Hawk is fully equipped with all necessary apparatus for conducting the investigations. The experience of the Commission has been so great that the apparatus for dredging, trawling, &c., is probably more perfectly adapted for its purposes than any which has been used elsewhere. Many important improvements have been suggested from time to time by members of the Commission, and changes are continually being made. Perhaps the most important addition to the apparatus this season was in the "trawl-wings." A large net-trawl is used more than anything else for obtaining bottom animals, and it has long been supposed that many of the more active ones escaped capture by swimming to one side after being aroused by the on-coming trawl. To capture these the trawl-wings were contrived. These are light nets which are attached to rods which run out on each side from the top of the trawl. The nets are fitted within with a transverse partition, perforated in the center, which prevents the escape of the animals after they are once confined. This arrangement was a complete success, many new species being taken by it.

But not all the energies of the Commission are devoted to the collection of specimens. Careful soundings are made by which the existing charts are often corrected. The temperature of the water is taken at all depths, particularly at the surface and bottom; and the specific gravity of the bottom water is determined. In fact a complete record is made of everything which can be supposed to have a bearing upon the subjects before the Commission.

Upon the prospect of pleasant weather the party would go aboard of the Fish Hawk and proceed directly to the southward, remaining off shore for from two to four days. Nine such trips were made during the past season. The Gulf Stream off the coast of Southern New England is situated about 100 miles from land. Its distinctness as a stream is well indicated by the soundings. The depth of the water from Gay Head outward is very uniform for nearly 90 miles, not more than 50 fathoms often occurring. Then comes the beginning of the slope. Within 10 or 15 miles 1,000 fathoms and probably greater depths can be reached. The work of the Commission was done in depths of less than 800 fathoms.

Upon reaching suitable ground, as indicated by the soundings, the trawl or dredge would be put over and allowed to drag on the bottom for perhaps twenty minutes. Or, if fish were desired particularly, the line-trawl, similar to that used by cod-fishermen, would be set. Upon

* From a paper read before the Portland Society of Natural History January 16, 1882.

making a haul with the net-trawl, the first thing to impress one is the wonderful abundance of life present, in both species and individuals. Nowhere in the previous history of the Commission have such results been obtained, surprising alike to the novice and the experienced. The bottom in this region is usually soft, and is composed of sand and mud, with many foraminifera, both calcareous and arenaceous. Much of the mud is brought up in the trawl, which at times must sink deeply into it. Within the trawl when it comes to the surface, the conspicuous features are the echinoderms, fishes, crustaceans, and annelids.

Of the many sorts of fishes taken, perhaps the several species of hake were the most abundant. The trawl often contained bushels of these, which, however, were usually of small size. Cod, haddock, and whiting were not so common, but good sized specimens sometimes occurred. Many of the species, particularly of the genera *Careproctus* and *Liparis*, were very soft and gelatinous, and could be preserved only by being dropped at once into strong alcohol. These occurred mostly at the greater depths, where they would naturally not be exposed to conditions requiring a more perfect protection. The most important species taken was the tile-fish. This was first discovered here in 1878 by a passing fisherman. A few were caught in 1880 by the Commission, and during the past season particularly attention was paid to this species, to determine whether its quality and abundance are such as to lead it to become an important food-fish. Trawl-lines were therefore set at different depths and localities, and special efforts were made to determine its limits. It was found to exist everywhere, from Cape Cod to Delaware (which is probably not its southern limit), in a depth of about 100 fathoms, and is nearly as abundant as all other kinds together. It is of large size, averaging in weight from 12 to 20 pounds, the largest taken weighing about 50 pounds. The color above is violaceous, and below light gray. On the back and sides are scattered bright yellow spots, each about an inch in diameter. What chiefly distinguishes it from other genera is the fact that it has a dorsal fleshy lobe just back of the head. It has been named *Lopholatilus chamæleonticeps* Goode and Bean. The flesh is white and firm and free from bones. The quality is very fine, so that it cannot fail of becoming a good market fish. It remains now for the fishermen to develop here a new industry.

Crustacea occur in large numbers and furnish an abundant supply of food for all kinds of fishes. They are mostly northern forms. Many have previously been known from the Norwegian coast, and others have close affinities to northern species. Several species which Stimpson long ago described from single or few small or imperfect specimens were re-discovered in abundance and of large size. Decapods largely predominate, particularly shrimps and anomurans. Hundreds and thousands of specimens were brought up in nearly every haul. The largest yet taken is a crab, *Geryon quinquedens* Smith, first described from specimens in the collection of this society, which were taken from the

stomachs of the fishes caught on our coast. This species, in life, is of a brilliant vermilion color. The carapax is often 6 inches in diameter. To some individuals were attached two species of stalked barnacles, one being the type of a new genus. An anomuran, *Latreillia elegans* Roux, is certainly an elegant species. The carapax is triangular in shape and rarely more than an inch in length, while the legs extend 4 or 5 inches on each side. The eyes are at the ends of stalks half as long as the carapax. The legs are banded alternately with bright red and light pink. One of the most interesting of the crustaceans was a hermit crab, *Parapagurus pilosimanus* Smith. This was first described in 1879 from a single specimen brought in by a fisherman from the Banks. We found it in great abundance, 500 specimens being taken at a single haul. This forms the type of a new family as well as of a new genus. It possesses characters hitherto unknown in its group, having gills in the form of papillæ instead of lamellæ as in most hermit crabs. The carcinœcium was originally a shell, as is commonly the case, but a compound polyp with a tough leathery integument soon becomes attached to the shell and extends beyond it, growing as the crab grows, often in time completely absorbing the shell. This polyp is also new to science, forming the type of a new genus. It is interesting to note that this crustacean and the polyp have never been found separated. While there are many other species of the hermit crabs in the same region, this polyp is never found upon any of them, and this crab is never protected by any other of the numerous species of polyps which abound.

Hitherto few species of Cephalopods have been found on our coast, but many new and interesting forms were taken during the past summer. The largest was *Alloposus mollis* Verrill, of which we took two specimens, each about three feet long and weighing 25 or 30 pounds. It belongs to the eight-armed group, and the arms are united throughout nearly their entire length by a muscular web. Its suckers are over half an inch in diameter. The body is very soft and gelatinous. It shrinks exceedingly when put into alcohol and is reduced to not more than one-third of its original weight. Such an animal would hardly seem to be a formidable enemy. This is also the type of a new genus. A species described by Sars from the Norwegian coast was taken sparingly. This closely resembles the common squid of our shores, but the tentacular arms, besides possessing the usual suckers, are supplied with horny hooks, giving it a fearful advantage in the struggles with its prey. A species described by Le Seur in 1821, *Taonius pavo*, also occurred, not having been seen on our coast since that time. This is well deserving of the name "goggle-eyed squid," its eyes being altogether out of proportion to the body. Fragments of the shells of the paper nautilus were frequently dredged, but the animal itself was not taken. Two or three living specimens have lately occurred on the New Jersey coast.

Each haul brought up an abundance of Echinoderms, mainly star-fishes. The number of new species taken was considerable. Certain forms were so plenty that they were cast overboard again by the bushel. Many curious modifications of structure occur among them. An interesting form, *Diplopteraster multipes* Verrill, is large and thick, with short arms, a rich purple above, beneath orange streaked with brown, the feet large and purple and arranged in four rows. Twenty species of star-fish were taken at one haul. Sea-urchins were not abundant, only a few species being taken. Some of these, however, were new and remarkable. Among them is a large species hitherto known only from off Florida. Several others were northern forms.

Annelids and other worms occurred in great variety. One new species was perhaps more plenty than any other form of life in those depths. It has been named *Hyalinœcia artifex* Verrill. In general appearance this is something like the common clam-worm, *Nereis*. But it secretes a tube 10 or 12 inches in length, of a horny substance, quill-like, amber-colored, sometimes one-third of an inch in diameter. The tubes containing the animal probably lie loosely on the bottom, but it is likely that the animal is sometimes able to swim about, dragging its tube behind. Often the trawl came up filled with their tubes. The large sea-mouse, *Aphrodita*, which is often found on our own coast, was also plentiful.

The forms of life thus far described are mostly those which have hitherto occurred only in the colder regions of the North Atlantic or those which show strong affinities to northern forms. We now come to the shell-bearing mollusca, and another wonderful variety of forms is discovered. The alliances of some of these are with tropical species, many being represented by similar species in the West Indies. The new form of rake-dredge did good service in the collecting of shells, nearly every haul bringing up something new. Conspicuous among the new species is a Trochus-like form, *Calliostoma Bairdii* V. and S., by far the handsomest shell found on the New England coast. This presents a decidedly tropical aspect. Two species of *Solarium* also occurred, both of small size. Another shell taken sparingly was *Dolium Bairdii* V. and S., a representative of a genus one would hardly expect here. These are all Gasteropods. The Lamellibranchs present, among many others, three genera new to the coast and remarkable for their close affinities to fossil forms. These are *Diplodonta*, *Mytilimeria*, and *Pholadomya*. Of the latter there is only one other living species, which occurs on the coast of Africa. Mingled with these were a large number of northern species of shells. In all, more than 200 species of mollusks were taken, of which more than 100 were additions to the American fauna, and nearly 75 new to science.

A surprising feature of life at the bottom is the large number of sea-anemones, some being of great size. They are attached to everything.

Even the tubes of *Hyalinœcia* give support to a peculiar species. The larger ones hold firmly enough to the mud bottom since they are subject to no wave action.

One species of sea-pen, *Pennatula aculeata* Dan., was taken in great abundance on several occasions. A very delicate branching coral, *Acanella Normani* Verrill, often covered the net with its orange-red branches. A simple, horn-shaped coral, *Parasmilia Lymani*, was secured in specimens of great perfection, while another coral of exceeding delicacy was brought up more often broken than perfect. The latter was a species of *Flabellum* very similar to one taken by the Challenger expedition.

Thus far I have spoken only of the bottom species. The surface and intermediate depths all abound in life. The floating weed at the surface conceals among its branches many fishes and crustaceans which remain there for protection. Jelly-fishes are seen in great variety, together with a gigantic *Salpa* which sometimes covered the nets so as to obscure the other specimens. But little surface collecting was done, although, without doubt, that would prove exceedingly profitable.

While we consider the life of this region as a whole, some curious questions arise. That of coloration is one. The crustaceans are nearly all brilliantly colored, but there is no great variety in their tints. Scarlet and vermilion predominate, with some orange-red. The star-fishes, too, are gorgeous in their purple and orange. The sea-anemones are pink and orange-red. The sea-pens are deep red. Many fishes also possess the same tints. What is the reason of such gorgeous array? Professor Verrill explains it by saying that these colors render the animals invisible in the great depths. The sunlight in passing through the water loses most of its red and yellow rays by absorption before reaching the bottom, and consequently, as none of the remaining rays could be reflected from these red and yellow pigments, the animal could not be seen by others in search of prey. He suggests that these colors have been produced by a process of natural selection.

Phosphorescence, too, is an interesting phenomenon exhibited by many forms of life. The sea-anemones and sea-pens show this most conspicuously, although many others are also highly phosphorescent. The light given off by these is usually bluish or greenish, rarely yellowish. There would seem to be a connection between this fact and the brilliant coloration of the forms previously mentioned.

The mingling of two apparently distinct faunæ on the Gulf Stream slope seems to be due to two causes: the low, uniform temperature and the currents. We find here the contact of a cold polar current with the warm Gulf Stream at a depth which prevents seasonal variations. The bottom temperatures are low enough for arctic forms, and the Gulf Stream has slowly brought up from the West Indies species which have become gradually fitted to their environment. The abundance of life can be accounted for by the rapidity of circulation which keeps the bottom water purer and better fitted for supporting life than is usually

the case at such depths. With such an abundance of life for food and with the uniform temperature there seems to be a combination of conditions which may make this the region to which the migratory fishes resort in winter.

## 20.—TABLES OF THE DISTRIBUTION OF FISH AND EGGS.

In the following tables, numbered I to X, which have been prepared by Mr. Charles W. Smiley, and in Table XI, prepared by Col. M. McDonald, will be found the condensed record of the distribution for the year of whitefish, lake trout, brook trout, California salmon, California trout, Penobscot salmon, Schoodic salmon, shad, and carp. Fuller details will be found in various papers of the Appendix: In XX, Mr. Clark's account of whitefish and trout operations; in XXI, Mr. Stone's account of California salmon operations; in XXII, Mr. Stone's account of California trout operations; in XXIII, Mr. Atkins' account of Penobscot salmon operations; in XXIV, Mr. Atkins' account of Schoodic salmon operations; in XXV, the account of shad operations.

TABLE I.—*Distribution of whitefish eggs by the United States Fish Commission during season of* 1881.

| States. | Destination. | Number of eggs. |
|---|---|---|
| | DOMESTIC. | |
| California | B. B. Redding, San Francisco | 750, 000 |
| Connecticut | H. J. Fenton | 10, 000 |
| District of Columbia | Central Station, Washington | 110, 000 |
| Iowa | B. F. Shaw, Anamosa | 500, 000 |
| New Jersey | Mrs. J. H. Slack, Bloomsburg | 100, 000 |
| | FOREIGN. | |
| France | F. Mather, for M. Raveret-Wattel, Paris | 250, 000 |
| Germany | F. Mather, for Herr von Behr, Berlin | 300, 000 |
| | F. Mather, for G. Ebrecht | 12, 000 |
| | Total | 2, 032, 000 |

TABLE II.—*Distribution of young whitefish by the United States Fish Commission during season of* 1881.

| States. | Destination. | Number of fish. |
|---|---|---|
| Michigan | Detroit River, near Detroit | 1, 250, 000 |
| | Lake Michigan, near Ludington | 1, 000, 000 |
| | Lake Michigan, near Muskegon | 1, 500, 000 |
| | Lake Huron, near Port Huron | 2, 000, 000 |
| New York | Lake Michigan, near Saint Joseph | 1, 500, 000 |
| | Near islands in Lake Erie | 3, 500, 000 |
| Wisconsin | Lake Ontario, near Oswego | 3, 500, 000 |
| | Lake Michigan, near Racine | 1, 750, 000 |
| | Lake Michigan, near Sheboygan | 1, 750, 000 |
| | Total | 17, 750, 000 |

TABLE III.—*Distribution of eggs of lake trout by the United States Fish Commission during season of* 1881.

| States. | Destination. | Number of eggs. |
|---|---|---|
| | DOMESTIC. | |
| Iowa | B. F. Shaw, Anamosa | 30,000 |
| New Jersey | F. Mather, Newark | 2,000 |
| | FOREIGN. | |
| Germany | F. Mather, for Herr von Behr, Berlin | 20,000 |
| | Total | 52,000 |

TABLE IV.—*Distribution of brook trout eggs by the United States Fish Commission during season of* 1881.

| States. | Destination. | Number of eggs. |
|---|---|---|
| | DOMESTIC. | |
| Maryland | Druid Hill hatchery, Baltimore | 30,000 |
| | FOREIGN. | |
| France | F. Mather, for reshipment | 20,000 |
| | Total | 50,000 |

TABLE V.—*Distribution of young brook trout by the United States Fish Commission during season of* 1881.

| States. | Destination. | Number of fish. |
|---|---|---|
| Maryland | Pond at Oakland, Md | 30,000 |
| Michigan | Tributaries of Rouge River | 20,000 |
| | Total | 50,000 |

TABLE VI.—*Distribution of California salmon eggs by the United States Fish Commission during season of* 1881.

| States. | Destination. | Number of eggs. |
|---|---|---|
| | DOMESTIC. | |
| California | Lenni Fish Propagating Company, Sonoma | 500,000 |
| | B. B. Redding, San Francisco | 200,000 |
| Maryland | T. B. Ferguson, Baltimore | 500,000 |
| Minnesota | R. O. Sweeny, Saint Paul | 200,000 |
| Nebraska | R. R. Livingston, Omaha | 500,000 |
| Nevada | H. G. Parker, Carson City | 50,000 |
| New Hampshire | A. H. Powers, Plymouth | 50,000 |
| New Jersey | Fred. Mather, Newark | 500,000 |
| | Percy C. Ohl, Plainfield | 50,000 |
| Pennsylvania | Seth Weeks, Corry | 100,000 |
| | Curtis Johnson, Saint Petersburg | 50,000 |
| South Carolina | C. J. Huske, Walhalla | 300,000 |
| West Virginia | C. S. White, Romney | 100,000 |
| | FOREIGN. | |
| Canada | S. Wilmot, Newcastle, Ontario | 500,000 |
| New South Wales | Zoological Society, Sydney | 50,000 |
| | Total | 3,650,000 |

TABLE VII.—*Distribution of California trout eggs by the United States Fish Commission during season of* 1881.

| States. | Destination. | Number of eggs. |
|---|---|---|
| California | B. B. Redding, San Francisco | 40,000 |
| Illinois | N. K. Fairbanks, Chicago | 35,000 |
| Iowa | B. F. Shaw, Anamosa | 35,000 |
| Kentucky | William Griffith, Louisville | 5,000 |
| Maryland | T. B. Ferguson, Baltimore | 36,400 |
| Michigan | J. G. Portman, Pokagon | 6,000 |
| Minnesota | R. O. Sweeny, Saint Paul | 8,000 |
| New Hampshire | S. Webber, Plymouth | 4,000 |
| New York | Eugene G. Blackford, New York City | 500 |
| Pennsylvania | J. P. Creveling, Marietta | 5,000 |
| Wisconsin | Philo Dunning, Madison | 5,000 |
| | Total | 179,900 |

TABLE VIII.—*Distribution of Penobscot salmon eggs by the United States Fish Commission during season of* 1881.

| States. | Destination. | Number of eggs. |
|---|---|---|
| Connecticut | H. J. Fenton, Windsor | 95,000 |
| Maine | Charles G. Atkins, Grand Lake Stream | 50,000 |
| Minnesota | R. O. Sweeny, Saint Paul | 200,000 |
| New Hampshire | A. H. Powers, Plymouth | 95,000 |
| New Jersey | E. J. Anderson, Bloomsbury | 95,000 |
| New York | E. G. Blackford, New York City | 344,500 |
| Pennsylvania | Seth Weeks, Corry | 100,000 |
| Virginia | S. F. Baird, Washington, D. C | 27,000 |
| | Total | 1,006,500 |

TABLE IX.—*Distribution of schoodic salmon eggs by the United States Fish Commission during season of* 1881.

| States. | Destination. | Number of eggs. |
|---|---|---|
| | DOMESTIC. | |
| California | B. B. Redding, San Francisco | 10,000 |
| Connecticut | H. J. Fenton, Windsor | 5,250 |
| Iowa | B. F. Shaw, Anamosa | 25,000 |
| Maine | A. J. Darling, Enfield | 5,000 |
| Maryland | T. B. Ferguson, Baltimore | 11,000 |
| Massachusetts | E. A. Brackett, Winchester | 5,000 |
| Michigan | F. N. Clark, Northville | 56,750 |
| Minnesota | J. G. Portman, Paris | 25,000 |
| Missouri | R. O. Sweeny, Saint Paul | 25,000 |
| New Hampshire | C. H. Brownell, Saint Joseph | 25,000 |
| New Jersey | A. H. Powers, Plymouth | 4,750 |
| New York | Mrs. J. H. Slack, Bloomsbury | 22,000 |
| | E. G. Blackford, New York City | 10,000 |
| Pennsylvania | Seth Green, Mumford | 11,000 |
| Tennessee | Seth Weeks, Corry | 11,000 |
| Vermont | E. M. Russell, Paris | 5,000 |
| Wisconsin | J. M. Haven, Rutland | 10,000 |
| | M. T. Bailey, Madison | 25,000 |
| | FOREIGN. | |
| Germany | F. Mather, for reshipment | 20,000 |
| | Total | 311,750 |

TABLE X.—*Distribution of shad from April 27, 1881, to June 22, 1881, by the United States Fish Commission.*

| States. | No. of lots. | Streams stocked. | Number of fish. |
|---|---|---|---|
| Connecticut | 1 | Connecticut | 1,000,000 |
| Delaware | 1 | Nanticoke | 940,000 |
| District of Columbia | 2 | Potomac | 205,000 |
| Georgia | 6 | Oconee, Ocmulgee, Flint, Little | 1,800,000 |
| Iowa | 1 | Mississippi | 1,106,000 |
| Kansas | 1 | Missouri | 200,000 |
| Kentucky | 4 | Barren, Green, Kentucky, Salt | 767,000 |
| Maine | 2 | Kennebec, Mattawamkeag | 1,150,000 |
| Maryland | 42 | Choptank, North East, Patapsco, Patuxent, Potomac, Susquehanna | 24,705,500 |
| North Carolina | 8 | Haw, Salmon Creek | 4,357,500 |
| Ohio | 2 | Maumee, Ohio | 1,020,000 |
| Pennsylvania | 3 | Juniata, Susquehanna | 3,500,000 |
| Rhode Island | 1 | Palmers | 500,000 |
| South Carolina | 3 | Catawba, Congaree, Pedee | 620,000 |
| Tennessee | 4 | Holston, Nolachucky, Tennessee, Wautaga | 400,000 |
| Texas | 5 | Brazos, Colorado, Sabine, San Antonio, San Marcus | 277,000 |
| Virginia | 15 | James, Potomac | 24,280,000 |
| West Virginia | 1 | Ohio | 175,000 |
| Total | 97 | Total | 67,003,000 |

TABLE XI.—*Distribution of carp during the year 1881, by the United States Fish Commission.**

| State. | Number of counties represented. | Number of applicants supplied by express. | Number of applicants supplied by messenger. | Total number of applicants supplied. | Total number of fish furnished. | Number of applicants remaining unsupplied. | Total number of applicants. |
|---|---|---|---|---|---|---|---|
| Alabama | 38 | 28 | 60 | 88 | 1,856 | 70 | 158 |
| Arizona | 2 | ..... | ..... | ..... | ..... | 7 | 7 |
| Arkansas | 17 | 5 | 28 | 33 | 818 | 5 | 38 |
| California | 24 | ..... | ..... | ..... | ..... | 38 | 38 |
| Colorado | 9 | 1 | ..... | 1 | 20 | 18 | 19 |
| Connecticut | 8 | 21 | 71 | 92 | 2,220 | 14 | 106 |
| Dakota | 5 | ..... | ..... | ..... | ..... | 8 | 18 |
| Delaware | 3 | 16 | 42 | 58 | 2,100 | 1 | 59 |
| District of Columbia | ..... | 1 | 3 | 4 | 86 | 7 | 11 |
| Florida | 11 | 2 | 23 | 25 | 432 | 5 | 30 |
| Georgia | 94 | 30 | 380 | 410 | 7,681 | 133 | 543 |
| Idaho | 2 | ..... | ..... | ..... | ..... | 2 | 2 |
| Illinois | 62 | 23 | 139 | 162 | 2,844 | 24 | 186 |
| Indiana | 52 | 135 | 10 | 145 | 3,896 | 27 | 172 |
| Indian Territory | 1 | ..... | 16 | 16 | 317 | ..... | 16 |
| Iowa | 29 | 1 | 15 | 16 | 292 | 28 | 44 |
| Kansas | 45 | 5 | 105 | 110 | 2,366 | 17 | 127 |
| Kentucky | 70 | 7 | 489 | 496 | 9,732 | 84 | 580 |
| Louisiana | 24 | 1 | 51 | 52 | 1,276 | 6 | 58 |
| Maine | 6 | 6 | ..... | 6 | 116 | 5 | 11 |
| Maryland | 28 | 15 | 240 | 255 | 22,424 | 9 | 264 |
| Massachusetts | 10 | 24 | 3 | 27 | 745 | 21 | 48 |
| Michigan | 20 | 3 | 37 | 40 | 1,848 | 9 | 49 |
| Minnesota | 18 | 4 | 1 | 5 | 100 | 17 | 22 |
| Mississippi | 55 | 139 | 389 | 528 | 9,445 | 97 | 625 |
| Missouri | 50 | 2 | 208 | 210 | 4,126 | 54 | 264 |
| Montana | 2 | ..... | ..... | ..... | ..... | 2 | 2 |
| Nebraska | 11 | 6 | 1 | 7 | 120 | 8 | 15 |
| Nevada | 2 | ..... | ..... | ..... | ..... | 2 | 2 |
| New Hampshire | 6 | 6 | ..... | 6 | 140 | 5 | 11 |
| New Jersey | 19 | 40 | 21 | 70 | 1,352 | 11 | 81 |

*The number of carp actually sent out in 1881 was from six to eight thousand greater than appears from the subjoined table, many having been distributed through agents whose reports were not available when this table was made. There should also be added the number of carp distributed in the spring of 1882, these being of the 1881 crop and amounting to five or six thousand. The crop of 1881 aggregated about 160,000.

TABLE XI.—*Distribution of carp during* 1881 *by United States Fish Commission*—Cont'd.

| State. | Number of counties represented. | Number of applicants supplied by express. | Number of applicants supplied by messenger. | Total number of applicants supplied. | Total number of fish furnished. | Number of applicants remaining unsupplied. | Total number of applicants. |
|---|---|---|---|---|---|---|---|
| New Mexico | 3 | | | | | 6 | 6 |
| New York | 40 | 140 | 50 | 190 | 4,616 | 68 | 258 |
| North Carolina | 56 | 47 | 115 | 162 | 3,104 | 91 | 253 |
| Ohio | 62 | 172 | 35 | 207 | 4,258 | 89 | 296 |
| Oregon | 18 | | | | | 35 | 35 |
| Pennsylvania | 54 | 209 | 141 | 350 | 7,256 | 73 | 423 |
| Rhode Island | 4 | 5 | 20 | 25 | 1,140 | 2 | 27 |
| South Carolina | 26 | 9 | 236 | 245 | 11,884 | 11 | 256 |
| Tennessee | 46 | 34 | 165 | 199 | 4,200 | 55 | 254 |
| Texas | 112 | 15 | 926 | 941 | 16,580 | 9 | 950 |
| Utah | 5 | 5 | | 5 | 180 | 5 | 10 |
| Vermont | 3 | 4 | | 4 | 76 | 2 | 6 |
| Virginia | 68 | 172 | 304 | 476 | 11,669 | 30 | 506 |
| Washington | | | | | | 11 | 11 |
| West Virginia | 21 | 35 | 41 | 76 | 1,935 | 6 | 82 |
| Wisconsin | 19 | 10 | 4 | 14 | 296 | 15 | 29 |
| Wyoming | 1 | | 2 | 2 | 200 | 2 | 4 |
| Total | 1,256 | 1,387 | 4,371 | 5,758 | 143,696 | 1,244 | 7,002 |

## 21.—LIST OF RAILROADS GRANTING FACILITIES IN 1881.

During the present year a large number of railroads have accorded the facilities for carrying fish in baggage cars and for stopping trains at bridges so as to deposit young fish. The list is given herewith, and the most hearty acknowledgment made of their interest and co-operation.

Alabama Great Southern Railroad Company. Charles P. Ball, general superintendent, Chattanooga, Tenn.

Alabama Central Railroad Company. W. L. Lanier, president, Selma, Ala.

Associated Railways of Virginia and the Carolinas. A. Pope, general passenger agent, Richmond, Va.

Atchison, Topeka and Santa Fé Railroad. George O. Manchester, assistant general manager, Topeka, Kans.

Atlantic, Mississippi and Ohio Railroad Company. N. M. Osborne, secretary, Petersburg, Va.

Atlanta and Charlotte Air-Line Railway. C. J. Foreacre, general manager, Atlanta, Ga.

Atlanta and West Point Railroad. A. J. Orme, general passenger agent, Atlanta, Ga.

Baltimore and Ohio Railroad Company. G. M. Serpell, master of transportation, Pittsburgh division; C. H. Hudson, superintendent Trans-Ohio division; W. M. Clements, master of transportation.

Boston and New York Air-Line Railroad Company. J. H. Franklin, superintendent, New Haven, Conn.

Boston and Albany Railroad. C. O. Russell, superintendent, Springfield, Mass.

Boston and Providence Railroad Company. A. A. Folsom, superintendent, Boston, Mass.

Burlington and Missouri River Railroad in Nebraska. A. E. Touzalin, general manager, Omaha.

Carolina Central Railroad. W. Q. Johnson, general superintendent, Wilmington N. C.

Central Railroad of New Jersey. James Moore, general superintendent and engineer, Elizabeth, N. J.; F. S. Lathrop, receiver.

Central Railroad and Banking Company of Georgia. William Rogers, general superintendent, Savannah, Ga.

Central Pacific Railroad Company. F. H. Goodman, general passenger and ticket agent, San Francisco, Cal.; A. N. Towne, general superintendent.

Central Vermont Railroad Company. J. W. Hobart, general superintendent, Saint Albans, Vt.

Charlotte, Columbia and Augusta Railroad Company. T. M. R. Talcott, general manager; A. Pope, general passenger agent, Richmond, Va.

Cheraw and Darlington, and Cheraw and Salisbury Railroads. J. F. Divine, general superintendent; A. Pope, general passenger agent, Richmond, Va.

Chesapeake and Ohio Railway Company. William S. Dunn, engineer and superintendent, Richmond, Va.

Chicago, Rock Island and Pacific Railroad Company. A. Kimball, general superintendent, Davenport, Iowa.

Chicago and Alton Railroad. J. C. McMullin, general manager, Chicago, Ill.

Chicago, Saint Louis and New Orleans Railroad Company. W. H. Osborn, president; J. C. Clarke, vice-president and general manager, New York.

Chicago and Northwestern Railway. M. Hughitt, general manager; Chicago, Ill.

Chicago, Burlington and Quincy Railroad Company. T. J. Potter, general manager, Chicago, Ill.

Chicago, Milwaukee and Saint Paul Railway Company. W. C. Van Horne, general supernt endent, Milwaukee, Wis.

Chicago, Saint Paul, Minneapolis and Omaha Railroad, North Wisconsin Railroad. E. W. Winter, general superintendent, Saint Paul, Minn.

Cincinnati, Hamilton and Dayton; Dayton and Michigan; Cincinnati, Hamilton and Indianapolis; and Cincinnati, Richmond and Chicago Railroads. L. Williams, general manager, Cincinnati, Ohio.

Cincinnati Southern Railway. S. Woodward, superintendent, Cincinnati, Ohio.

Cincinnati, Sandusky and Cleveland Railroad. D. W. C. Brown, general manager and superintendent, Springfield, Ohio.

Cleveland, Columbus, Cincinnati and Indianapolis Railway Company. E. B. Thomas, general manager, Cleveland, Ohio.

Cleveland, Mount Vernon and Columbus Railroad Company. G. A. Jones, receiver, Mount Vernon, Ohio.

Columbia and Greenville Railroad. T. M. R. Talcott, general manager; A. Pope, general passenger agent, Richmond, Va.

Connecticut River Railroad. J. Mulligan, superintendent, Springfield, Mass.

Delaware and Chesapeake Railway. O. S. Sanford, superintendent, Easton, Md.

Delaware, Lackawanna and Western Railroad. Samuel Sloan, president, New York.

East Tennessee, Virginia and Georgia Railroad. John F. O'Brien, chief engineer and superintendent, Knoxville, Tenn.

European and North American Railroad. F. W. Cram, superintendent, Bangor, Me.

Fitchburg Railroad Company. John Adams, general superintendent, Boston, Mass.

Flint and Pere Marquette Railway. Sanford Keeler, superintendent, East Saginaw, Mich.

Florida Central Railroad Company. W. M. Davidson, superintendent, Jacksonville, Fla.

Fort Wayne and Jackson Railroad Company. M. D. Woodford, general superintendent, Jackson, Mich.

Galveston, Harrisburg and San Antonio Railroad Company. James Converse, general superintendent.

Galveston, Houston and Henderson Railroad. W. H. Harding, general manager, Galveston, Tex.

Georgia Railroad Company. E. R. Dorsey, general freight and passenger agent, Augusta, Ga.

Gulf, Western Texas and Pacific Railroad. M. D. Monserrate, general superintendent, Cuero, Tex.

Hannibal and Saint Joseph Railroad Company. W. R. Woodward, superintendent, Hannibal, Mo.

Hartford and Connecticut Valley Railroad Company. Samuel Babcock, president, Hartford, Conn.

Houston and Texas Central Railroad. G. Jordan, vice-president, Houston, Tex.

Indianapolis and Saint Louis Railroad Company. E. B. McClure, general superintendent, Indianapolis, Ind.

Illinois Central Railroad Company. Joseph F. Tucker, traffic manager, Chicago, Ill.

International and Great Northern Railroad. H. M. Hoxie, vice-president and manager, Palestine, Tex.

Jacksonville, Pensacola and Mobile Railroad. Edgar Vliet, master of transportation, Tallahassee, Fla.

Kansas City, Fort Scott and Gulf Railroad; Short Creek and Joplin Railroad; Fort Scott, Southeastern and Memphis Railroad; Rich Hill Railroad; Memphis, Kansas and Colorado Railroad; Springfield and Western Missouri Railroad; Kansas City, Lawrence and Southern Railroad, Southern Kansas and Western Railroad. L. W. Towne, general superintendent, Kansas City, Mo.

Kansas City, Saint Joseph and Council Bluffs Railroad Company. I. F. Barnard, general superintendent, Saint Joseph, Mo.

Keokuk and Saint Louis Line. H. B. Blood, general freight and passenger agent, A. L. Griffin, general superintendent, Keokuk, Iowa.

Lake Shore and Michigan Southern Railroad. Charles Paine, general superintendent, Cleveland, Ohio.

Little Rock and Fort Smith Railway. Theodore Hartman, general superintendent, Little Rock, Ark.

Louisville, Cincinnati and Lexington Railway Company. William Mahl, general superintendent, Louisville, Ky.

Louisville and Nashville Railroad. D. W. C. Rowland, general superintendent, Louisville, Ky.

Montgomery and Eufaula Railroad. William Rogers, general superintendent, Montgomery, Ala.

Macon and Brunswick Railroad. J. M. Edwards, superintendent and general manager, Macon, Ga.

Marietta and Cincinnati Railroad. J. H. Stewart, superintendent, Cincinnati, Ohio.

Memphis and Little Rock Railroad. W. E. Smith, general manager, Little Rock, Ark.

Memphis and Charleston Railroad Company. John A. Grant, general superintendent, Memphis, Tenn.

Missouri Pacific Railway. A. A. Talmage, general superintendent, Saint Louis, Mo.

Mississippi and Tennessee Railroad. M. Burke, general superintendent, Memphis, Tenn.

Mobile and Ohio Railroad. A. L. Rives, general manager, Mobile, Ala.

Morgan's Louisiana and Texas Railroad. Charles A. Whitney and Co., managers, New Orleans, La.

Nashville, Chattanooga and Saint Louis Railway. J. W. Thomas, general superintendent, Nashville, Tenn.

New York, Lake Erie and Western Railroad. E. S. Bowen, general superintendent, New York.

New York and New England Railroad Company. A. C. Kendall, general passenger agent; O. M. Shepard, superintendent of transportation, Boston; J. H. Wilson, vice president.

New York, New Haven and Hartford Railroad Company. E. M. Reed, vice-president, New York.

New York, Pennsylvania and Ohio Railroad. P. D. Cooper, general superintendent, Cleveland, Ohio.

Northern Central Railway Company; Baltimore and Potomac Railroad; and Alexandria and Fredericksburgh Railway. L. P. Farmer, general passenger agent, Philadelphia, Pa.

Northeastern Railroad of Georgia. Lyman Wells, superintendent, Athens, Ga.

Ohio and Mississippi Railway Company. W. W. Peabody, general superintendent, Cincinnati, Ohio.

Old Colony Railroad Company. J. R. Kendrick, superintendent, Boston, Mass.

Pennsylvania Company. J. D. Layng, general manager, Pittsburgh, Pa.

Pennsylvania Railroad Company. L. P. Farmer, general passenger agent, Philadelphia, Pa.

Petersburg Railroad Company; R. G. Pegram, receiver, Petersburg, Va.

Pittsburgh, Cincinnati and Saint Louis Railway Company. D. W. Caldwell, general manager, Columbus, Ohio.

Philadelphia, Wilmington and Baltimore Railroad. H. F. Kenny, superintendent, Philadelphia, Pa.

Richmond and Danville Railroad. T. M. R. Talcott, general manager; A. Pope, general passenger agent, Richmond, Va.

Richmond and Petersburg Railroad Company. Theo. D. Kline, general superintendent, Richmond, Va.

Richmond, Fredericksburg and Potomac Railroad Company. E. T. D. Myers, general superintendent, Richmond, Va.

Savannah, Griffin and North Alabama Railroad. William Rogers, general superintendent, Savannah, Ga.

Savannah and Memphis Railroad Company. W. C. Fowler, cashier, Opelika, Ala.

Savannah and Charleston Railroad Company. C. S. Gadsden, engineer and superintendent, Charleston, S. C.

Savannah, Florida and Western Railway Company. H. S. Haines, general manager, Savannah, Ga.

Seaboard and Roanoke Railroad Company; Raleigh and Gaston Railroad Company; Raleigh and Augusta Air Line Railroad Company; Baltimore Steam Packet Company; Albemarle Steam Navigation Company. John M. Robinson, president, Baltimore, Md.

Selma, Rome and Dalton Railroad. John F. O'Brien, superintendent, Selma, Ala.

Southwestern Railroad of Georgia. William Rogers, superintendent, Macon, Ga.

South Carolina Railroad. John B. Peck, general superintendent, Charleston, S. C.

Saint Louis and San Francisco Railway. C. W. Rogers, general manager, Saint Louis, Mo.

Saint Louis, Iron Mountain and Southern Railway. A. W. Soper, general superintendent, Saint Louis, Mo.

Saint Paul, Minneapolis and Manitoba Railway. James J. Hill, general manager, Saint Paul, Minn.

Texas and Pacific Railway Company. George Noble, general superintendent, Marshall, Tex.

Texas and New Orleans Railroad. J. F. Crosby, vice-president and general manager, Houston, Tex.

Union Pacific Railway. Thomas L. Kimball, assistant general manager, Omaha.

Vandalia Line; Terre Haute and Indianapolis Railroad Company. D. W. Caldwell, general manager, Saint Louis, Mo.

Vicksburg and Meridian Railroad Company. E. F. Raworth, general superintendent, Vicksburg, Miss.

Wabash, Saint Louis and Pacific Railway. John C. Gault, general manager, Saint Louis, Mo.

Washington City, Virginia Midland and Great Southern Railroad. Peyton Randolph, general superintendent, Alexandria, Va.; John S. Barbour, receiver.

Western and Atlantic Railroad Company. William MacRae, general manager, Atlanta, Ga.

Western North Carolina Railroad. James W. Wilson, president, Morganton, N. C.

Western Railroad of Alabama. Cecil Gabbett, general manager, Montgomery, Ala.

West Jersey Railroad Company, passenger department. L. P. Farmer, general passenger agent, Philadelphia, Pa.

Western Maryland Railroad Company. J. M. Hood, general manager, Baltimore, Md.

Wilmington and Weldon, and Wilmington, Columbia and Augusta Railroads. A. Pope, general passenger agent, Wilmington, N. C.; John F. Divine, general superintendent.

Wisconsin Central Railroad Company. F. N. Finney, general manager, Milwaukee, Wis.