

R E P O R T
OF THE
UNITED STATES COMMISSIONER OF FISH AND FISHERIES
FOR THE
FISCAL YEAR ENDING JUNE 30, 1889.

The constitution of the Fish Commission as a separate bureau of the Government, which was accomplished by act of Congress approved January 20, 1888, terminated those relations of coöperation which had been so happily maintained with the Smithsonian Institution and National Museum under the wise and liberal administration of Prof. S. F. Baird—a coöperation which enlisted the aid of scientific workers in the solution of important economic problems, and also stimulated and encouraged research by presenting specific and important practical questions for investigation.

Another important and fruitful result of this coöperation was the acquisition (during investigations relating to the fishing-grounds and the distribution and abundance of the economic species of fishes) of rich stores of specimens of the strange and curious life of the ocean's depths. These collections are of the utmost value for systematic study and for the enrichment of museums.

The abrupt termination of relations so long subsisting was not without serious embarrassments and inconveniences, requiring new adjustments and arrangements, which it has been the care of the Commissioner to provide as rapidly as circumstances and means would permit.

The offices of the Commission, which had been previously scattered in different parts of the city, were as far as practicable brought together in one building, thus permitting better supervision and more prompt communication, and resulting in more convenient and economical administration of affairs. The want of adequate accommodations for the offices of the Commission having been brought to the attention of Congress, provision was made in the sundry civil bill, which became a law March 2, 1889, for an appropriation of \$7,000 for altering and fitting up

the interior of the Armory building then and now occupied as a hatching station of the Commission. The appropriation was made immediately available, to be expended under the direction of the Architect of the Capitol. Having advised with the Commissioner as to the work to be undertaken, Mr. Clark immediately began operations, and at the close of the fiscal year all was complete and ready for occupation.

A portion of the building was by the act referred to reserved for the use of the Smithsonian Institution, and the accommodations afforded the Commission are not adequate to its necessities; it is therefore desirable that the entire building should be assigned to the use of the Fish Commission as soon as practicable.

OFFICE ADMINISTRATION.

The large number of stations of the Commission, its vessels, and the great increase in the distribution of food-fishes over the country, have involved an enormous mass of correspondence and other details of administration. In these duties the Commissioner has had the faithful and efficient services of Mr. J. J. O'Connor, chief clerk, and Mr. Herbert A. Gill, disbursing agent, in charge of the office of accounts.

The appropriations for the fiscal year ending June 30, 1889, aggregated \$257,580, as follows:

Compensation of Commissioner.....	\$5,000
Propagation of food-fishes.....	135,000
Rent of offices.....	2,500
Distribution of food-fishes.....	31,180
Maintenance of vessels.....	53,900
Inquiry respecting food-fishes.....	20,000
Statistical inquiry.....	10,000

In accordance with law a detailed report of expenditures under these several items of appropriation was made to Congress on December 9, 1889.

CLASSIFICATION OF THE COMMISSION'S WORK.

The classification and assignment of the work of the Commission to the several divisions which had been established or projected by my immediate predecessor in office, Dr. G. Brown Goode, has proved of great advantage. While maintaining independent responsibility in the heads of divisions it has made practicable a coördination and concurrence of activity in reference to the problems relating to the fisheries and has prevented any unnecessary duplication of work.

The following brief account of the current work in the divisions will illustrate very clearly the extent, importance, and diversity of the operations of the Fish Commission and its value to the country at large.

INQUIRY RESPECTING FOOD-FISHES AND THE FISHING-GROUNDS.

The investigation of the character and resources of the fishing-grounds, and of the conditions controlling the distribution of fishes and other aquatic animals, together with the ascertainment of the life-history of commercially important species, furnishes the only correct basis for the regulation and improvement of our fisheries, for the instruction of the fisherman as to the best and most profitable methods of pursuing his calling, and for the successful conduct of fish-cultural operations.

In the early period of the Commission the inquiries pursued were necessarily general in character. A survey of the immense field to be exploited was first necessary to suggest or to give precise direction to those more particular inquiries upon which we are now entering, and which are intimately and essentially related to various important problems affecting the fisheries.

The following brief review will illustrate the activity and energy displayed in the division of the Commission having charge of the inquiry in regard to the fishing-grounds, as well as the significance and practical importance of the subjects investigated. Fuller details will be found in the very interesting and instructive report of the assistant in charge of the division, Mr. Richard Rathbun, which is appended to and forms a part of this report.

The most important sea-coast inquiries conducted during the year have been the investigations in the North Pacific Ocean by the steamer *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. The *Albatross* reached San Francisco from the Atlantic coast in May, 1888, and, after a month and a half spent in preparations for the cruise, left July 4 for Alaskan waters, where a running survey was made of the fishing-grounds situated south of the Alaska Peninsula between Unalaska and Middleton Island. The area covered by these explorations comprised the entire width of the continental platform, extending into depths of 100 to 200 fathoms, and including five principal cod-fishing banks, having a total area of over 15,000 square miles. The intervening ground, moreover, is in most places adapted to fishing and the adjacent shores are well provided with good and secure harbors. Although cod fishing has been carried on in this region to a limited extent during the past twenty-five or thirty years, no systematic inquiry had been made to determine the distribution and value of its resources prior to the visit of the *Albatross*. The result of these researches can not fail, therefore, to have an important influence on the development of this territory.

After returning from Alaska, in September, the *Albatross* began a similar investigation along the coasts of Washington and Oregon, which was continued during October, 1888, and again in June, 1889. During the winter and early part of the spring, the work was extended

to the coast of southern California, between Point Conception and the Mexican boundary line, and to the Gulf of California. In the course of these inquiries important results were accomplished and several new fishing-grounds were brought to the attention of the fishermen. The most important discoveries in this line had reference to Cortez and Tanner banks, directly off San Diego. Hequeta Bank, off the coast of Oregon, and the halibut banks off Cape Flattery were also examined and the character and value of their resources partly determined. The observations made in the Gulf of California, together with an investigation of the Colorado River and its principal tributaries at about the same time, tend to prove that this river system is not suited to the introduction of the Atlantic shad, which has done so well farther north on the Pacific coast, and no traces were discovered of the few plantings made in this region several years ago. The problem of oyster-culture on the coast of California received attention from the naturalists of the *Albatross*, and the vessel also rendered assistance in distributing the live lobsters sent over from New England and placed in those waters.

On the Atlantic coast, instead of continuing the general explorations which had been carried on for several years, the steamer *Fish Hawk* was assigned to special investigations, having reference chiefly to the oyster-grounds of Long Island Sound and Rhode Island. No other fishing industry, probably, has greater claims at present upon the attention of the Fish Commission with respect to its maintenance and development than that afforded by the oyster. On the coast of New England and New York, some measures of protection are demanded against the drills and starfishes which destroy large quantities of oysters every year; in Chesapeake Bay the production has steadily been decreasing since 1880, and on the South Atlantic and Gulf coasts an active interest has recently been shown in devising means for improving and developing the wild growths of oysters which occur wherever favorable conditions now exist. Moreover, the natural supply of seed oysters is totally inadequate to meet the demands of planters and some economical methods of artificial cultivation are desirable in order to relieve this want.

In connection with all of these questions the several States have looked to the U. S. Fish Commission for assistance, especially in the way of scientific investigation and experiments on which to base the necessary measures for relief. While not having sufficient means to press the inquiries in this direction as rapidly as seems desirable, arrangements have been made to give them every possible attention and to detail for this purpose the steamer *Fish Hawk* and such launches as may be necessary, when not required for fish-cultural and other more urgent work. The researches conducted by the *Fish Hawk* on the southern coast of New England during the season of 1888 are described in the special report of the assistant in charge of scientific inquiry. The grounds visited were carefully examined as to their conditions in every

particular, and observations were made upon the physical characteristics of the waters and upon the natural history of the oyster, its enemies and associates. It is proposed to continue the investigations in the same field during the summer of 1889.

During the winter of 1888-89 extensive operations were conducted in the Gulf of Mexico by the schooner *Grampus* and the steamer *Fish Hawk*. The former vessel was detailed to examine the southern part of the important red-snapper fishing-ground which occupies the submerged continental platform off the west coast of Florida. The in-shore or shallow-water part of this ground is now visited to a greater or less extent by fishermen, and the work of the *Grampus* was restricted to depths between 15 and 50 fathoms, in which the conditions and resources of the bottom were comparatively unknown. Notwithstanding the fact that much stormy weather was encountered, important results were obtained and the attention of the fishermen has been called to the advantages offered by this region for the prosecution of their industry. In addition to the fishing carried on, the dredge was used at frequent and regular intervals to determine the composition of the bottom and the characteristic animals which live upon it. In conjunction with the *Grampus* Dr. James A. Henshall made an examination of the adjacent coast of Florida from Biscayne Bay to Tampa, during which he obtained a very large collection of fishes and secured much information regarding the abundance, distribution, and habits of the more important species.

The principal work done by the *Fish Hawk* in the Gulf of Mexico had reference to the breeding habits of the mullet, sheepshead, and squeeteague in Charlotte Harbor and vicinity, on the west coast of Florida, and the measures necessary to be taken for the artificial propagation of those species. Spawn of the two species last mentioned was obtained and hatched successfully, but when the *Fish Hawk* reached this locality it proved to be too late for the spawning of the mullet, although the young were observed in great numbers and their habits were, to some extent, determined.

An essentially novel feature of the scientific work, introduced during the past year, has been the systematic investigation of interior waters, with respect both to their physical and natural-history characteristics. This subject was taken up with the object of obtaining more accurate and extensive information in that direction, as a basis for fish-cultural operations and the distribution of useful fishes; for, until the conditions and principal features of any stream or lake have been determined it is impossible to say whether they require attention, and, if so, what measures should be taken to multiply their resources or perfect the quality of the latter. With respect to this subject, it is necessary to ascertain not only what kinds of fishes inhabit each fresh-water system, but also the abundance and distribution of the lower forms of life serving them as food and those physical conditions which, regulating their habits, determine what new species may be adapted to the region.

In carrying on this series of investigations it has been necessary, owing to the lack of sufficient funds, to rely chiefly on the services of volunteer naturalists, and most assistance in this direction has been furnished by Dr. David S. Jordan, president of the Indiana University, and his associate professors and students in ichthyology. Special mention should be made in this connection of Prof. Charles H. Gilbert, Prof. B. W. Evermann, and Mr. C. H. Bollman. Dr. James A. Henshall, of Cincinnati, Ohio, also volunteered his services during the summer of 1888. After a conference with Dr. Jordan as to the observations which it was desirable should be made, the work was mostly placed under his immediate direction, and the part intrusted to him has been conducted in a very zealous and appreciative manner. The investigations made up to the close of the year had reference to seventeen States, as follows: New York, Virginia, West Virginia, North Carolina, South Carolina, Tennessee, Kentucky, Georgia, Alabama, Mississippi, Louisiana, Ohio, Indiana, Michigan, Iowa, Missouri, and Arkansas.

During the winter of 1888-89 Congress passed an act to provide for the protection of the salmon fisheries of Alaska, which, owing to the rapid increase in the number of salmon canneries established in certain parts of that Territory and the wholesale methods of capture resorted to, seemed in great danger of being seriously depleted within a comparatively few years unless subjected to appropriate regulations. By this enactment it was declared unlawful to erect dams, barricades, or other obstructions in any of the rivers of Alaska, which might prevent or impede the ascent of salmon and other anadromous fishes to their spawning-grounds, and, furthermore, the Commissioner of Fisheries was directed "to institute an investigation into the habits, abundance, and distribution of the salmon of Alaska, as well as the present conditions and methods of the fisheries, with a view of recommending to Congress such additional legislation as may be necessary to prevent the impairment or exhaustion of these valuable fisheries, and placing them under regular and permanent conditions of production."

In accordance with this provision, arrangements were made for undertaking the investigation directed during the summer of 1889, and a party suitably equipped for that purpose was organized in June. It set sail for Alaska early in July, immediately after the close of the fiscal year. The party was in charge of Dr. Tarleton H. Bean, ichthyologist of the Commission, and personally acquainted with Alaskan waters, and consisted besides himself of Mr. Livingston Stone, superintendent of the Fish Commission salmon station in California; Mr. Franklin Booth, engineer, of the University of California; and Mr. Robert E. Lewis, general assistant. They have been directed to first visit Kadiak and Afognak islands, the principal centers of the canning interests in Alaska, and subsequently, if the time permits, Cook Inlet and Bristol Bay. Their instructions comprehend a very thorough investigation, and it is confidently expected that sufficient informa-

tion will be obtained to permit of a full understanding of the situation by the next Congress.

The daily observations of temperature along the sea-coasts and on the interior lakes and rivers, begun several years ago, have been continued during the past year at a number of the more exposed light-houses and at many stations of the Signal Service. The value of such observations will readily be appreciated by the student of geographical distribution, and a comparison of the results now in progress of compilation will undoubtedly throw much light on the movements of our migratory fishes.

The temperature data heretofore obtained serve only to show the temperature fluctuations in the waters immediately adjacent to the coast. The deductions from these have been sufficient to show that the movements of the fishes in the inshore waters, their appearance and departure, and their failure to appear in certain seasons in certain localities are to be attributed to differences of temperature conditions prevailing at different times. Observation and experience have suggested that the seasonal migrations and distribution in our coastal waters of many important economic fishes is to be explained and indeed to be predicted when we can obtain precise knowledge of the laws governing the seasonal changes of temperature in the area of water lying between our coast and the western border of the Gulf Stream. The migration of the areas of equal water temperature will be different in the different seasons and determine corresponding differences in the areas over which fishing may be profitably pursued.

It will, however, doubtless be found that the seasonal migrations of the areas of equal temperature in the sea will be in close and essential relations with the meteorological conditions on the land, which are under constant observation and discussion, and in time a knowledge of one will enable us to interpret the other, and thus indicate the probable distribution for the season of such species as the mackerel, the menhaden, the sea herring, and others which are pursued for their commercial value. Such information would relieve many perplexities and embarrassments which now discourage our fishermen, and give better direction to their enterprise and consequently better assurance of success in their endeavors. The investigations proposed and the discussion of the data obtained would doubtless lead to many important generalizations on the physical geography of the sea and the relations of marine species to their physical environments.

Being impressed with the importance of a systematic study of the temperature conditions and the changes of conditions in our offshore waters, I have instituted a systematic investigation to this end and have assigned the Fish Commission schooner *Grampus* to this work. Prof. William Libbey, of Princeton College, has been selected to take charge of the investigation, and the vessel is now being fitted with the necessary apparatus and appliances for the work, and will enter upon it at the beginning of the next fiscal year.

The scientific laboratory attached to the marine station at Wood's Holl, Mass., was opened as usual during the summer of 1888, the Commissioner being present during most of the time. The assistants engaged in Fish Commission work were employed only for the season, and in addition the facilities of the laboratory were granted to several biologists interested in the study of marine life. The persons in attendance were representatives of a number of the prominent scientific institutions of the country, and by their presence and coöperation they added very greatly to the value of the practical results obtained. The institutions thus represented were as follows: University of Pennsylvania, Harvard University, Johns Hopkins University, Princeton College, Williams College, University of Indiana, Swarthmore College, Wooster University, and the Lake Laboratory at Milwaukee, Wisconsin. Prof. John A. Ryder, of the University of Pennsylvania, a former assistant on the Fish Commission, was in direct charge of the scientific work.

The opportunities for research afforded by the Wood's Holl laboratory have been fully described in previous reports. Not only is the equipment well adapted to the study of marine problems of nearly every essential character, but the geographical position of the station with respect to a large assemblage of useful fishes gives it unusual advantages from the standpoint of the practical objects of the Commission.

The transfer of the steamer *Albatross* to the Pacific coast and the detail of the steamer *Fish Hawk* to the investigation of oyster-grounds have for the time removed the principal means of obtaining material from the offshore regions, and it has been necessary to restrict the researches chiefly to such inquiries as are offered by the immediate vicinity of the shores, but in this way the requirements of fish-culture have been more directly benefited, as the most important fisheries of the region are located within the bays and sounds or directly adjacent thereto.

The studies of Prof. Ryder have related chiefly to the life history of the sea bass and the Atlantic sturgeon, two important species, the artificial propagation of which may soon become expedient. The material bearing upon the sturgeon was obtained in Delaware Bay the previous spring, but the sea bass is one of the most highly prized fishes of the Vineyard Sound region, where it breeds during May and June. Mr. S. F. Denton, an experienced naturalist and artist, was employed in making colored drawings of the principal food-fishes indigenous to these waters, and Mr. C. F. Hodge was occupied with the natural history of the common starfish, the most serious and destructive enemy of the oyster on the New England coast. Other investigations have had reference to the cod, scup, tautog, mackerel, bonito, lobster, and soft clam. Summarizing the work accomplished, Prof. Ryder states that at least eight important monographic reports may be expected as the outcome wholly or in part of the investigations carried on at Wood's Holl during the season.

Mr. V. N. Edwards, who has been stationed permanently at Wood's Holl since 1871, has continued his observations upon the movements, habits, and abundance of the fishes of this region and has obtained large and valuable collections. A compilation of his results during the past eighteen years, which is now in progress, will prove a very valuable contribution to the natural history of our marine fishes.

The Commissioner is pleased to note the establishment at Wood's Holl of a marine biological laboratory intended for both students and investigators, which can not fail to have an important function in stimulating scientific research in this direction, and ultimately in promoting the interests of fish-culture by its contributions. This institution had its origin in Boston, and counts several well-known biologists among its instructors. The director is Prof. C. O. Whitman, of Clark University.

Prof. W. O. Atwater, of Wesleyan University, Middletown, Conn., who began for the Fish Commission, about ten years ago, a very comprehensive series of experiments upon the chemical composition and nutritive values of the American food-fishes, has completed his undertaking during the past year, and his report upon the subject is published in the appendix to this volume. Fifty-five species of fishes and eleven of mollusks and crustaceans were analyzed. The report is divided into two parts, the first being chiefly occupied with the technical details of analyses, while the second is more popular in character and explains the deductions reached by the author, together with their bearing upon different fishery problems. This important monograph can not fail to attract much attention from those interested in the fisheries, whether from a practical or scientific standpoint.

METHODS AND STATISTICS OF THE FISHERIES.

The work of this division relates to the history, methods, and statistics of the commercial fisheries; and the discussion and interpretation of the data obtained will, it is expected, contribute greatly to the advancement of these interests.

The appropriation for this branch of the service, \$15,000, was small for the extent of territory to be covered, but it was used with economy, the expenses of the field agents having been especially low, the cost of travel and subsistence averaging only \$3.86 per man daily. Investigations were carried on in Maine, Massachusetts, Rhode Island, New York, Pennsylvania, New Jersey, Delaware, Maryland, North Carolina, Florida, Alabama, Mississippi, Louisiana, Texas, the Great Lakes, the Pacific Coast, and Alaska. The statistics, methods, and relations of the fisheries of these regions were studied in detail, and with a view to the preparation of reports. Valuable information of a similar nature was obtained also through the medium of the statistical circulars of the Treasury Department, of which more than 10,000 were returned

to the Fish Commission in 1888 and 1889. Through local agents and bureaus, as well as by correspondence and the utilization of newspaper items, much additional knowledge of the fisheries was obtained.

Pending the negotiations looking toward a fishery treaty with Great Britain, the American commissioners were furnished with statistics, papers, maps, and personal explanations bearing upon the relations of the interested parties, and although the treaty was not ratified a *modus vivendi* was agreed upon for a period of two years.

The announcement to the fishery interests, through the investigations of the *Grampus* in the spring of 1888, of the scarcity of mackerel along the coast partly prepared the fleet for the unfavorable season which followed. Inasmuch as the history of this fishery shows many similar great fluctuations in the abundance of this species without adequate explanation, it may reasonably be expected that recourse to artificial hatching, the methods of which are now fully understood, will aid in reëstablishing this valuable fishery on a permanent basis.

The artificial freezing of fish recommended by this Commission as available for adoption by New England fishermen, was successfully and very profitably applied by Mr. William H. Jordan, of Gloucester, Mass., in the transportation of herring from Newfoundland.

Fuller details of the work of this division for the current year will be found in the report of the assistant in charge of the division, Capt. J. W. Collins, which is appended to and constitutes a part of this report.

FISH-CULTURE.

The work of this division has been under the immediate direction of the Commissioner, such duty being made necessary by his previous relations to and experience as assistant in charge of the division of fish-culture. With the continual expansion of the operations of the Commission and the increasing care and responsibilities incident to the general administration, it will not be practicable for the Commissioner to continue personal supervision of the fish-cultural operations longer than is necessary to establish satisfactory direction of the work under the superintendence of an assistant.

The work for the present season shows a gratifying improvement over the results of the previous year. This is indicated both by the large increase in the number of eggs and fry distributed; and by the greater number of yearling fish reared and distributed. The total effective production is shown by the following table:

REPORT OF COMMISSIONER OF FISH AND FISHERIES. XIX

Fish and eggs furnished for distribution by the stations for the year ending June 30, 1889.

Station.	Species.	Eggs.	Fry.	Yearlings.	Total.
Alpena, Mich	Whitefish	(a)	23,320,000		23,320,000
	Lake trout		80,000		80,000
Baird, Cal.	California salmon	3,450,000	1,500,000		4,950,000
Battery Island, Md.	Shad		41,543,000		41,543,000
Craig's Brook, Me	Landlocked salmon			5,984	5,984
	Atlantic salmon	1,395,000	19,000	13,961	1,427,961
Central, Washing- ton, D. C.	German carp			190,928	190,928
	Goldfish			6,509	6,509
	Landlocked salmon		27,000		27,000
	Rainbow trout			10,280	10,280
	Brook trout		21,000	125	21,125
	Lake trout		36,000		36,000
	Whitefish	4,595,000			4,595,000
	Rock bass			1,218	1,218
	Tench			1,530	1,530
	Shad		34,501,000		34,501,000
Clackamas, Oregon.	California salmon		4,500,000		4,500,000
Cold Spring Harbor, New York.	Landlocked salmon		20,000		20,000
	Atlantic salmon		638,000		638,000
	Lake trout		430,000		430,000
Duluth, Minn.	Landlocked salmon		50,000		50,000
	Lake trout		985,000		985,000
	Whitefish		8,000,000		8,000,000
	Pike perch		3,000,000		3,000,000
Ft. Washington, Md.	Shad	(b)	2,994,000		2,994,000
Gloucester, Mass.	Codfish		11,011,000		11,011,000
	Pollock		7,258,000		7,258,000
Schoodie, Me	Landlocked salmon	c 350,000	205,000		555,000
	Atlantic salmon		198,000		198,000
Northville, Mich	Rainbow trout	d 55,000		40,264	104,264
	Brook trout	e 150,000		13,875	163,875
	Lake trout	f 655,000		28,525	683,525
	Loch Leven trout		120,000		120,000
	Whitefish	g 6,250,000	4,520,000		10,770,000
Sandusky, Ohio	Pike perch		47,190,000		47,190,000
	Whitefish	h 24,400,000	40,700,000		65,100,000
Steamer Fish Hawk	Shad		22,956,000		22,956,000
	Sheepshead		14,000,000		14,000,000
Wood's Holl, Mass.	Codfish		8,137,000		8,137,000
	Lobsters		1,574,000	333	1,574,333
	Scup		30,000		30,000
	Sea bass		1,025,000		1,025,000
	Sole			28	28
Wytheville, Va	Mackerel		185,000		185,000
	Landlocked salmon		4,950		4,950
	Rainbow trout			39,308	148,808
	Brook trout	100,500		500	500
	Lake trout			575	575
	Rock bass			4,430	4,430
	Goldfish			3,101	3,101
	German carp			18,315	18,315
	Spotted catfish			20,180	20,180
	Buffalo			10,360	10,360
	Crappie			16,768	16,768
	White bass			15,552	15,552
	Black bass			17,687	17,687
	Smfish			3,688	3,688
	Pickeral			7,811	7,811
	White perch			2,485	2,485
	Pike perch			5,000	5,000
	Native carp			460	460
(International ex- change) from Ber- neuchen, Germany.	Brown trout	44,000			44,000
(Int. exchange from Schmaldow, Ger- many.	Säbling	9,000			9,000
	Brown trout	66,000			66,000
	Total	37,053,500	285,252,950	489,380	322,795,830

a 5,000,000 transferred to Central Station; 5,000,000 to Duluth Station.

b 54,064,000 transferred to Central Station.

c 25,000 transferred to Craig's Brook Station; 25,000 to Cold Spring Harbor Station; 30,000 to Central Station; 50,000 to Duluth Station; 30,000 to Wytheville Station.

d 2,500 to Craig's Brook Station.

e 2,000 to Craig's Brook Station; 25,000 to Wytheville Station; 30,000 to Central Station.

f 1,000,000 to Duluth Station; 40,000 to Central Station; 500,000 to Cold Spring Harbor Station; 2,000 to Craig's Brook Station.

g 5,000,000 to Car No. 3.

h 9,000,000 to Duluth Station.

Note.—The "Summary of Distribution for the year ending June 30, 1889," p. 380, should be amended so that the total of eggs would be 37,053,500, and the grand total 322,795,830, credit having been taken for the foregoing transfers both as eggs and fry.

A comparison of this with a similar table contained in the report of the previous year shows a gratifying increase in the number of eggs and fry distributed. The most notable advance, since it promises such important results in stocking, was the increase in the number of yearling trout, salmon, and other native food-fishes distributed. The often inadequate and disappointing results from stocking with the fry of trout and salmon has led to this new departure, preparations for which were begun in 1886 by enlarging the trough capacity at several of the stations and by building rearing ponds and increasing the water supply. The number of yearling fish distributed in 1888 was 48,000, nearly all of which were the Eastern brook trout and the rainbow trout of the Pacific coast. The distribution the present year amounted to 274,000 fingerlings of the following species, artificially bred and reared, viz, Atlantic salmon, landlocked salmon, rainbow trout, brook trout, salmon or lake trout, carp, goldfish, tench.

The artificial propagation of the pike perch was undertaken by the Commission at the Sandusky and Duluth hatcheries. Fifty million fry were obtained, which were distributed to lakes and streams in Minnesota, Illinois, Ohio, New York, and Pennsylvania.

The following species, collected from the overflow ponds of the Mississippi Valley, were also distributed: Fresh-water drum, rock bass, crappie, black bass, white bass, pike perch, pickerel, buffalo, catfish. This branch of our work will be extended as rapidly as the requisite additional facilities can be provided.

During the year terminating June 30, 1888, fifteen stations, including Sandusky and Quincy, were in active operation:

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| 1. Schoodic Station, Maine. | 8. Central Station, Washington, D. C. |
| 2. Craig's Brook Station, Maine. | 9. Fish Ponds, Washington, D. C. |
| 3. Gloucester Station, Massachusetts. | 10. Wytheville Station, Virginia. |
| 4. Wood's Holl Station, Massachusetts. | 11. Sandusky Station, Ohio. |
| 5. Cold Spring Harbor Station, New York. | 12. Quincy Station, Illinois. |
| 6. Battery Island Station, Maryland. | 13. Northville Station, Michigan. |
| 7. Fort Washington Station, Maryland. | 14. Alpena Station, Michigan. |
| | 15. Baird Station, California. |

The following stations were under construction or repairs with a view to their occupation the present season:

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| 1. Baird Station, California. | 3. Neosho Station, Missouri. |
| 2. Clackamas River Station, Oregon. | 4. Duluth Station, Minnesota. |

The stations in active operation during the present fiscal year are as follows:

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| 1. Schoodic Station, Maine. | 10. Wytheville Station, Virginia. |
| 2. Craig's Brook Station, Maine. | 11. Sandusky Station, Ohio. |
| 3. Gloucester Station, Massachusetts. | 12. Quincy Station, Illinois. |
| 4. Wood's Holl Station, Massachusetts. | 13. Northville Station, Michigan. |
| 5. Cold Spring Harbor Station, N. Y. | 14. Alpena Station, Michigan. |
| 6. Battery Island Station, Maryland. | 15. Duluth Station, Minnesota. |
| 7. Fort Washington Station, Maryland. | 16. Clackamas River Station, Oregon. |
| 8. Central Station, Washington, D. C. | 17. Baird Station, California. |
| 9. Fish Ponds, Washington, D. C. | |

The station at Baird, Cal., for the collection of the eggs of the rainbow trout, having served its purpose, was discontinued.

The oyster-cultural station at St. Jerome's, Md., was abandoned, the results obtained not justifying the expenditure required.

The station at Neosho, Mo., was under construction, but not completed at the close of the fiscal year.

Additional stations were authorized by Congress, and provisions made for them by special appropriations in the sundry civil bill, which became a law March 2, 1889, as follows:

<i>Fish-hatchery, Maine.</i> —For the purchase of ground, construction of buildings and ponds, and purchase of equipment of fish-hatchery and rearing stations near Craig's Brook, Reed's Pond, and Branch Pond, Maine	\$11,000
<i>Fish-hatchery in Lake County, Colorado.</i> —For the construction of a Government trout-breeding and distributing station in Lake County, Colorado	15,000
<i>Fish-hatchery on Lake Erie.</i> —For the purpose of establishing and equipping a station at some convenient point on Lake Erie, to be designated by the Commissioner of Fish and Fisheries, for the taking of spawn and the propagation of whitefish	20,000

These stations when completed and in operation will require annually an aggregate expenditure of \$18,000, which must be provided for by a corresponding increase in the appropriation for the propagation of food-fishes; the present appropriation of \$130,000 is barely adequate to provide for the expenses of the general administration and the maintenance of stations now in operation.

SCHOODIC STATION, MAINE.

Mr. Charles G. Atkins, the superintendent of Craig's Brook Station, also has charge of the Schoodic Station, at Grand Lake Stream. This latter station is devoted to the collection and distribution of landlocked salmon eggs, and is conducted jointly by the United States, New Hampshire, and Massachusetts. The routine work was begun by the foreman, W. H. Munson, September 3, 1888. Frequent rains in the fall of 1888 delayed operations. Between October 24th and November 24th, 974 breeding salmon were taken in barrier and pound nets. Exactly one-half of these were males; 963,900 eggs were taken, which were divided as follows: To Massachusetts, 14,000; to New Hampshire, 65,000; to the United States, 510,000. The share of the United States was distributed as follows:

To Maine Commission	25,000	To Michigan Commission	100,000
To New York Commission	100,000	To Deutscher Fischerei Verein ..	50,000
To New Hampshire Commission ..	65,000	To Richard Young, Ediuburgh,	
To Plymouth, N. H., for distri-		Scotland	25,000
bution on account of the United		To Wytheville Station, Va.	30,000
States	50,000	To Duluth Station, Minn	50,000
To Minnesota Commission	25,000	To Central Station, Washington,	
To Iowa Commission	25,000	D. C	30,000

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On account of the warmer temperature of the spring water, the eggs matured earlier than they usually do in the river hatchery, and shipments were begun January 29, 1889, and completed February 5. There were retained 204,365 for Grand Lake Stream and its tributaries; the work was completed June 22. The distribution of Schoodic salmon fry was as follows:

Date.	No.	Age.	Where deposited.
Oct. 16, 1888.....	2,349	Six months.....	Craig's Pond.
Oct. 17, 1888.....	2,021	do.....	Do.
Oct. 26, 1888.....	1,281	Eight months.....	Do.
May 28, 1889.....	333	Thirteen months...	Do.
Total.....	5,984		

The eggs reserved at Schoodic Station counted 211,100. From these about 205,000 fish were hatched at the joint expense of the United States and New Hampshire, and liberated in Grand Lake and Grand Lake Stream in June, 1889. May 27th, 153 landlocked salmon, thirteen months old, were deposited in the same waters.

The 200,000 eggs of the Penobscot salmon sent from Craig's Brook Station to the Schoodic Station yielded about 198,000 fry, which were liberated in Grand Lake and connecting waters in June, 1889.

CRAIG'S BROOK STATION, MAINE.

This brook empties into Alamoosook Lake, which discharges its waters through Narramissic or Eastern River into the Penobscot near its mouth. The mouth of the brook is about 3 miles from the head of tide water at Orland. Experiments in salmon-culture in the United States began near the mouth of the Penobscot in 1871, and Craig's Brook became the place of inclosure for breeding fish. The work was temporarily removed to another hatchery near Bucksport, but the original location was again occupied in 1879. In 1886 the operations at Craig's Brook were extended to include the feeding and rearing of *Salmonidae* in troughs and ponds; but this work was temporarily suspended because the superintendent of the station, Mr. Charles G. Atkins, was assigned to duty elsewhere.

In 1888 the plan was revived, and it was decided to buy the farm inclosing Craig's Brook and establish a permanent station for rearing *Salmonidae*, and especially the Atlantic salmon. One hundred and thirty-five acres of land, inclosing both banks of the stream for its entire length, were leased with the privilege of purchase; and in April, 1888, the superintendent began preparations for the season's work. Breeding Atlantic salmon were confined as usual at Dead Brook. Between May 27th and June 10th, 612 salmon were bought and placed in the inclosure. Of these, 435 were retaken in October and November; 255 females, averaging 15.43 pounds in weight, yielded 2,253,206 eggs, of which

85,906 died during development. The remainder were divided among the subscribers, as follows: U. S. Fish Commission, 1,527,600; Massachusetts, 290,000; Maine, 350,000; reserved at Craig's Brook for rearing, 132,600; packed and shipped as indicated in the tables of distribution, 1,395,000.

The following stock of fish and embryos were retained for breeding:

Atlantic salmon:	
One year old	1,520
In the egg	109,965
Landlocked salmon:	
One year old	80
In the egg	26,191
Rainbow trout in the egg	2,500
Brook trout in the egg	4,000
<hr/>	
Total	144,256

Forty open-air troughs were added to the accommodations. Arrangements were made to feed them on maggots and chopped meat, the use of entomostraca, insect larvæ, etc., having been abandoned because of the expense involved in getting them. The fish began to feed June 1. Fungus did not make its appearance, and the loss in this month was unusually small.

Five thousand eggs of the Atlantic salmon were sent from Craig's Brook to Mr. E. G. Blackford, New York, for transshipment to Quito, Ecuador.

Coregonus albula.—Of this little German whitefish, 51,000 one month old were planted in Heart Pond, Maine, April 21, 1888, by Mr. Atkins.

Atlantic salmon.—The distribution of young salmon of this species was as follows: 1888, October 16, to December 15, 13,498 six to eight months old in tributaries of the Alamoosook Lake, Orland, Maine. May 3, 1889, 310 one year old, same waters.

GLoucester Station, MASSACHUSETTS.

The active operations at this station, which is under the superintendency of E. M. Robinson, are confined to the winter and early spring. During the rest of the year it is closed and in charge of a custodian. The station was occupied with a working force about the middle of October, necessary repairs made, and equipment overhauled and put in order.

Cod.—On November 3, the first codfish eggs were taken, and the work continued until March 15, 1889. The percentage of loss was very large, which was attributed to the fact that many of the eggs were killed by exposure to severe weather; moreover, frequent storms roiled the water, and mud in suspension, being carried into the hatching boxes, adhered to the eggs and destroyed their buoyancy. Total number of eggs taken, 45,000,000; lost in incubation, 28,000,000; transferred to the Wood's Holl Station, 6,000,000. Eleven million young were hatched and planted in Gloucester Harbor, near Eastern Point.

Pollock.—Experiments were made in hatching pollock eggs, with fair success considering the disadvantages in handling a species new to artificial propagation. Total number of eggs obtained, 32,000,000; lost in incubation, 25,000,000; number of fry hatched and turned out, 7,000,000. Seventeen million eggs were lost at one time in consequence of a heavy storm occurring in the latter part of November. In hatching, the best results were obtained with the McDonald tidal box, having the water turned on sufficiently strong to keep the siphon from breaking after the water had been drawn down to its lowest point.

WOOD'S HOLL STATION, MASSACHUSETTS.

This station was operated during the entire year, with Mr. John Maxwell as superintendent and Prof. John A. Ryder in charge of the laboratory. Mr. Richard Dana conducted the fish-cultural work. Important changes and improvements were made in the pumps and boilers, and the electric-light plant was finished and put in operation.

Cod.—The cod work was very much hampered by the difficulty of obtaining spawning fish, and by the northwesterly gales during December and January, when many of the eggs were killed by the mud and slime.

The *Grampus* furnished 967 codfish from October 25 to November 22, 1888. These were kept in live cars and fed occasionally; and 11,640,000 eggs were obtained from them between October 29, 1888, and February 23, 1889. From the eggs kept at the station 5,871,000 fish were obtained. From the Gloucester Station 4,284,000 live eggs were received, which yielded 3,306,000 fry. Seventy thousand fry were kept in a glass aquarium twenty-two days, being fed on clam juice; but a sudden change of temperature killed them all. From dead fish were taken 148,000 eggs, which were hatched and planted.

The apparatus employed consisted of Chester hatching boxes and McDonald improved tidal boxes. The period of incubation in the McDonald apparatus averaged eighteen days; in the Chester apparatus, twenty days.

Sole.—The soles imported from England were kept at Wood's Holl until October 6, 1888, when the Commissioner personally superintended the planting of 28 individuals in Vineyard Sound, near Quick's Hole.

Mackerel.—Vinal N. Edwards, on May 21 and 24, collected 215,000 mackerel eggs, from which 185,000 fry were hatched and planted in Vineyard Sound, May 29. Eggs taken June 3 from fish which had been dead a few minutes could not be developed.

Scup.—On May 22, 50,000 eggs of this species were taken; 30,000 were hatched, and the young were deposited in Wood's Holl Harbor, May 29.

Sea bass.—From the 5th to the 10th of June, 1,150,000 eggs were collected. Of these 1,025,000 were hatched, and the fry were planted between June 10 and 13.

Lobster.—Between the 30th of April and the 26th of June 3,059,000 lobster eggs were taken from 330 females; 1,574,000 fry were hatched from these and planted in the vicinity of Wood's Holl. The hatching apparatus used were the Chester inverted jars, the McDonald improved hatching box, and the McDonald hatching jar, the latter being the most successful. Seven hundred and ten adult lobsters were packed in seaweed in 104 wooden crates and shipped to the Pacific coast on car No. 3 on January 14, 1889; 431 of these were females, 63 of them having their eggs fertilized. On the way about 500 died, and the remainder, of which 54 were females with eggs, were planted in Puget Sound. The attempt to rear young lobsters at the station was again unsuccessful.

COLD SPRING HARBOR, NEW YORK.

This station is owned and operated by the New York fish commission, but the privilege is granted to the U. S. Fish Commission to send here eggs of Atlantic salmon, landlocked salmon, lake trout, etc.; to be hatched and distributed under the direction of the superintendent. The fry of these species were planted, with a single exception, in New York waters. Eggs of California, Atlantic, and landlocked salmon intended for shipment to foreign countries were repacked at this station and forwarded to their destination. The results of stocking the Hudson River with Atlantic salmon were reported by Mr. Fred Mather, superintendent, in the Bulletin for 1887, page 40.

Eggs of brown trout and sálbling were received from Germany and distributed in accordance with instructions from the Commissioner.

Landlocked salmon.—From Schoodic Station were received 50,000 eggs of this salmon; 25,000 of these were sent to the Sacandaga hatchery. The eggs kept at Cold Spring Harbor furnished 22,344 fry, of which 10,000 were planted in Lake Ronkonkoma, Long Island, and 10,000 in a lake in Passaic County, N. J; the remainder were kept at the station, where they thrived until May 10, when they began to die suddenly and in large numbers and the survivors were liberated in the rearing ponds.

California salmon.—A few eggs were kept for hatching from those received for foreign shipments. In May, 1889, 1,350 fry were planted in Lake Ronkonkoma, Long Island, which has no outlet and has depths of 60 to 64 feet.

Lake trout.—Between December 26 and 31, 1888, were received from Northville, Mich., 450,000 eggs of lake trout. The resulting fry, 430,000 in number, were planted in Suffolk, Putnam, and Hamilton counties, N. Y.

BATTERY ISLAND STATION, MARYLAND.

The lease of this station (W. de C. Ravenel, superintendent) having expired in June, 1888, and Mr. T. B. Ferguson, the lessor, having declined to renew the same except upon a rental of \$1,200 per annum, which was

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considered unreasonable, it was determined to transfer the equipment and such of the buildings as were necessary for the work of the Commission to the breakwater constructed by the Engineer Department of the Government for the protection of the wharves and buildings of the Commission and the channel of approach from damage by floating ice. The necessary authority for such occupation was granted on request duly made to the Secretary of War, and the transfer of property and the equipment of the station completed in the spring of 1889. Certain of the property not required for use or which could not be removed was condemned by a board of survey, duly advertised and sold, and the proceeds, amounting to \$374.65, covered into the Treasury.

For the convenience of the work of distribution an auxiliary station was established at Havre de Grace in the canning house of Mr. S. J. Seneca. The first eggs were taken on April 15, 1889, and from that time to May 24 nearly 58,000,000 shad eggs were obtained, over 7,600,000 eggs having been taken in one day. About 5,000,000 fry were hatched and planted near the station and 35,000,000 were distributed to other points. The difference in the number of eggs taken and the number of fry distributed represents the loss of eggs during incubation.

FORT WASHINGTON STATION, MARYLAND.

The operations at this station were again under the charge of Mr. S. G. Worth. The egg-collecting season began April 12, and continued until May 17. The total number of eggs taken was 58,233,000. The eggs were not measured until thirty-six hours old, so that the number stated represents impregnated eggs. Nearly one-third of the eggs were furnished by the Fish Commission seine at the station, an equal number was obtained from the fishing shores, and the remaining eggs, upward of 20,000,000, were received from the gill-net fishermen. A freshet suspended the egg-collecting for a week in the middle of the season. On the three days preceding the freshet, April 22 to 24, the daily average take of eggs was 4,500,000; but from April 25 to May 1 only 2,922,000 were collected. Mr. Worth notes great gluts of eggs, 8,368,000 on May 6, and 6,311,000 on May 7. During the seven best collecting days, an average of over 5,000,000 per day was secured.

CENTRAL STATION, WASHINGTON, D. C.

This station, with S. G. Worth as superintendent, is located in the Armory Building. Besides containing the offices of the Commission, this building is the scene of many other important operations. Shad eggs are received here from Fort Washington Station, to be hatched and distributed. Eggs of whitefish, salmon, and trout are hatched and forwarded to eastern waters. Carp, goldfish, and other species of the carp family, and various important food-fishes of the Mississippi Valley, including catfish, black bass, rock bass, and crappie, are sent

here for distribution. Three cars, which were built expressly for the purpose, are engaged in transporting fish and eggs to and from this station. The steamer *Fish Hawk* and the launch *Blue Wing* are occupied part of the time in bringing supplies of various kinds, including fish and eggs, to Washington for the Central Station. The building is also the depot into which come all the natural-history collections and records of physical investigations made by the schooner *Grampus* and the steamers *Fish Hawk* and *Albatross*.

At this station will be found illustrations of fish-culture and fishery methods, together with the appliances and results of scientific inquiry. This is supplementary to the exhaustive permanent exhibit of the U. S. Fish Commission in the Fisheries Department of the National Museum. Fish-cultural work is shown by the actual hatching of several species, by models of apparatus now in use and formerly employed, and by means of photographs. The appliances and methods of the fisheries and of the scientific inquiry are at present illustrated chiefly by means of photographs; but it is the intention to develop these features as rapidly and fully as possible. For the investigation and illustration of scientific and fish-cultural problems, and for the gratification of visitors, the aquaria have become an invaluable resource. Their future utilization for experiment and observation promises most valuable results.

During the present fiscal year the following adult fish, fry, and eggs have been distributed through this station:

Fingerlings:		Fingerlings:	
German carp	190,928	Brook trout	125
Goldfish	7,440	Fry:	
Golden ide	7	Shad	23,404,000
Tench	1,532	Whitefish	4,595,000
Spotted catfish	301	Lake trout	38,000
Garfish	37	Brook trout	21,000
Black bass	20	Landlocked salmon	28,600
Rock bass	1,174	Eggs:	
Rainbow trout	10,160	Shad eggs	11,097,000

Two heavy freshets in the Potomac River in 1889 greatly reduced the fish supply.

Extensive improvements were made in the hatching facilities of the station, including an increased water supply, permanent aerating apparatus, enlargement of the machine room and storage quarters, and, in general, bringing the station to a point of efficiency not excelled by any other.

Aquaria.—In October a small grotto was constructed in the doorway at the western end of the building; this contained 16 running feet of glass frontage. For some weeks marine fishes were successfully maintained by means of air circulation. Immediately thereafter a similar grotto for fresh-water species was constructed in a doorway on the south side, and finally in January an annex for marine species the full

length of the west end of the building. Twenty-four special aquaria were built at the station and occupy 130 running feet in the annex. Besides being carefully fitted into paper work of massive and ornamental character, in imitation of stone, the whole was housed in with glass, requiring a considerable amount of varied work. In addition to the above, twelve large and substantial aquaria were constructed for the reception of fry on the hatching tables.

Preparations for Expositions.—During the year exhibits were sent to the Ohio Valley Exposition, held at Cincinnati, and to Augusta, Ga. More than a month's time was spent in preparing for the Cincinnati exhibition, all the station employés and also outside help being engaged.

FISH PONDS, WASHINGTON, D. C.

Mr. Rudolph Hessel, superintendent, accompanied the original importation of carp from Germany to the United States and has been in charge of the breeding and rearing ponds in Washington since they were first established. The total area under pond cultivation is now about 19 acres. The entire production of carp, goldfish, and tench in 1888 was 200,000, or about 10,000 to the acre. In 1889 the promise of increased production was very favorable, but an unusual flood in the Potomac submerged the ponds to a depth of 9 or 10 feet, and the greater portion of adult and young fish escaped into the river. At the same time many of the native fishes of the Potomac obtained entrance into the ponds, and preyed upon the young fish which had not escaped during the season of high water. As a result, the production of the ponds for the year was small, and only a limited proportion of the requests on file for carp and goldfish could be supplied.

Shad.—Nearly 3,000,000 shad fry were placed in the west pond in May, 1888. These were held in the ponds during the summer, but were not fed; on the natural food found in the ponds they made rapid growth. In October, when the young shad were released in the Potomac River, they had attained an average length of 3 inches. It was not possible to determine by actual count the number of fish liberated, but conservative estimates placed the number at 50 per cent of the number of fry placed in the pond. These results were as satisfactory as they were unexpected, and indicated a new departure in fish-cultural work, which promises important consequences.

In April, 1889, the same pond was stocked with about 4,000,000 shad fry. These had by the 1st of June attained a length of three quarters of an inch, when a flood swept the entire crop into the river. Only a few hundred remained in the pond, and these, when the water was drawn off in October, had acquired a length of from 6 to 8 inches, thus illustrating, in a very striking way, the rapid growth made by fishes when there is an abundant supply of food, and other conditions are favorable.

WYTHEVILLE STATION, VIRGINIA.

This station has been occupied, as heretofore, under lease from the State of Virginia, and George A. Seagle was continued as superintendent. The black bass, which were collected and placed in the ponds the previous fall, spawned this season for the first time, but all the young and a part of the breeding fish were lost through the overflow of Tate's Run, which also damaged the ponds and caused a considerable loss of carp, perch, and goldfish. The cultivation of the brook and brown trout proved to be unprofitable, and was therefore discontinued. On October 1, 1889, Mr. Seagle estimated the fish on hand to be as follows: Rainbow trout, 56,000; brook trout, 1,000; carp, 5,000; rock bass, 6,000; goldfish, 500.

Rock bass.—There were taken from the ponds 6,628 fish, and 400 adults were collected from Wolf Creek. To Central Station were forwarded 100 fish two and three years old; 4,300 yearlings were distributed to North Carolina and Virginia.

Landlocked salmon.—Early in February 30,000 eggs were received from Schoodic Station, Me., of which 28,700 were hatched; 4,950 fry were planted in Reed Creek, Wythe County, Va. The loss of fry in the hatchery up to June 30 was very great.

Rainbow trout.—From the first week in December, 1888, to March 25, 1889, 314,000 eggs were taken. Of these 40,000 were sent to England and France, 69,500 to various places in the United States, and 148,000 were hatched at the station. In the waters of Virginia, Kentucky, and Georgia, 46,000 yearlings were planted, and 1,900 were sent to Central Station for distribution.

Brook trout.—From the 23,800 eggs received from Northville, and the 42,000 taken at this station, were obtained 24,400 fry, which were released in the ponds; 500 yearlings also were planted in Virginia, and 185 were sent to Central Station for distribution.

Lake trout.—575 of this species were deposited on December 31, 1888, in Salt Ponds, Giles County, Va.

Grayling.—Six adults of this species were sent from Wytheville to the Cincinnati Exposition, and six to Central Station.

Carp.—The ponds yielded over 20,000 during the season of 1888-89, and 18,315 were distributed to applicants in Virginia, Tennessee, Mississippi, and Florida.

Goldfish.—Of 5,600 goldfish, over 3,000 were sent to applicants in the Middle and Southern States. Owing to the cold and cloudy weather only a small percentage of the goldfish colored.

SANDUSKY STATION, OHIO.

By agreement with the Ohio fish commission the U. S. Fish Commission took charge of this hatchery during the season of 1888-89. The species propagated included the whitefish (*Coregonus clupeiformis*)

and the pike perch (*Stizostedion vitreum*). Mr. Henry Douglas is superintendent of the station.

Whitefish.—Eggs were collected at Toledo and the Lake Erie islands from November 3 to November 28, 1888. On November 8 and 9 the temperature was 14° higher than upon these dates in 1887, and 75,600,000 eggs were lost thereby; the loss was made good by later collections. Eggs were distributed as follows:

Date.	Destination.	Number.
Nov. 9, 1888	Pennsylvania, hatchery at Erie.	9,000,000
Nov. 22, 1888	do	6,400,000
Dec. 22, 1888	do	9,000,000
Dec. 28, 1888	do	9,000,000
		33,400,000

Forty million seven hundred thousand whitefish were hatched at Sandusky and the fry deposited in the western end of Lake Erie, from March 22 to April 1, 1889.

Pike perch.—Eggs of this species were collected from April 10 to 25, 1889, at Toledo and the islands. About 90,000,000 were obtained, of which 60,000,000 were hatched; but 10,000,000 were lost through lack of facilities for shipping them. Eggs have been taken at Sandusky during six years ending with 1889, but never before in such large numbers. The following distribution of fry was made:

Date.	Destination.	Number.
Apr. 29, 1889	Illinois waters	12,000,000
May 4, 1889	Ohio waters	16,400,000
May 7, 1889	Pennsylvania waters	12,000,000
May 8, 1889	Ohio waters	10,000,000
		50,400,000

QUINCY STATION, ILLINOIS.

During the winter of 1887–88 the attention of the Commissioner was attracted to the work done by the Illinois State fish commission in the collection and distribution of the native food-fishes of the Mississippi Basin. The overflow ponds and lakes formed during the seasons of high water are the fruitful nurseries of the young of the crappies, the basses, the pike perch, the yellow perch, and the spotted catfish. Here they grow rapidly, until, with the contraction of the water areas and the increasing demands for food, the waters become overstocked and they die in countless thousands by starvation, or perish by the drying up of the ponds during the season of summer drought. It was recognized that these natural nurseries furnished ready to our hands, at little comparative cost, an immense supply of choice food-fish and well adapted by their habits and conditions of life to the more sluggish streams of

the interior, whence they have in many cases disappeared by reason of the obstructions in the course of the waters, or by the improper and wasteful methods of fishing pursued.

When it was proposed by the very efficient superintendent of the Illinois commission, Dr. S. P. Bartlett, that the U. S. Commission should tentatively undertake the work of collection and distribution, coöperating with the State commission and sharing expenses and results, his proposition was accepted, and a detail of cars and men was sent to Quincy, where headquarters were established, and the work of collection and distribution carried on for several weeks. The results have been so satisfactory and compensating that it has been determined to greatly extend operations in the future, having special reference to the needs of those States which receive only indirect and remote benefit from the work of our regular fish-cultural stations.

NORTHVILLE STATION, MICHIGAN.

Mr. Frank N. Clark, superintendent of the Michigan stations at Alpena and Northville, reports better aggregate results at these stations during the last year than any other year since their establishment. In the distribution of partially grown fish the success has been most marked; and Mr. Clark mentions an experiment in planting yearling brook trout which clearly shows the wisdom of this method of stocking streams. The entire yield of the season was 47,771,411 eggs and fish, of which nearly 45,000,000 were whitefish, and upward of 2,000,000 lake trout.

Whitefish.—In 1888 it was decided to devote the Northville Station wholly to trout and transfer the whitefish operations to Alpena. During October, however, operations were authorized on Detroit River in penning whitefish from the seines and holding them until they were ripe. Three penning stations were selected, and 4,500 fish were inclosed, from which were obtained 15,000,000 eggs of an inferior quality, because of very warm weather. Many of the fish died before their spawn was secured. This was said to be the warmest season known on the Detroit River. The whitefish work has therefore not been so satisfactory as in former years.

Von Behr trout.—Eighty-four thousand four hundred eggs of this species were obtained from 131 females between October 31, 1888, and January 4, 1889, or more than three times as many as were secured the previous year. Seventy of the females were yearlings. A female weighing 4½ pounds yielded 4,800 eggs; but the average yield was 644 eggs each. On July 1, 1889, there were 40,000 fry in the feeding tanks, which had been kept since April.

Loch Leven trout.—From 410 females there were obtained 225,125 eggs, an average of 556 each. The season opened October 28, 1888, and closed January 4, 1889. Of these eggs 120,000 were shipped as follows: Wisconsin commission, Madison, 30,000; New Hampshire commission,

Plymouth, 30,000; Nebraska commission, South Bend, 30,000; Pennsylvania commission, Corry, 30,000. The balance were hatched at Northville, yielding 89 per cent of fry. The Loch Leven trout is thriving at this station. The stock of breeders will soon be increased, as 6,000 healthy yearlings are now on hand.

Rainbow trout.—The distribution of one-year-old rainbow trout from the Northville Station included upwards of 53,000 fish, which were liberated in streams of Michigan, Ohio, Indiana, Iowa, Nebraska, and Tennessee. Fewer eggs were taken than last year, but the yield next year should be greatly increased, because in addition to the old breeders the station now has 1,500 trout two years old. The breeding females numbered 223, and yielded 204,400 eggs, an average of about 900 each. There were distributed 57,500 eggs between February 18 and April 2, of which 10,000 were sent to E. Cházari, national commissioner of fisheries, City of Mexico.

Brook trout.—The egg-taking began October 20 and continued until January 7. Females numbering 945 furnished 332,950 eggs, averaging about 350 each. More than one-third of the eggs were obtained from yearlings. The shipments of eggs aggregated 207,000. Among these were 25,000 to William Burgess, London, England; and 10,000 to E. Cházari, City of Mexico. The States receiving eggs of this species were Minnesota, Ohio, Delaware, New Jersey, and Massachusetts. The number of yearling brook trout distributed from January 13 to April 1, 1889, was 13,875, besides 1,000 which were held at the station.

Lake trout.—The main supply of eggs for the Northville hatchery was obtained at Thompson on Lake Michigan. The first eggs were taken October 16, and the season continued until November 15, when the hatchery contained 3,400,000, the greatest number ever laid down in one season. There were taken also in Lake Huron, near Alpena, 300,000. On December 21, 1888, 50,000 eggs were sent from Northville to E. Cházari, City of Mexico.

ALPENA STATION, MICHIGAN.

The season was one of the most successful recorded. From the egg-collecting stations on lakes Huron and Michigan upward of 45,000,000 whitefish eggs were obtained, completely filling the hatchery. More than 20 men were employed as spawn-takers during the season, which began November 1. In April and May, 1889, 23,320,000 whitefish fry, reared at Alpena, were deposited in lakes Huron and Michigan.

Lake trout.—In the fall of 1888 Mr. William Bolton, of Alpena, collected 150,000 shoal trout eggs, which were hatched at Alpena and planted in Long Lake; the expense was borne by private parties. In March, 1889, about 80,000 fry were liberated in Long Lake.

DULUTH STATION, MINNESOTA.

As announced in the last report, the hatchery building at Duluth was let to contract on May 21, 1888. The construction of the building was begun under the supervision of Mr. George Tolbert. On September 9, 1888, Dr. R. O. Sweeny was appointed superintendent, and reported at the station. The completed building was accepted from the contractors, Messrs. James Carlisle & Sons, of Minneapolis, January 15, 1889, and was received into the custody of the superintendent.

The grounds are located on the left bank of Lester River, at its mouth, where it enters into Lake Superior. The hatchery is built of wood upon stone foundations. It is divided into three portions: the front is 38 feet wide and 21 feet deep; the remainder of the building is 60 feet long and 30 feet wide, except the rear 18 feet, which is 34 feet wide. The front and back ends are two stories high and connected by a low attic. The stone basement contains the coal room, pump and boiler room, etc.

On the first floor is the hatching room, 60 by 32 feet, located in the back part of the building, facing the lake. In a room occupying the rear gables it is intended to place an elliptical tank, into which water will be pumped from the lake until a supply can be obtained from Lester River. From this tank the water will be distributed through pipes to the hatching and rearing apparatus in the room below. The present water supply is pumped from Lake Superior at a point nearly opposite to the hatchery. It is intended in the future to construct a dam in Lester River and convey the water through a flume to a reservoir in the hatchery grounds. Permission has been obtained from the Duluth and Iron Range Railroad Company to support this flume upon their bridge where it crosses Lester River. The hatchery is supplied with 400 jars, capable of accommodating 60,000,000 whitefish eggs. It is intended to establish collecting stations for whitefish eggs in Lake Superior, but arrangements for this could not be perfected the present season.

The following consignments of eggs were received and hatched at the station during the season:

Description.	Source of supply.	Date.	Number.
Whitefish ova	From Sandusky hatchery ..	Jan. 3	4,500,000
Do	From Alpena station	Feb. 28	5,000,000
Lake trout ova	From Northville station ..	Jan. 3	500,000
Do	From Alpena station	Feb. 28	500,000
Landlocked salmon ova	From Schoodic station		50,000
Von Behr trout ova	From Germany		50,000
Sälbling ova	do		9,000

The landlocked salmon, whitefish, and lake trout fry were planted in Lake Superior in localities adjacent to the station. The fry obtained from the Von Behr trout and sälbling eggs were held at the hatchery until the end of June and then transferred to the Minnesota State

hatchery, the State commission kindly affording accommodations for them until suitable ponds could be prepared for them at the Duluth station.

Pike perch.—During the spring of 1889 the superintendent collected 25 quarts of the eggs of this species. These were hatched with fair success, and about 3,000,000 fry were obtained, which were planted off the north shore of the lake about $2\frac{1}{2}$ miles above Lester River. The work of the present season was preliminary to much more extended operations with this important food species. Eggs intended for development at Duluth were provisionally sent to Northville to be cleaned up and forwarded to Duluth when the station was ready.

NEOSHO STATION, MISSOURI.

The resolution of Congress directing the Fish Commissioner to select a site for a fish-cultural station in the Ozark region of southwest Missouri, the exploration of that country in pursuance of the order of Congress, and the provision in the sundry civil bill for the construction of an establishment and its maintenance for the fiscal year ending June 30, 1889, are fully set forth in the last report.

By act approved October 2, 1888, an appropriation of \$8,000 was made for the construction of buildings, ponds, and appliances for a fish-cultural station at Neosho, Mo. On December 7, 1888, a certificate of title for the land required was approved by the Attorney-General of the United States. On November 19, 1888, Lemuel B. Herrell and his wife executed a deed to the United States transferring a part of the northwest quarter of the northeast quarter of section 30, township 25, range 31 west, fifth principal meridian, containing about $12\frac{3}{10}$ acres, more or less. By a subsequent deed of December 17, 1888, a strip of land 25 feet wide on each side of this spring was transferred to the United States, in order to insure control of the water supply.

The consideration for these pieces of property was \$2,472.43, and this was paid by the city of Neosho. In securing this land the Commission was greatly indebted to the services of Hon. Lee D. Bell, mayor of the city. On January 12, 1889, the engineer of the Commission began a survey of the tract of land, and prepared a map giving the relief of the ground and indicating the best method of introducing the water from Herrell Spring into the grounds. On February 1, 1889, Mr. W. F. Page was appointed superintendent of construction, and left Washington February 24, to begin the establishment of ponds, laying out of roads, etc. On March 6, 1889, an act introduced in the legislature of Missouri by Representative Gallemore, of Newton County, ceding jurisdiction to the property occupied by the United States as a fish-cultural station, became a law of the State. On March 18, 1889, Mr. George H. Tolbert was assigned to duty at Neosho, to assist the superintendent. The rest of the fiscal year was devoted to inclosing the property and constructing ponds and roads and wooden piping for the introduction of the water supply.

LEADVILLE STATION, COLORADO.

A station for breeding and rearing trout in the Rocky Mountain region having become a necessity, the Commissioner made a careful examination of the country available for the purpose and decided to locate the station in Colorado. The site selected is in Lake County, near Evergreen Lakes and about 6 miles west of the city of Leadville. By act of Congress approved March 2, 1889, the sum of \$15,000 was appropriated for the purpose of erecting a hatchery building in Colorado. A Government reservation for the use of the U. S. Fish Commission was created by proclamation of President Harrison dated April 16, 1889, and consists of 1,935 acres, beginning on the western edge of the Arkansas Valley and extending to the top of Mount Marcy, 14,298 feet above tide water, so as to include the upper valley of Rock Creek, which has its sources in an extensive permanent ice and snow field, lying in a depression on the flank of the mountain. Detailed plans and specifications have been prepared, and the work will be contracted for at an early date.

BAIRD STATION, CALIFORNIA.

No active fish-cultural operations were carried on at this station from 1883 to 1888. The work had been undertaken chiefly with the object of procuring the eggs of the California salmon for the purpose of stocking our eastern rivers flowing into the Atlantic and the Gulf of Mexico. It was thought probable that this species would thrive in rivers south of the Hudson, in which the Atlantic salmon does not occur naturally and in which the attempts by the Federal and State commissions to introduce the species have not proved successful. These experiments were undertaken on a scale unprecedented in the history of fish-culture. Millions of eggs were transferred to the eastern stations, hatched out, and the fry planted in nearly every one of the larger rivers south of the Hudson. In no single case did the experiment prove satisfactory, and the Commissioner was forced reluctantly to abandon an experiment which, reasoning from *a priori* considerations, gave fair promise of success, and which, had it succeeded, would have given us a new and valuable fishery in the Atlantic rivers.

The work was resumed in 1888, with Mr. G. B. Williams as superintendent, with the definite purpose of aiding in the maintenance of the salmon fisheries of the Sacramento River, which had been for several years rapidly deteriorating. All necessary preparations for work were completed by the middle of August, when the capture of gravid salmon began and continued until September 24, when the first run of salmon ceased. The second run began October 29 and continued until December 15, when the fishing ceased. The total number of eggs taken was 5,500,000, the second run of fish furnishing 4,000,000 of these (in previous years the eggs were obtained entirely from the first or August

run); 3,320,000 were transferred to the State hatchery at Sisson, the State commission completing the work of developing, hatching, and distributing at their own expense; 2,000,000 were retained and hatched at the station and planted in the McCloud River; 100,000 were forwarded to the Society of Acclimation of France through the intervention of Mr. Eugene G. Blackford, commissioner of fisheries for New York, and arrived at their destination in excellent condition.

The racks placed across the river at the station completely arrest the ascent of salmon and enable us to judge with reasonable accuracy as to the number of fish in the river. The August run this year was much less than usual, and is to be attributed to the fact that the State has abolished the close time in August and substituted for it a close time in September, when the first run of salmon is over.

CLACKAMAS STATION, OREGON.

Deeds to this property were given April 13 and November 28, 1888. Subsequent proceedings, made necessary by the death of some of the devisees, delayed its final acquisition until February 22, 1889. In the meantime, however, Mr. Livingston Stone proceeded to operate the station as agent of the U. S. Fish Commission. On July 1, 1888, Mr. Waldo F. Hubbard was engaged as acting superintendent. During the summer various repairs and improvements were made. The property purchased from the Oregon fish commission for the sum of \$5,155.60 included a rack 400 feet long, a dam across Clear Creek 160 feet long, a flume 16 inches square conducting water to the hatchery (a distance of 1,800 feet), filtering tanks, a dwelling-house, a house for workmen, a hatching-house, and a stable, all in good condition. The hatching-house is a wooden building 40 feet wide and 100 feet long, having a capacity for 6,000,000 eggs, and the water supply is sufficient to hatch 30,000,000.

On account of the great number of salmon which collected at the rack, it became necessary to guard them day and night from poachers. The station is located at the mouth of Clear Creek, on the Clackamas River, a tributary of the Willamette, which empties into the Columbia about 180 miles from its mouth. By the consent of the Oregon commissioners the egg-collecting and hatching continued until the middle of November, when the station was turned over to the Oregon fish commission to complete the work of the season at their own expense. Some difficulty was experienced with the water supply from Clear Creek until the fall rains set in about the middle of October, a deficiency which Mr. Stone would obviate by utilizing the water from a small tributary of the creek and the construction of a temporary hatching-house large enough to carry all the eggs prior to the fall rains. An additional supply could be obtained also by using the power furnished by the surplus water from the Clear Creek flume to pump water from the river.

On August 25 the first good eggs were secured, and from that date

to November 2 over 4,500,000 were taken; of this number about 1,500,000 were hatched and planted in the Clackamas and its tributaries, and the remainder were turned over on November 17 to Mr. F. C. Reed, of the Oregon fish commission, who hatched and planted about 3,000,000 in the tributaries of the Clackamas.

STATE FISH COMMISSIONS.

It has been the policy of the U. S. Fish Commission in the development of its work of stocking the waters of the country with desirable food-fishes, to coöperate as far as possible with the various State commissions. In pursuance of this plan, during the winter of 1888-89, 3,320,000 eggs of the quinnat salmon were delivered at the State hatchery at Sisson, Cal., and the fry therefrom were distributed by the California commission. In conjunction with the same commission the experiment was also made of transferring lobsters from the Atlantic to the Pacific sea-board.

As in previous years, the propagation of the Schoodic salmon was continued at Grand Lake Stream, Maine, conjointly with the States of Maine, Massachusetts, and New Hampshire.

The New York commission coöperated in the important experiment of stocking the Hudson River with salmon.

The State commission of Ohio aided the conduct of operations with whitefish and pike perch on Lake Erie, and transferred the charge of its hatchery at Sandusky, Ohio.

In the collection and distribution of the fishes native to the Mississippi Basin, the United States commission received the hearty coöperation of the Illinois Commission.

PUBLICATIONS AND LIBRARY.

The editing of the publications of the Commission and their passage through the press continue under the charge of Dr. Tarleton H. Bean, the ichthyologist of the Commission. Under his supervision the issuance of the articles bearing upon the researches and operations of the Commission has been greatly facilitated, and the knowledge conveyed therein has been promptly placed before the general public and those specially interested.

In advance of the completion of the Report of the year 1886 and the Bulletin for the year 1887, the following papers, constituting part of the same, were issued in pamphlet form:

- The American Sardine Industry in 1886. By R. Edward Earl and Hugh M. Smith. (Bulletin for 1887, pp. 161 to 192.)
- Notes on Eutozoa of Marine Fishes of New England with Descriptions of Several New Species. By Edwin Linton. (Report for 1886, pp. 453 to 511.)
- A Review of Scleridae of America and Europe. By David Starr Jordan and Carl H. Eigenmann. (Report for 1886, pp. 343 to 451.)

- A Review of Flounders and Soles (*Pleuronectidae*) of America and Europe. By David Starr Jordan and David Kop Goss. (Report for 1886, pp. 225 to 342.)
- The Sea Fisheries of Eastern North America. By Spencer F. Baird. (Report for 1886, pp. 3 to 224.)
- Lists of Dredging Stations in North American Waters from 1867 to 1887. By Sanderson Smith. (Report for 1886, pp. 873 to 1017.)
- Report on the Medusæ collected by the U. S. Fish Commission Steamer Albatross in the Region of the Gulf Stream in 1885 and 1886. By J. Walter Fewkes. (Report for 1886, pp. 513 to 536.)
- Report on the work of the U. S. Fish Commission Steamer Albatross for the year ending December 31, 1886. By Lieut. Commander Z. L. Tanner, U. S. N. (Report for 1886, pp. 605 to 692.)
- Report on the operations at the Wytheville Station, Virginia, from January 1, 1885, to June 30, 1887. By Marshall McDonald. (Report for 1886, pp. 793 to 800.)

The distribution of the publications of the Commission during the year was, of Annual Reports, 1,360; Annual Bulletins, 313; Fisheries and Fishery Industries of the United States, 4,231; and of pamphlet articles, about 2,700.

The accessions to the library, which were secured mainly by gift and exchange for publications of this Commission, including pamphlets, periodicals, and bound volumes, were as follows: On fish, fisheries, and fish-culture, 178; on botany, geology, chemistry, and natural sciences in general, 146; making a total of 324.

COURTESIES EXTENDED AND RECEIVED.

By authority of the President, the Commission's steamer *Albatross* was placed at the disposal of the Senate Committee on Indian Affairs for an extended trip through southeastern Alaska, during the summer of 1889. Arrangements were also completed for carrying the Senate Committee on Relations with Canada to Alaska in June, but the trip was abandoned.

Materials were furnished for exhibition at the Augusta National Exposition, Georgia, the Minnesota Industrial Exposition, and the American Institute Fair.

The Navy Department has continued to assist the Commission by the detail of officers and men to its vessels and extending the facilities of the navy-yards for their outfit and repair.

The War Department continued to the Commission the privileges of the reservation at Fort Washington, Maryland, on the Potomac River, and of the breakwater near Edmonson's Island, Susquehanna River, for use as shad-hatching stations.

To the Treasury Department the Commission is indebted for many courtesies. From the Light-House Board permission was obtained to occupy the buildings on the Soldier Key Reservation, Fla., for fish-cultural purposes, and from the U. S. Coast and Geodetic Survey many copies of charts were received for use in connection with the investigations of the Commission.

The facilities of the navy-yard at Esquimalt, British Columbia, were furnished the Commission's steamer *Albatross* through the courtesy of Mr. James H. Innes, storekeeper.

Acknowledgments are also due to the Alaska Commercial Company, San Francisco, Cal., for assistance rendered agents of the Commission in the investigation of the salmon rivers of Alaska in 1889.

The work of the Commission in stocking with desirable food-fishes the various waters of the country has been greatly aided by the railroads, many of which have given instructions to their employés that messengers of the Commission be allowed access to the baggage cars, and that space be provided for cans and other accessories. In addition to these facilities, many of the roads have furnished free transportation for the cars and employés of the Commission. The following table gives the names of these roads and the number of miles for which free transportation was furnished:

Name of railroad.	No. of miles.	Name of railroad.	No. of miles.
Burlington and Missouri River.....	413	Lake Shore and Michigan Southern.....	1,262
Chicago and Alton.....	88	Michigan Central.....	2,586
Chicago, Burlington and Quincy.....	4,490	Missouri Pacific.....	1,043
Chicago and Grand Trunk.....	538	Mobile and Ohio.....	46
Chicago, Milwaukee and St. Paul.....	532	Northern Pacific.....	4,223
Chicago and Northwestern.....	1,247	Oregon and California.....	1,024
Cincinnati, Hamilton and Dayton.....	284	Oregon Railway and Navigation Company.....	856
Cincinnati, Sandusky and Cleve- land.....	10	St. Louis, Alton and Terre Haute.....	62
Central Pacific.....	290	St. Louis, Iron Mountain and South- ern.....	872
Detroit, Bay City and Alpena.....	210	St. Louis, Keokuk and Northwestern.....	1,133
Duluth and Iron Range.....	12	Texas Pacific.....	2,077
Flint and Pere Marquette.....	2,113	Utah Central.....	590
Fremont, Elkhorn and Missouri River.....	1,362	Wabash.....	4,337
Grand Rapids and Indiana.....	900	Wisconsin Central.....	882
Hannibal and St. Joe.....	1,104	Total.....	35,430
Illinois Central.....	580		
Indianapolis and St. Louis.....	294		

To various fishing firms of the country acknowledgment is also due for courtesies rendered to agents of the Commission in the collection of statistical and other data pertaining to the fisheries and their methods.

MARSHALL McDONALD,
Commissioner.