REPORT OF THE COMMISSIONER.

A.—GENERAL CONSIDERATIONS.

1.—INTRODUCTORY REMARKS.

The present report is intended to include an account of the operations of the United States Fish Commission for the calendar year 1878, although the history of a portion of its work, especially that connected with the propagation of salmon, is continued to the date of the actual planting and disposition of the young fish in 1879. It constitutes the sixth volume of the series, although relating to the eighth year of the existence of the Commission.

As in previous years, the history of the work of 1878 shows a continued increase in the scale of operations, commensurate with the increased appropriations made by Congress. This, however, has involved no material addition to the expense of the management, the clerical force remaining the same, notwithstanding an enormous increase of correspondence, especially with the fish commissioners of States, fish culturists, and generally persons interested in having private or public waters supplied with the fish covered by the work of the Commission.

In the accompanying reports, the operations of the Commission will be treated, as heretofore, under two heads—Inquiry and Propagation.

Under the former is included the history, condition, and statistics of the great fisheries and the proper methods of prosecuting them; and with this are closely connected questions as to the natural or adventitious causes influencing the abundance of fish and the methods by which such abundance may be increased.

Under the second head is given the history of measures taken to actually increase the supply of desirable fishes in particular waters, either by artificial propagation, or by transfer from other localities, or both combined.

The first-mentioned division of the work, including research into the character of the fishes belonging to the North American fauna, has been in charge of Mr. G. Brown Goode, assisted by Dr. T. H. Bean. The collection and investigation of marine invertebrates has been conducted by Prof. A. E. Verrill, assisted by Mr. Richard Rathbun, Mr. Sanderson Smith, and Mr. Warren Upham. The work of propagation of food-fishes was under the superintendence of Mr. James W. Milner, assistant commissioner, aided by Mr. Frank N. Clark, and with the very valuable co-

operation of Mr. T. B. Ferguson, Fish commissioner of Maryland. To all these gentlemen I am under great obligations for efficient assistance in carrying out the objects of the Commission. To Dr. Farlow I am indebted for an important research upon the peculiar reddening of salted codfish, to which further reference will be made.

2.—OBJECTS OF THE UNITED STATES FISH COMMISSION.

It had been my intention in this report to go into very minute details in explanation of the plan of research adopted by the Commission for carrying out its objects and the actual results that have been accomplished. This, however, will be more conveniently deferred until the next report, which will chronicle some important changes; and I will here present only a brief synopsis of the subject, in illustration of the extent of the general programme and the amount of labor involved in carrying it out; as also shadowing forth the benefit to American fisheries to be hoped for as the result of such action. Not the least important feature in the research is the securing of statistics for the proper treatment of international questions connected with the common use, by the United States and the British Provinces, of the waters of the North Atlantic.

The results hoped for by the inquiries initiated or contemplated may be summarized as follows:

1. The preparation of a series of reports upon the various groups of aquatic animals and plants of North America, especially those that have a direct relation to the wants or luxuries of mankind; these to be published as monographs in successive volumes of the Commission, to be illustrated by wood-cuts and otherwise, as may be necessary for the proper comprehension of the subject. The aim, of course, will be to present the descriptions of the various species in intelligible phraseology, and to add accounts of the habits and peculiarities of the species, with their relation to each other and the physical conditions of their surroundings. This will include, among others, an illustrated history of the various food-fishes of the United States, and towards which great progress has been made, especially in the preparation of a large number of admirable illustrations, executed by Mr. H. L. Todd.

2. The utilization of the very extensive facilities at the command of the commission in the interest of educational and scientific establishments in the United States, by securing large numbers of specimens of aquatic animals and plants which, after reserving the first series for the National Museum, will be distributed, properly labelled, to colleges and academies and scientific societies. A vast amount of material of this kind has already been gathered, and is now in the hands of specialists, who are engaged in preparing it for the treatment referred to. It is hoped the coming year to distribute many hundreds of thousands of specimens.

3. A complete account of the physical character and conditions of

the waters of the United States, as to chemical composition, temperature, &c., with special reference to their availability in nurturing the proper species of food-fishes.

4. A history and description of the various methods employed in North America, in the pursuit, capture, and utilization of fishes and other aquatic animals, with suggestions as to imperfections of existing methods and the presentation of devices and processes not hitherto adopted in the United States. A careful study of all the circumstances connected with this division of the proposed work of the Fish Commission has shown that an exchange of experiences may be of very great importance in improving the old fisheries and developing new ones. Several methods of fishing employed in Europe and unknown in the United States can be introduced to very great advantage; but so far no special effort has been made to bring this about. Among the noteworthy of these is the system of beam trawling, so universal and so productive in Europe, and by means of which the flat fishes, especially the turbot and sole, are obtained in immense quantities, in otherwise unproductive localities and at moderate cost. It may almost be said that there is a larger investment in this fishery than in any other in Great Britain; and yet it is practically entirely unknown in the United States, its use having been confined to the operations of the United States Fish Commission, of Professor Agassiz, and perhaps the Chicago Academy of Sciences. There is no doubt that beam trawling will add enormously to the facilities for procuring wholesome food at a very cheap rate. The sandy coast of the United States, especially south of Cape Cod, is pre-eminently adapted to the use of this apparatus, and there are thousands of square miles over which it can be carried with no possibility of exhausting the supply.

Another method of fishing, in great part unknown, or at least unpracticed in the United States, is that of taking codfish by means of gill-nets. Could this be introduced on our shores, especially in connection with the vast schools of cod that come in winter on our coast to spawn, it would relieve fishermen of their great embarrassment, namely, that of procuring bait. During the winter season it is frequently almost impossible to obtain bait of the proper kind, and without which fish cannot be taken. In the Loffoden Islands there is a fishery very similar to that referred to, in which, during the winter, large numbers of fish are taken, one-half of which, and these the finest and fattest, are caught in gill-nets without any bait whatever. The American methods of the treatment of fish in preparation for market can also be greatly improved by adopting foreign experience.

5. Statistics of the various branches of the American fisheries from the earliest procurable dates to the present time, so as to show the development of this important industry and its actual condition. There is no nation so badly provided with such statistics as the United States; and in the absence of appointed methods of gathering them the task

will be a very onerous one, but the later it is deferred the more and more difficult will it be, with but little on record. Old men, still living, alone possess the traditions in regard to the existence and progress of many of our most important elements of the fisheries, and it has been a special object of the Commission, at its several stations, to find such depositories and to collect, by the help of a phonographer, all the facts they can furnish, as also to overhaul old account-books and other memoranda more or less fugitive in their character. A great amount of such history has already been secured, especially in regard to the mackerel-, cod-, and halibut-fisheries.

6. The establishment either by the general government or in connection with the States of a thoroughly reliable and exhaustive system of recording fishery statistics for the future, to be combined annually and published by some of the public departments of the government. Something of this kind is done by the Treasury Department for a few branches of the fisheries, but the result is necessarily inadequate and incomplete.

7. The bringing together in the National Museum not only of a complete collection of the aquatic animals and plants referred to, but of illustrations of all apparatus or devices used in the prosecution of fisheries at home and abroad, together with specimens of the results.

In the winter of 1874–'75 Congress made an appropriation to enable the Departments of the Government to present at the International Exhibition at Philadelphia a complete display of the resources of the United States. A portion of this fund having been assigned to the Fish Commission, the occasion was embraced to commence such a collection as that referred to. This was exhibited at Philadelphia and was highly appreciated. Since that time every opportunity has been made use of to secure additional objects of the same kind, showing the earlier and perhaps obsolete methods and applications, as well as those that are now in current use. To these have been added illustrations of the methods and apparatus of artificial propagation of fishes, or of technical fish culture.

8. An investigation of the movements and habits of the various kinds of fish, to serve as a basis of legislation, either by the general government or by the States.

It is very difficult to establish data of this kind upon facts furnished by any one State; it is only by considering the subject in its relations to the whole country that an equitable system of legislation can be suggested. Dates and conditions that answer admirably for one part of the country will be entirely unsuited to another, especially so far as relates to the periods during which fish should not be taken. The question, too, of keeping open the natural channels of the water, so that fish may ascend to their source, is one that will generally require the action of the general government.

Other inquiries involved are the introduction into the water of substances injurious to fish, either of a mechanical or chemical nature, &c.

A corollary to the above is the determination of the best form of

fishways for the different conditions of American rivers, of methods of chemical or mechanical purification of the waters, &c.

9. By means of the information to be thus obtained, it will be possible to determine what regulations shall be made by the general government or by the States in respect to close seasons or intermissions of capture, the size of the fish to be caught, the enforced use of fishways, regulations as to introduction of refuse, &c. All this will require careful consideration, so as to avoid infringing upon natural or vested rights, while doing everything to the best interest of the community.

10. The stocking the various waters of the United States with the fish most suited to them, either by artificial propagation or transfer, and the best methods and apparatus for accomplishing this object.

3. ASSISTANCE RENDERED THE COMMISSION.

The act of Congress authorizing the prosecution of the labors of the United States Fish Commission instructs the Heads of the various departments of the Government to render to it all necessary and possible aid; and, as in previous years, the most generous and liberal interpretation of the law has been given by them.

To the Secretary of the Navy, Hon. R. W. Thompson, obligations are especially due for aid, without which the success of the Commission would have been much diminished, both in the branch of Inquiry and Propagation.

The most notable favor rendered by the Secretary has been the fitting out of the iron steamer Speedwell, and placing it at the disposal of the Commission for the summer-work, this being the third year of its detail for such service. Only second in importance to this was the furnishing of two steam launches, with two firemen each, to be used in connection with the propogation of shad in Albermarle Sound and in the Susquehanna River.

In accordance with the instructions of the Secretary of the Navy to the commandant, the facilities of the navy-yard at Washington have been freely extended in the fitting out or repairs of the scows and other vessels belonging to the Fish Commission.

The Treasury Department, through the Bureau of Revenue Marine, has also rendered a hearty co-operation by transporting the hatching barges of the Commission to and from their various stations. The revenue-cutter Ewing, under Captain Fengar, towed these boats from Washington to Norfolk *en route* for the scene of operations on Albemarle Sound, and, at its conclusion, from Norfolk to Havre de Grace, for service there, and finally back to Washington when the hatching season was completed for the year.

The revenue-cutter E. A. Stevens, under command of Capt. J. G. Baker, and stationed at Newbern, was also instructed to render similar aid, whenever necessary, in the Albemarle Sound waters.

To the Light-House Board of the Treasury Department is due the means of initiating and prosecuting important observations upon water temperatures in the vicinity of various light-houses and light-ships along the coast the necessary blanks being furnished by the Commission. These, when filled, were delivered to the light-house inspectors and by them forwarded through the Light-House Board to the Commission.

The War Department has furnished eight Springfield rifles and eight hundred cartridges for the purpose of the protection of the United States salmon-hatching station on the McCloud River against lawless depredators, white and Indian. General McDowell also supplied a detail of men for special service during the critical period of operations.

The Signal Office of the War Department, under General Myer, has also extended important co-operation, by continuing the series of observations of water temperatures initiated several years ago at the request of the Commission. It has been possible by this means to get a general idea of the variations of temperature in the principal streams of the country, and thus to supply, incidentally, information necessary to judicious action in connection with the introduction of the different kinds of food fish.

The observations taken at the sea-coast stations of the Signal-Office are also of great importance in determining the conditions of the movements of the pelagic fish, such as the mackerel, menhaden, blue-fish, &c.; and the extension of this system promised by the Chief Signal-Officer, by which all the coast telegraph and life-saving stations and light-houses and light-ships are to be included in the series of observations and furnished with the best kind of instruments, is also of very great importance.

Partly for the service of the Commission, and also to assist in the commerce and fisheries of the coast, the Chief Signal-Officer made Gloucester a storm-warning station during the summer of 1878, thus adding greatly to the facilities of the work. The forecasts of weather were also sent daily, arriving some time before the receipt of the Boston papers.

To the Patent Office of the Interior Department is due, through Dr. Dyrenforth, chief examiner, a list of all the patents relating to fish and fish culture issued in Great Britain and some other countries, as well as in the United States.

For the purpose of better facilitating the operations at the McCloud River salmon station the Post-Office Department authorized the establishment of the post-office of Baird, in Shasta County, by means of which the station and its vicinity generally are provided with the necessary postal facilities. Previously, the nearest convenient post-office had been at Redding, a number of miles distant, and for the receipt of the mail therefrom the station was dependent upon the courtesy of the stage-drivers.

To Colonel Casey, Superintendent of Public Buildings and Grounds in Washington, the Commission is indebted for the construction and

improvement of the carp ponds on Monument Lot, the work being executed with great economy and with satisfactory results.

The public and official acknowledgments of the Commission for important services rendered are also equally due to many private establishments and individuals. The most important of these is the Maryland Fish Commission, under the direction of Mr. T. B. Ferguson. By combining operations at various times with this organization, the United States Commission has been enabled not only to secure the valuable superintendence and aid of Mr. Ferguson in its work, but the free use of important apparatus, and a consequent reduction of the absolute expense.

The Druid Hill Park Commission, of the city of Baltimore, is also entitled to mention in this connection for authorizing the use of the park for the cultivation by the Commission of the German carp, golden ide, and other fishes. For this purpose it constructed several ponds at a large expense to itself, for the continued culture of these fish, thus serving as an auxiliary station to the establishment at Washington. This is a matter of very great importance, as the ponds in Washington are very low, and the locality has been overflowed by the Potomac River several times within the last thirty years; and as this may at any time occur again, involving the loss of all the fish, the Baltimore station will furnish the means of renewing the supply at Washington.

A large number of railroads throughout the country, a list of which will be furnished hereafter (see p. xxxvii–xxxviii), have also co-operated with the Commission. The special favor conferred is that of receiving quartermaster's orders for the transportation of messengers, and in permitting the cans containing the young fish to be carried in the baggage cars of express trains without extra charge, and allowing at the same time the attendance of one or more messengers.

The extent of this favor can be better appreciated by the fact that not unfrequently there are two messengers, with twelve to eighteen 50-quart milk cans filled with water, to be transported on a passenger train.

Acknowledgments due to other co-operating bodies and to individuals, will be made in their proper place.

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

4.—FIELD OPERATIONS DURING THE SUMMER OF 1878.

The ability to carry on the researches along the coast of the United States, for the purpose of solving the problems referred to in a preceding page, has been dependent in a great measure upon the facilities furnished by the Navy Department for the purpose; and I have already mentioned that the liberal interpretation of the law of Congress made by the predecessor of the present Secretary of the Navy and carried out by the latter in the earlier years of his administration, has been continued during the year 1878.

The United States steamer Speedwell, assigned to the United States Fish Commission in 1877, was also placed at its disposal in 1878. Commander L. A. Beardslee, who had been in charge of the steamer Blue-Light during the field-work of 1873, 1874, and 1875, was placed in command of the Speedwell; Commander Kellogg, who was in charge of the vessel in 1877, having been assigned to other duty.

All the necessary repairs to the Speedwell were made at the Portsmouth navy-yard, at which place she had been laid up during the preceding winter.

After a careful inquiry into of different points on the sea-coast from which a critical scientific research might profitably be made in the interest of the fisheries, Gloucester, Mass., was selected, and on the 9th of July I established my headquarters there for the season, accompanied by the entire clerical force of the Commission.

After due inquiry, a suitable wharf and buildings were rented on Fort Hill, at the mouth of Gloucester Harbor. Rooms for laboratories, offices, storage, &c., as also a large apartment, used afterwards for the hatching of codfish, were included in the accommodations supplied. The wharf, directly on which the buildings were situated, fronted about 150 feet on two sides.

The Speedwell arrived on the 18th of July, and from that time until her departure, on the 30th of September, the work was carried on without serious interruption other than that caused by the weather, excepting for one period, from the 4th of August until the 14th, when she was at Portsmouth undergoing certain necessary repairs.

The personnel of the Speedwell consisted, in addition to her commander, Captain Beardslee, of Dr. J. F. Bransford, surgeon; H. E. Drury, paymaster; R. W. Galt, engineer; James H. Smith, executive officer; James. H. Kuhl, mate. The wharf, buildings, and apparatus were in charge of Capt. H. C. Chester, under whose superintendence also the work of dredging and trawling was usually conducted. The total force of the steamer, including petty officers and men, amounted to about 40.

The laboratory work was, as usual, under the special charge of Mr. G. Brown Goode and Prof. A. E. Verrill; Mr. Goode, aided by Dr. Bean, taking charge more particularly of the fishes, while Professor Verrill, assisted by Mr. Richard Rathbun, and for a portion of the time by Mr. Warren Upham, superintended the dredging and trawling work and the collection of marine invertebrates.

For a portion of the season Dr. W. G. Farlow was engaged in carrying on some researches into the peculiar condition to which salted codfish is liable during the moist summer weather. Small red specks show themselves upon the fish and rapidly spread, in time covering it completely. This is accompanied by a tendency to decomposition, which spoils the fish for market. As a very important subject, I invited Dr. Farlow's attention to it, and his report will be found in the appendix

herewith. He considers the affection to be due to the presence of a minute red alga, possibly derived from the salt used in curing the fish. The Cadiz salt, examined by him, was found to contain the spores of this alga in large quantity, being tinted of a pink color thereby. These were doubtless derived from the vats or evaporating places of the salt. The Trapani salt, also used by the fishermen of Gloucester, was found to be free from this admixture, and its use is therefore recommended. The attempt to eradicate the affection will require that the holds of the vessels and the salt-houses be kept perfectly free from the introduction of this plant.

During a visit by Prof. W. O. Atwater to Gloucester, during the summer, an arrangement was made with him to prosecute a series of investigations upon the food-qualities of various species of fishes and their availability for the manufacture of fertilizers, involving many chemical analyses.

The various researches prosecuted during the summer's campaign will be presented hereafter in the form of special reports.

The usual collections were made, especially by means of the dredge and trawl, and the specimens secured are held for the National Museum and for distribution to educational establishments throughout the United States.

An extremely valuable mass of information was obtained during the summer, by Mr. Goode, in connection with the early history of the Gloucester fisheries, and by means of questioning some old fishermen and sailors he secured full details as to the inception and early history of the mackerel, halibut, cod, and other fisheries. This will be embodied with the series of investigations undertaken for the purpose of securing statistical information on the American fisheries, the importance of which was referred to in the previous report. Many specimens of fishery apparatus were also secured, some of them obsolete or displaced by modern apparatus, others illustrating the present condition of operations; all, however, of interest.

In addition to the collections made, many soundings and temperatures of the water were taken, the condition of the bottom ascertained, &c.; and an important generalization was made by Professor Verrill, based upon certain collections of fossil remains brought in by fishermen from various parts of the fishing banks. These were evidently of Tertiary age, but of a formation and distribution differing remarkably from anything known on the mainland, and suggesting to Professor Verrill the existence of a Tertiary deposit off the coast, hitherto unknown. While some of the species are the same as those found on the mainland, others are entirely different and appear to be new to science.

The work of the Commission was greatly facilitated during the period of its stay by the establishment, by order of General Myer, of a storm-warning station at Gloucester. This was erected on the top of the custom-house, one of the highest edifices in the city and visible for a great

distance. Apart from its aid to the work of the Commission it enabled the large fleet of Gloucester fishermen to regulate their departure to sea with great advantage.

As usual, the Commission had many visitors during the summer; some for the purpose of taking a special part in its work, and others to familiarize themselves with its general operations.

Among the visitors were a number of gentlemen belonging to the Boston Fish Bureau, and familiar with the coast fisheries, to whom I had the pleasure of exhibiting the Pole flounder, seen by them for the first time. A similar experience was had with fish merchants and skippers of Gloucester. Reporters from the principal Boston papers, and some from New York, were also included in the number of those receiving the attention of the Commission.

A special incident of the season was a call from the Secretary of the Navy, Hon. R. W. Thompson, on the Tallapoosa, on the 25th of July. The Secretary was accompanied by several of the officers of the department, as the chief naval constructor,the chief engineer, the Paymaster-General, the attending surgeon, &c. The vessel remained in port for two days, and the occasion was taken to show the Secretary and party the operations of the Commission on the Speedwell, in the way of trawling and dredging.

For the purpose of determining more particularly the character of the animal life on the Grand Banks, especially of the ocean birds, which are used in great numbers by the fishermen for bait; I made arrangements with Captain Collins to carry Mr. R. L. Newcomb on a halibut trip to the banks. He was absent from the 28th of August to the 18th of September, and brought back many interesting specimens of birds as well as of marine invertebrates. It was found that the birds serving as bait were for the most part a species of petrel, of which many hundreds are often taken on a single trip by means of the hook and line.

The most active field-work of the Commission closed for the season on the departure of Professor Verrill on the 12th of September; but other branches were continued until the departure of the Speedwell for Washington on the 30th of that month. She reached her station in good season and was laid up in the Washington navy-yard for the winter.

I remained in Gloucester until the 15th of October for the purpose of finishing up certain statistical inquiries and of making the necessary arrangements for the propagation of codfish, to which reference will be made in a succeeding section of the report. Leaving on the 15th, I reached Washington with my party on the 24th. Mr. Milner, with Mr. R. E. Earll, Frank N. Clark, and Capt. H. C. Chester remained behind in connection with the last-mentioned interest.

C.—THE PROPAGATION OF FOOD FISHES.

5.—WORK ACCOMPLISHED IN 1878.

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

The McCloud River Station.—The heavy rains of the winter of 1877–1878, and during the spring of the latter year, caused great damage in the valley of the McCloud River, and especially to the works on the United States Salmon Reservation. Many of the buildings were swept away, and the dam and works for raising water to the hatching-house were entirely ruined. A special allowance of $2,500 was made to Mr. Stone for restoring the station to the proper condition; and, reaching the ground on the 9th of May, he immediately went to work to reduce the disorder and render the works satisfactory for future operations.

The establishment by the Postmaster-General of the post-office of Baird, on the reservation, on the 3d of May, 1878, was of very great service to the Commission in keeping up its communication with the outside world. Previously the nearest convenient post-office was that of Redding, 22 miles distant, and the party at the works was dependent upon the courtesy of the stage-drivers for bringing along the mail. This act proved of service, not only to the reservation itself, but to the settlers scattered around, who appreciated the advantage to them in diminishing their travel.

As in previous years, there were various alarms in regard to lawless whites and Indians who threatened to raid the establishment and burn the buildings, as also to take possession of the penned-up fish, and thus nullify the work of the Commission. An application made to the War Department for arms was met by the issue of eight Springfield rifles and eight hundred cartridges. This equipment, supplemented by the detail by General McDowell of some soldiers, placed the establishment in a satisfactory condition of defense, and no violence was attempted.

The season of 1878 proved to be the most productive in the history of the establishment, and the number of eggs obtained, fourteen millions, was truly enormous, far exceeding those taken in any one season by all the salmon establishments in the world put together. According to Mr. Stone's estimate 18,000,000 could easily have been secured if desired, but the take was limited to the number applied for by the State commissioners and those needed to maintain the supply in the Sacramento River.

The first eggs of the season were taken on the 20th of August, and from that time until the 5th of October, when the last car was loaded with salmon eggs, the time of Mr. Stone and his assistants was employed without intermission. The fish were unusually abundant, thousands being often taken at a haul.

A notable feature in the season was the small size of the parent fish, these averaging less than nine pounds, some of the mother fish, full of

ripe eggs, weighing only from six to eight pounds. This, Mr. Stone thinks, is due to the stoppage of the large salmon by the fishing at the canneries on the Lower Sacramento, allowing only the smaller fishes to pass.

It will doubtless somewhat astonish many persons at the East who are not familiar with the scale of operations on which the business is conducted at the West, to be told that from seven to nine thousand salmon were several times taken at the station in a single day.

The number of eggs actually secured and embryonized was so large that two cars were required to transport them to the East. Of these, the first left Redding with 4,000,000 on the 29th of September, arriving at Chicago on the 3d of October. The second, with 3,250,000, arrived at Chicago on the 7th of October. They were met by Mr. Fred. Mather, and the distribution was immediately made from that city by express. The details of distribution will be found in the schedule attached to Mr. Stone's report.

As usual, a large number were hatched out and planted in the McCloud, for the purpose of keeping up the supply in the Sacramento, 2,500,000 being thus treated; 500,000 eggs were presented to Canada, 100,000 to England, 100,000 to France, 100,000 to Holland, 250,000 to Germany, and 200,000 were sent to New Zealand.

In the report for 1877 mention is made of the shipment to various foreign countries of California salmon. The half million of eggs sent to New Zealand arrived in perfect condition, and were distributed by the government, to the several provinces. The latest advices speak of the young fish being seen in every direction, and promising to be the ancestors of a numerous progeny. Owing to various causes, however, the consignments to Germany, France, England, and the Netherlands in 1877, were failures, only about 25,000 eggs of the German lot surviving. These had been packed in a special manner by Mr. Mather, and escaped the fate of the rest.

Owing to the very high opinion entertained by European fish culturists of the California salmon as a food fish, both on account of the ease of its cultivation and the fact that it resists higher temperatures of water than the Atlantic salmon, it was determined to renew the experiment, by a transmission in 1878; and Mr. Mather was authorized to repack the eggs in his own way and accompany them to their destination. In accordance with instructions he, therefore, met the car containing the eggs from California at Chicago and received 250,000 for Germany, 100,000 for France, 100,000 for Great Britain, and 100,000 for the Netherlands. These he carried to his residence at Newark, and after repacking them by his own method, he took passage by the Bremen steamer Oder, and arrived at Bremerhaven on the 23d of October. The consignment for France was shipped from Southampton, on the way, and that for England was sent, for the most part, to the Southport Aquarium. The eggs for the Netherlands were met by an agent of the gov-

ernment at Bremen and transported to Amsterdam, where they were hatched out by the Zoological Garden.

The new venture proved to be a perfect success, a very small percentage of the eggs failing to be hatched out. Of the eggs of the German consignment 45,000 were sent directly to Mr. Haack at Hüningen, for introduction into the Rhine. One hundred and fifteen thousand were sent to Mr. Schuster, at Freiburg, for the Danube and the Rhine; and 30,000 to Hameln, for the river Weser. Various smaller lots were distributed to other places; and all were successfully hatched out and placed in their destined waters.

The 100,000 sent to France were also hatched out with comparatively small loss and introduced into various rivers of the republic. Those for the Netherlands were equally successful. The number actually received in Amsterdam was estimated at 85,000, and of these over 60,000 produced healthy fish, and were planted in various streams.

In the general table of distribution of California salmon will be found the indications of the various streams in which the fish were placed respectively.

Later in the season a consignment of the land-locked salmon was sent to the Société d'Acclimatation in Paris. These, however, owing to some unexplained casualty, arrived in poor condition, and comparatively few were saved.

Full details in regard to the work at the McCloud River station will be found in Mr. Stone's article, given in the Appendix.

Clackamas Station.—In the report of 1877 reference is made to the fears of the salmon-canners on the Columbia River as to a threatened diminution of the fish, and to the arrangement made through Mr. Stone for the establishment of a station for artificial propagation. This, after considerable delay, was established in the Clackamas River, but owing to the lateness of the season when the work was completed only a small number of eggs were obtained. These were supplemented by a transmission from the McCloud River, and a successful result accomplished.

The work was continued in 1878; but the funds available for the purpose being very limited, I agreed to assign a portion, not to exceed $5,000 of the appropriation, to the work, believing that in so doing I was properly carrying out the intention of Congress.

The first eggs were taken on the 5th of September; and up to the 30th 2,081,000 had been taken from 478 females. Some casualties were experienced in the course of the season by the heavy rains, which caused the dam to break; but a reasonable percentage of eggs was satisfactorily hatched out and introduced into the river. The principal part of the hatching and depositing in the river was done between the 24th of December, 1878, and the 2d of January, 1879, the number of young turned in being estimated at 1,203,000. The percentage of loss would have been much less but for the necessity at one time of moving the eggs from the hatching house to the river and back on account of a flood.

The details of the work will be found in the appended report of Mr. William F. Hubbard, the assistant superintendent.

At the close of the season it was found that the bills, in regard to which proper vouchers could be rendered, and applicable to the actual work, and not simply to the construction of permanent improvements, amounted to about $3,600, which was duly paid to Mr. J. G. Megler, the secretary of the Oregon and Washington Fish Propagation Company, to which the works belonged.

Proposed salmon-hatching station for the Southern States.—It is well known to all fish culturists that the expense of moving impregnated eggs of fish is very much less than that of transporting the same number of the young fish, as the former, with proper precautions, can be forwarded by express to any part of the United States, while the latter require the constant care and attendance of a messenger, and a much larger space, in proportion, for their accommodation.

The demand for the California salmon on the part of the southern and middle tier of Mississippi Valley States has suggested the propriety of a station where the eggs can be received and hatched, and from which the fry can be distributed at much less expense than from Baltimore, Maryland; Northville, Michigan, and other stations, where the hatching in question has been carried on.

An extensive correspondence was entered into with parties in Tennessee, Northern Alabama, Mississippi, &c., and several points were visited by Mr. Clark to ascertain their adaptation for the purpose. The especial requisites are, an ample supply of pure spring water of a temperature as much under 60° as possible; a proper fall of water; and convenient relation to a railroad center from which the fish can be distributed to assigned depositaries. Of course the place must be healthy, and one where the desired facilities will be freely granted by the owners of the ground.

Several localities were found possessing more or less of the necessary requisites. Among these were Huntsville, Ala.; Vicksburg, Miss.; Bon Aqua Springs, Tenn.; Birmingham, Ala., &c. The highest temperature found, of 63⅓°, was at Vicksburg; the lowest, about 59°. The outbreak of the yellow fever in Tennessee during the summer of 1878 prevented any action on the subject. This, however, is only deferred for the present, and it is hoped that another season, when a selection will be arrived at, it will be possible to arrange a temporary establishment where the eggs of California salmon and possibly of California trout may be successfully hatched. It will not be necessary to keep the works in operation for more than a month for either of these occasions; so that the expense will be comparatively trifling.

Atlantic salmon (*Salmo salar.*)

In view of the uncertainty as to the results of earlier efforts connected with securing the eggs of the Atlantic salmon, operations were sus-

pended in 1877, and this intermission continued in 1878, it being thought desirable to wait for evidence that the work had been successful.

I am happy to say that during the present year the indications of success have been so unquestionable as to warrant the re-establishment of the Bucksport station, and it is hoped that the result for 1879 will show a good progress in this connection. It may be stated in general terms that nearly every stream on the Atlantic coast as far south as the Susquehanna in which young salmon were introduced as far back as 1874 and 1875 has proved to contain adult spawning fish in 1878.

An exact statement of the catch of salmon in the rivers along the coast is impossible, but the daily newspapers have been filled with the records of capture from Denny's River, in Eastern Maine, to the Susquehanna, in Maryland. In addition to this the correspondence of the Commission contains numerous references to captures of salmon, some of which I will proceed to present.

The increase in the rivers of Maine, although decided, has not been much a matter of specific statement, as the salmon have never been entirely absent from its waters, and consequently their occurrence in the rivers excited less remark.* The case was quite different, however, in the Merrimack, where salmon of late years have only been seen at very rare intervals. As the result of the action of the commissioners of Maine and New Hampshire, large numbers of salmon were observed while ascending the fishway in the dam at Lowell for the purpose of performing the function of spawning in the headwaters of the rivers, especially in the Pemigewasset, where many young were afterward seen.

For the details of these runs of salmon I refer to the extracts from the reports of the commissioners of Massachusetts and New Hampshire given in the Appendix.

In October, 1878, a salmon weighing 11 pounds was caught in Narragansett Bay, between Narragansett and Wickford. Other instances of captures in the same waters are recorded.

The weirs in Martha's Vineyard Sound, especially at Menemsha, secured a considerable number of salmon, most of which were sent to the

* In connection with the subject of salmon in Maine, it should be borne in mind that the fish from which the eggs are taken at the Penobscot or Bucksport station are not destroyed by the operation, but are returned to the water uninjured. Mr. Atkins has been in the habit of affixing a platinum tag to each fish before returning it to the water, bearing a number corresponding to a record of the date of capture, the weight before spawning, the weight of the eggs taken, and the weight of the fish when restored to the water. Mr. Atkins found several instances of a second capture of the same fish. Thus he records No. 768 as having been stripped on the 1st of November, 1875. It then weighed 21 pounds 7 ounces, and yielded 5 pounds 7 ounces of eggs. When turned back into the river it weighed 15 pounds. The same fish was recaptured at Lincolnville, Me., on the 14th of June, 1877, weighing 26 pounds.

Another fish, No. 1010, which on the 9th of November, 1875, weighed 18 pounds 2 ounces, had 4 pounds 10 ounces of eggs, and when dismissed weighed 13½ pounds, was retaken, also near Lincolnville, on the 13th of June, 1877, weighing 30½ pounds, thus showing an increase of 12½ pounds in two years.

New York market with the other captures. The greatest success was, however, experienced in the Connecticut, where the catch from the beginning to the end of the season is considered as amounting to not less than 600 individuals, varying in size from 9 to 20 pounds, most of them finding a market in New York. A great deal of enthusiasm was excited in the early part of the season by these captures, and the fish first taken were sold readily for a dollar per pound, and even more.

One of the earliest catches in the Connecticut was on the 4th of May, when a fish weighing 11 pounds was sent to Benjamin West, of New York, from Saybrook. On the 10th of May Mr. S. B. Miller reported a salmon taken in a seine near the west end of Long Island. Two were taken eight miles from the mouth of the Connecticut on the previous day, and on the same day 12 other salmon were received in New York from the Connecticut, one weighing 19 pounds, and all selling for from 85 cents to $1 per pound. Mr. James A. Bill, fish commissioner of Connecticut, on the 14th day of May informed me that within his knowledge 80 fish had been taken up to that time in the Connecticut River between its mouth and Windsor, these varying from 8½ to 18 pounds in weight. From 6 to 12 were captured daily.

It is known that in addition to what were caught by the fishermen in the Connecticut many others entered it, as shown by the holes made in the gill-nets. These holes were at first supposed to be caused by sturgeons, but it was subsequently ascertained that they were due to large salmon that could not be held by the thin twine.

There were no authentic cases of the occurrence of salmon in the Hudson during the year. This is easily explicable from the fact that no young were introduced by the commissioners of the State, they being unwilling to take any steps in this direction until the proper means for their protection, as well as that of the shad, against the gill and stake nets should be passed by the legislature. A very few planted by private enterprise yielded no positive result, although several rumors of captures were given in the newspapers.

The case was very different in regard to the Delaware River; in which quite a number of deposits were made, partly by the fish commissions of the State and of the United States, and partly by individuals. The earliest introduction of salmon in this river was made in 1871 by Mr. Thaddeus Norris at the expense of some public-spirited citizens of Philadelphia, the eggs having been hatched out on the Hudson River, and the young transported to the Delaware. Only about 2,000 survived the journey. In 1872 12,000 eggs were purchased of Mr. Wilmot, at Newcastle, Ontario, and hatched out near Easton, Pa., with a loss of only ten per cent. The young were placed in the Bushkill, a tributary of the Delaware, near Easton.

The next lot of salmon planted in the Delaware consisted of 5,000 fry, the sole product of 750,000 eggs received from Germany by the United States Fish Commission, in the winter of 1872–'73.

These were hatched out by Dr. Slack, at Bloomsburg, and planted in the Muscanetnong in the spring of 1873. Subsequently the commissioners of New Jersey and Pennsylvania introduced other lots, and it is difficult to say how many of these deposits contributed to the results of 1878.

The first show of salmon in the Delaware was in the autumn of 1877, when a large fish was seen directly engaged in the act of spawning at the mouth of the Bushkill River, this quite probably being one of Mr. Norris's fish. It was killed by a rifle-ball in ignorance of its true character, and sent to me for identification. It is now preserved in the collections of the National Museum.

On the 19th of January Dr. Abbott, of Trenton, reported the capture of a salmon 16 inches in length at Trenton, this being probably a grilse.

On the 6th of April Mr. E. J. Anderson, fish commissioner of New Jersey, announced the taking of two salmon, one weighing 18 and the other 23½ pounds, in the Delaware. One of these was also sent to the United States commission at Washington, where it is preserved, together with an excellent cast.

Later in the year the catches in the Delaware were quite numerous, the total number, according to the fish commissioner of the State, amounting to some hundreds.

The southernmost locality in which salmon have been taken is the Susquehanna, a fine one of 19 pounds having been caught in a gill-net in the vicinity of Spesutie Island, just below Havre de Grace, and obtained by Mr. James W. Milner, in charge of the United States shad-hatching operations there, and sent to Washington. This was a fresh-run fish, in perfect condition, and formed the subject of an admirable drawing and plaster cast. It probably was derived from a lot of salmon planted by Mr. Ferguson, fish commissioner of Maryland, in one of the tributaries of the Susquehanna.

For fuller details of the occurrence of salmon in the Eastern and Middle States and in Maryland I refer to the appendix, where a condensed statement, as prepared by Mr. C. W. Smiley from reports of State commissioners, will be found.

While these facts show conclusively that the experiment of introducing the *Salmo salar* into the more northern rivers of the Atlantic States by the United States has been a success, it will be readily understood that the great object will be to establish a continued run to be kept up by naturally spawned fish, a result which should be continually aimed at. It is not to be expected that the general government or the States will continue indefinitely their effort to obtain eggs and plant the young fish, especially as the time may come when this resource will not be at their command.

Where rivers are entirely destitute of salmon, either from an exhaustion of the supply or from never having existed there, artificial

propagation must begin the work. But unless this is supplemented by the enactment and enforcement of laws forbidding absolutely the capture of the fish for a period of four to six years, and then establishing a close time of several days in each week up to a certain period, after which no fish at all shall be taken, the efforts now being made might as well be intermitted first as last. There is no object in going to the expense for the purpose of furnishing a few fishermen with a supply of fish to be sold for their benefit, and not administered for the good of the community. The magnitude of the results will be in direct proportion to the enactment and enforcement of the proper legislation.

Schoodic salmon (*Salmo salar*, subsp. *Sebago.*)

Grand Lake Stream Station.—Of the various species of *Salmonidæ*, treated by the United States Fish Commission, the fish variously known as landlocked salmon, Schoodic salmon, Sebago salmon, Glover's salmon, Win-ni-nish, &c., is one that is most eagerly sought after by State fish commissioners, fishing clubs, and fish culturists generally. An exact miniature of the sea salmon or *Salmo salar* in appearance, flavor, game qualities, &c., the difference in size was for a long time considered sufficient to establish it as a distinct species. Late researches, however, prosecuted by Professor Gill and Professor Jordan, among the large collections at Washington, have satisfied these gentlemen that it must be regarded as a dwarfed form, hardly even a variety, of the *Salmo salar*, owing its reduced proportions to its abode in lakes or ponds, and consequently more limited range than it would have in the ocean, although its continual sojourn in fresh water may have had something to do with it. The westernmost locality where it is found on the New England coast appears to be Sebago Pond, a large body of water which discharges into Casco Bay, north of Portland. Here it is called Sebago salmon or Sebago trout, and attains a considerably larger size than in most other waters, as in the Sebec Lakes, northwest of Bangor, in certain ponds in the Mount Desert region, and the Schoodic Lakes of Maine and New Brunswick, which are perhaps its best-known localities. It is also seen in the Saint John's River and certain ponds of New Brunswick and Nova Scotia, as well as in the tributaries of the Saint Lawrence. To what extent it is taken on the south shore of the Gulf of Saint Lawrence or on the coast of Labrador, I am unable to say.

In various parts of the British provinces it is known as the Win-ni-nish, which would perhaps be a much more appropriate appellation than the term landlocked salmon, since other species of the Salmonidæ present themselves under similar circumstances. A similar variety occurs in Sweden, and possibly elsewhere in Europe, and relating to the same species, *Salmo salar*.

In the opinion of many persons, and especially of Mr. Samuel Wilmot, the salmon of Lake Ontario belongs to the same division, although in size it more nearly corresponds with the sea-going salmon. Formerly

immense numbers of these fish existed in Lake Erie and ascended its tributaries on both the Canadian and American sides to spawn. They have, however, for the most part, been exterminated on the American side, and but for the efforts of Mr. Wilmot would probably have experienced the same fate on the north shore. A number of years ago, however, that gentleman, finding a few pairs in a small tributary of Lake Ontario, near Newcastle, undertook their artificial propagation, and so successful were his efforts that he increased the number enormously, although no great increase in the number of captures has resulted. This is probably due to the fact that they cannot be taken at the time when they are fresh run and in good condition for food. Their present spawning-grounds are very near the lake, and, as in the short rivers of California, they come into the streams only when they are nearly ripe, and remain a very short time, returning at once to the lake. It would seem that, to have a satisfactory river salmon fishery, the stream must be long enough for the fish to remain a considerable time in it, so that they may enter it before they are ripe and give an opportunity for their capture by suitable devices.

The advantages of this landlocked form, which, so far as the United States Fish Commission is concerned, it is proposed hereafter to term the Schoodic salmon, unless the name Win-ni-nish be considered preferable, are the readiness with which the eggs can be obtained, the hardiness of the fish, and their perfect adaptability to a great variety of circumstances and temperature. They are said to resist warmth of water better than even the brook trout and to be an available fish not only for lakes and ponds, but also for long reaches of deep water in rivers through which there is comparatively little current, such as are found in the Saint John's River in New Brunswick and elsewhere.

The Schoodic salmon has, for several years, occupied the attention of the United States Fish Commission, and the successive reports will show what has been done in this connection. A trial made several years ago in Sebec Lake and this year at Sebago Pond, have led to the conclusion that the Schoodic lakes of Maine, and perhaps New Brunswick, will furnish the best stations for the collection and distribution of eggs. The locality controlled by the United States Fish Commission is situated not far from the tannery of the Messrs. Shaw Brothers, on Grand Lake Stream, the outlet of Grand Lake, one of the Schoodic chain of eastern Maine, and at no great distance to the west of Calais. This, for many years, had been the resort of fishermen in the proper season, the fish occurring in immense numbers and furnishing admirable sport. By arrangement with the Messrs. Shaw, certain privileges of water and fishing were obtained by payment of an annual rental, on the usual condition as established by the laws of Maine, that one-fourth of the eggs obtained should be hatched out and the young returned to the waters. In addition to this, a considerable per-cent. of the remainder goes into the waters of the State in other localities. Here, the United States, in conjunc-

tion with the States of Maine, Massachusetts, New Hampshire, and Connecticut (two or more of them), has carried on operations under the superintendence of Mr. Charles G. Atkins and with varying success, for which reference may be made to the detailed report of Mr. Atkins. There have been some difficulties from time to time in getting a proper head of water for developing the eggs to a suitable stage for shipping, and numerous obstacles have been found in the securing of the fish. These, however, have now all been palliated or overcome.

The taking of eggs in 1878 was begun on the 7th of November, and closed on the 4th of December, at which time the return of the parent fish to the lake ended. The total number of eggs for the season amounted to 1,723,000. One great advantage connected with the taking of eggs from salmon as well as trout is that the parents are not injured, but by careful handling may be returned to the water in good condition, so that another year they may yield an additional supply. Great care is exercised in this respect, so that neither at Bucksport or Grand Lake Stream are many fish absolutely lost.

While, by actual experiment, about 90.1 per-cent. of all the eggs taken were impregnated and embryonized by the artificial process, scarcely more than 10 per cent. would have been by natural propagation. If we consider the immense number of even impregnated eggs consumed by the white perch and other vermin of the lake, and compare the remainder with the absolute propagation artificially, the vast disproportion of results can be readily appreciated.

Mr. Atkins, in referring to the impregnation of the Schoodic salmon states that at Bucksport the successful impregnation of 96 to 98 per cent. of the sea salmon was accomplished. This difference from the experience with the former he considers to be due to possible circumstances affecting the fish in their somewhat artificial detention in fresh water, from which the sea-run individuals escape.

Owing to various circumstances beyond the control of Mr. Atkins, such as an abrupt change to colder weather, a certain portion of the eggs collected were destroyed. But, of the 1,723,000, there were 1,470,000 embryonized, or carried to that point where the eyes of the young fish could be seen through the envelope. Of these, 370,000 were retained for Grand Lake Stream, and of the remainder 1,110,000 were shipped by the United States Fish Commission, and distributed among a number of States. The rest went to Massachusetts, Connecticut, and New Hampshire. Of the 370,000 retained for Grand Lake Stream, 350,000 healthy young fish were hatched out and turned into the water.

The details of the distribution of these fish will be found in the tables of Mr. Atkins's report, to which I refer for much interesting information.

Sebago Station.—An earnest appeal by Mr. E. M. Stilwell, fish commissioner of Maine, determined the United States Fish Commission to make an experiment in regard to securing a supply of eggs of the Sebago Pond variety of landlocked salmon, in view of its much greater size than

that found at Grand Lake Stream, and of the greater accessibility of the locality.

It will be remembered that the Sebago is a large stream, situated in Southwestern Maine, which discharges through the Presumpscat River into Casco Bay to the north of Portland. The landlocked salmon found in it have always been celebrated for their beauty and weight, a size of six or eight and ten pounds, and even more being not unfrequent.

Unsuccessful efforts were made some years ago to obtain spawning fish from Sebago Pond, for the purpose of securing their eggs. It was imagined that, owing to the protection afforded by recent legislation and the removal of certain obstructions in the water, a new effort might be more satisfactory. Acting upon this impression, Mr. Atkins was directed to establish a station, for the purpose of an experiment, which he accordingly did, leaving Mr. Buck, one of his assistants of long experience, in charge. After giving the matter a fair trial, the enterprise was abandoned, as, with all the devices in the way of nets, &c., only ten males and six females were captured, and the entire number of fish entering the river for the purpose of spawning was estimated at scarcely more than fifty. The largest fish taken was a female, weighing 8 pounds 10 ounces after spawning, and the average was about three pounds.

Whitefish.—(*Coregonus clupeiformis.*)

The great amount of attention paid to the artificial propagation of the whitefish by the commissioners of the lake States, especially of New York, Ohio, Michigan, and Wisconsin, has rendered it unnecessary for the United States Commission to take up the subject to any great extent, although Mr. Frank N. Clark usually collects several hundreds of thousands of eggs, and develops them at his fish-culture establishment at Northville, Mich., for any desired assignment. These, for the most part, have been sent to the commissioners of California, and also to various parties in Pennsylvania, New Jersey, Wisconsin, &c.

The actual distribution made will be found in the appropriate page of the tables.

Shad.—(*Alosa sapidissima.*)

As in previous years, the propagation and distribution of shad was conducted under the able and efficient superintendence of Mr. James W. Milner, co-operating for a portion of the time with Mr. T. B. Ferguson, the fish commissioner of Maryland, whose help, as in previous years, is gratefully acknowledged.

To Mr. Milner's report, in the appendix to the present volume, I refer for details of the work accomplished, confining myself here to a mere abstract.

Albemarle Sound Station.—In previous reports reference has been made to the advantages of substituting Mr. Ferguson's cone and bucket apparatus for the floating hatching-boxes, so unsatisfactory in tidal waters. Desirous of testing the experiment with this apparatus on a

large scale, operations were commenced much earlier in the season than usual, and at a southern station, in Albemarle Sound. The barges used by the Maryland commission in its work in 1877 were purchased and thoroughly equipped by the United States Commission, and towed by the revenue-cutter Ewing, in command of Captain Fengar, to Norfolk, whence a private tug carried them to Avoca, a plantation and fishing landing of Dr. W. R. Capehart, situated near the mouth of the Chowan River. The Maryland steamer Lookout was also employed in the service by an arrangement with Mr. Ferguson.

In addition to the Lookout, a steam-launch, furnished by the Navy Department, rendered essential aid in visiting distant landings for the collection of spawn and in transporting young fish from the station to the steamer for shipment via Franklin to various portions of the Southern States.

The work commenced about the 1st of April, with the benefit of every possible aid from Dr. Capehart, and up to the 1st of May about 10,000,000 eggs had been secured; the largest number taken in any one night being 1,605,000, on the 15th of April. The shipments of fish to remote points began on the 11th of April, amounting in all to about 5,000,000. These were distributed in part by the United States Commission, and in part by the fish commissioners of Maryland, North Carolina, and Virginia, who were furnished with what they could well transport to waters within these States.

A remarkable feature of the fishery season on the North Carolina coast consisted in the unprecedented number of alewives, or fresh-water herring, captured at various landings, as many as 400,000 having been taken at one haul. The glut of these fish was so great, that at one time they were sold at 50 cents per thousand; indeed, it became necessary to stop using the seines ten days earlier than usual on account of the difficulty of handling so many fish.

Mr. Ferguson, having been appointed one of the Commissioners to the Paris Exhibition, was obliged to leave Avoca before the close of the season, and the work was then continued by Mr. Milner and his assistants. On the 2d of May the station was closed, and the barges and launches were towed to Norfolk by the revenue-cutter E. A. Stevens. At Norfolk the Ewing again took charge of the tow and reached Havre de Grace with her charge on the 11th of May, where the hatching work was resumed under direction of Mr. Frank N. Clark—Mr. Milner, however, having general supervision.

The station selected this year at Havre de Grace was the same as that used in 1877, namely, a sheltered harbor between Spesutia Island and the western shore. The work was prosecuted on four barges and aided by two navy launches, a second one having been furnished for the purpose by the Navy Department. The steamer Lookout was dispatched to the Potomac for the purpose of collecting eggs of shad and hatching them on that river.

The entire take of eggs at Havre de Grace amounted to 12,730,000; the largest number secured at one time being 1,940,000 from 97 spawners, on the 29th of May. The total shipments and distribution of fish from this point amounted to over 9,000,000.

In the absence of Mr. Ferguson, the interests of Maryland were cared for by Mr. Thomas Hughlett, another member of the State fish commission.

The total production of the season at the three stations of Avoca, the Potomac, and at Havre de Grace amounted to 15,500,000 fish. The shipments extended to all parts of the United States, as far even as California, a fourth transmission having been made to the Sacramento River—a stream in which the success of the work in the past has been notably manifest.

Special acknowledgments are due on the part of the United States Fish Commission to Col. Marshall Parks, the president of the Albemarle and Chesapeake Canal, who not only tendered the use of the canal, passing all of our vessels to and fro free of toll charges, but having learned that toll had been collected from the steamer Lookout on her first voyage of reconnaissance, made in December, 1876, generously refunded the amount collected.

Col. Parks has, throughout all of our operations on Albemarle Sound, given us every aid, and by his cordial co-operation has evidenced his interest in the development of the resources and the future prosperity of that region.

A pleasant feature of the shad hatching operations at Havre de Grace consisted in the visits made by various persons to the station. Thus, on the 5th of June, I accompanied the President and the Secretary of the Navy, with a party of other invited guests, in a special car, returning the same night, and at a later date, a number of members of Congress. Many reporters from New York, Philadelphia, and Baltimore also embraced the opportunity to become familiar with the aims and results of the Commission, and to publish an account of the same.

To complete the history of the operations of the year 1878, connected with the propagation of shad on the Atlantic coast, I may remark that Colonel McDonald, fish commissioner of Virginia, made a station at Tobago Bay, near the mouth of the Roanoke River, and hatched out about 1,960,000 fish between the 3d of May and the 1st of June. All of these were placed directly in the Roanoke, and cannot fail to make their presence known within the next three or four years.

I am gratified in being able to state that the labors of the United States Commission in introducing shad into new or depleted waters have commenced to show results during the year 1878. Some of the earliest efforts in regard to stocking the rivers with shad were prosecuted in connection with the Sacramento River, a shipment of 12,000 fish having been made June 19, 1871, by Seth Green at the expense of the

California commission, followed in subsequent years by transmissions by the U. S. Fish Commission. The Sacramento River may now be considered as fairly supplied with fish, numerous adults having been taken during the year, although they have been sold surreptitiously, in consequence of a prohibitory law. It is to be hoped that with a few additional shipments the stock will soon be self-sustaining, and possibly that the adjacent rivers north and south will receive an ample supply.

For the Mississippi Valley, we have a very satisfactory result of the operations of the Fish Commission in the Ohio River at Louisville, where several hundreds of fish were captured in 1878 and exposed for sale in the Louisville market. The citizens are naturally jubilant at this great addition to their food resources, and stoutly maintain that, compared with the shad of the Connecticut, the Delaware, and the Susquehanna, those of the Ohio are by far the finest. Should this run continue, I hope to give further information in regard to it in a future report.

As nearly as we can ascertain, these fish have all been derived from a deposit of 30,000 made in the Allegheny River by Seth Green, and 200,000 by Mr. Wm. Clift in the year 1872, at Salamanca, in Western New York, in both cases in behalf and at the expense of the U. S. Commission.

For the purpose of ascertaining the facts in regard to the occurrence of shad at points in the Mississippi Valley other than Louisville, the commissioners of fisheries of Kentucky caused a circular of inquiry to be published in the principal newspapers, asking to be informed on this subject. Several responses were received, and among them one from Mr. John F. Oliver, of Steubenville, Ohio, who on the 25th of September wrote to say that a number of shad were caught in the Ohio at that place early in the season, on their way up, very many having been brought into market. He urges the importance of legislative measures for the protection of these fish, at least for a time, stating that two fishermen at Wing and Wing Rock, three miles above Steubenville, on the West Virginia side of the river, caught with hoop or set nets six or seven bushels of shad.

Dr. Paul Sears, of Mount Carmel, Ill., also writes to say that parties fishing with set nets in March, April, May, and June, caught what they supposed to be a new species of hickory shad (*Pomolobus mediocris*), but which he found on examination a different variety, in not having the lower jaw protruding as in the hickory shad, and in being thicker below the dorsal fin. These are points in which the true shad differs from its ally, and render the fact of its occurrence at Mount Carmel unquestionable.

In addition to these statements, Mr. George Spangler announced on the 3d of May the capture of about a dozen shad near Madison, Ind. The first sold for a trifle, but the price rose considerably when the fish were identified.

Mr. George F. Akers, of Nashville, Tenn., wrote on the 21st of May that many shad were taken during the year near Nashville.

On the 20th of March a four-pound shad was caught at Wetumpka, Ala., in the Coosa River, and on the 18th of April several shad were taken at Rome, in George Creek, according to the report of Dr. George A. Hampton.

Specimens of the Ohio River and Alabama shad were sent to the National Museum for identification.

A very decided increase in the catch of shad in the Roanoke River in 1878 is ascribed to the fact of the introduction of so many young fish in previous years, as the result of the operations of the United States Fish Commission on that river.

It may here be remarked that the fishermen, at least on the Potomac and in Albemarle Sound, distinguish what they call a May shad, a fish coming in later than the ordinary shad, in Albemarle Sound appearing from the middle to the end of May. These are said to be very fat, with short, thick tails, and with the back more golden than blue. Whether we are to establish two species of shad, as has been done with the herring, one composing an earlier run and another a later, has not been shown for want of sufficient material.

Herring.—(*Clupea harengus.*)

Experiments prosecuted at Gloucester before the eggs of the cod were ripe showed satisfactorily that the sea herring could be multiplied artificially on a sufficiently large scale for economical purposes. A large run of the spawning fish came on the coast in October, and, for a few days at least, ripe eggs could be had in any desired abundance.

Mr. Clarke fitted up an extempore apparatus by placing slides of glass vertically in a long box, somewhat in the style of the Williamson apparatus, so that the same water was made to flow through a series of compartments. The glass plate was laid flat in shallow pans, and the eggs dropped upon them, adhering tenaciously wherever they touched. A portion of the milt being added, a small quantity of water was introduced so as to dilute it, and by coming in contact with the eggs, produce the desired impregnation in the current of water. The eggs hatched out rapidly, and a very considerable number of young were produced and placed in Gloucester Harbor.

Partial experiments, indicating the same general result, were made in 1877 at Noman's Land, by Mr. Vinal Edwards, of the United States Fish Commission, and mentioned in detail in the report for the year 1877. About the same time Dr. Meyer, of Kiel, made a very elaborate investigation upon the development of the herring and the means of retarding it. He suggests that the result as published may be applied to lengthening the hatching period of the egg of the American shad and alewife, in connection with the effort to transmit these fish to Germany.

It is proposed to test this question more fully during the coming year;

but the conditions are quite different in the case of these species. The shad and alewife have non-adhesive eggs (those of the latter slightly so at first), and are hatched out in warm water, or with a rising temperature. The egg of the herring, on the other hand, is adhesive, and is hatched at a low and descending temperature, the difference in physical conditions demanding different treatment, the nature of which the proposed experiments will no doubt settle satisfactorily. In Dr. Meyer's apparatus glass plates are arranged horizontally with the eggs on the under side, a condition impossible in the case of the alewife.

The Carp.—(*Cyprinus carpio.*)

The Druid Hill Park Station.—I have already referred in previous reports to the various experiments of the Commission looking to the introduction into the United States of the best varieties of the German carp, a species considered to be of very great utility, especially to the South, for food purposes, and bidding fair to stand in the same relation to the farmer among fishes that domestic fowl do among birds. The fish brought in by Mr. Hessel in 1877 were cared for at the Druid Hill Park, under the direction of Mr. T. B. Ferguson, commissioner of fisheries of the State of Maryland, and by permission of the park authorities. It was considered advisable, however, to have a portion of the supply in Washington, where the fish could be more immediately under supervision. Inquiry was therefore made as to a suitable location for the fish, either in ponds already built, or to be constructed. It was, of course, thought best that they should be placed on government ground, where there would be no question as to rental. Several small lakes on the Soldiers' Home property were at first thought of, but the governors were unwilling to allow the changes necessary to fit them for the purpose, and it was with difficulty that suitable ground could be found for the construction of new receptacles. The work was under the direction of Mr. Hessel, who had a survey made, and laid out the contour. Soon after the work was begun, it was ascertained that the supply of water that had been relied upon for this purpose was inadequate, and the enterprise was abandoned. In this emergency Mr. Hessel had his attention called to the so-called "Babcock Lakes," two in number, which have a surface of about 6 acres each, situated on the Monument Lot, and separated by a driveway. These were found suitable in every way as to size, supply of water, &c. Application was made to Congress, at its special session, for the privilege of using these ponds, and for an appropriation to adapt them to the required service. The application was granted, and $5,000 allowed to put them in order. The work was conducted by Colonel Casey, with all due economy, the plans being furnished by Mr. Hessel. The ponds were drawn off and graded, so that a series of ditches, radiating from one point, would concentrate therein the contents of the pond. A basin or collector was built at this outlet, walled with brick and armed with heavy plank, and a suitable gateway and overflow was established.

This portion of the work was completed in the spring, and after the water was let in, two-thirds of the fish in Druid Hill Park were brought over and placed in their new abode. For the purpose of having a suitable series of hatching-ponds, the surface of an island in the west pond was elevated, and the area subdivided so as to form two basins of suitable dimensions. These were fitted up properly with reservoirs and ditches, so that they could be drawn off on the same general principle as that adopted for the larger pond. Into these were placed several of the breeding carp, and quite a number of the young fish resulting therefrom. In the mean time work was also prosecuted on the westernmost of the two ponds; but owing to the adverse weather and incessant rains of the spring it could not be completed, as the warm weather suggested the necessity of restoring the water to its place to prevent malarious exhalations. This was accordingly done, and further action deferred for the time. A second appropriation for $2,400 was used in completing the work, and especially in paving the bank to prevent the washing of the wind and waves. As an additional means of putting the ponds in proper order for the discharge of the necessary functions, a series of brick tanks were planned (six in number), in which the fish could be classified when the ponds were drawn off, and those taken out that served for shipment, and the others returned. These were to be 20 feet long, and respectively 2, 5, and 9 feet in width, with a uniform depth of 5½ feet. The work on the ponds was postponed, owing to the fear of endangering the health of the city by making the necessary excavations on the island for the walls of the bank, and the completion was delayed by various vexatious causes, so that it was not till the early part of the winter that they were completed, and to disturb the fish in their winter quarters was not considered desirable. The construction, however, is available for service, and it is hoped that in 1879 an extensive distribution of fish may be made.

Of the fish brought from Germany by Mr. Hessel in 1877, the following were found alive and in good condition in the Druid Hill Park Pond when drained in the spring of 1878: 10 mirror carp, 90 leather carp, 80 scale carp, 40 gold orfe, 50 King or Hungarian tench, 20 common tench, 2 golden tench. As already explained, the three varieties of carp all belong to the species *Cyprinus carpio*. The gold orfe is a variety of the *Idus melanotus*, a large, fine Cyprinoid fish of Europe, somewhat resembling in size and shape the fall fish (*Semotilus shotheus*) of American waters, and of a brilliant red something like that of the common gold fish. The tench (*Tinca vulgaris*) like the carp, occurs in several varieties, the best being the king tench. The gold tench is a red form of the species just mentioned.

Of the fish above enumerated, there were retained in the Baltimore ponds the ten mirror carp, one-fourth the stock of the leather and scale carp, the hungarian tench, and gold orfes, respectively; all the common tench and the two golden tench. There were brought to Wash-

ington 65 leather carp, 48 scale carp, 10 golden ides, and 14 tench, which were distributed as follows:

	Babcock Lake, or East Pond.	Island Pond No. 1	Island Pond No. 2	Arsenal Pond.	Total.
Leather carp	39	13	13	.....	65
Scale carp	.....	.....	.....	48	48
Golden ides	10	.....	.....	.....	10
King tench	14	.....	.....	.....	14
Total	63	13	13	48	137

All the mirror carp and the golden tench, about half of the scale carp, three-quarters of the stock of ides, and most of the tench remained in Baltimore.

In order to diminish the danger of loss of the carp in the Monument Park by disease, inundation, or theft, the offer of Major McKee, commandant of the United States Arsenal, to accommodate a portion of them in the ice-pond of the arsenal grounds, was gladly accepted, and all of the scale carp, 48 in number, were placed therein on the 23d of May. So far as known, these fish continued in excellent condition throughout the year and without loss.

The very severe weather of the end of December, 1878, and beginning of January, 1879, caused the two carp ponds to freeze over sufficiently thick to bear skaters, and the opportunity was eagerly embraced by large crowds of both sexes. As any disturbance overhead was likely to seriously injure the carp in the east pond, a notification was placarded around it forbidding entrance on the ice on any pretense whatever. No restriction, however, was made in regard to the western pond, and while the deprivation was cheerfully borne, the community enjoyed the facilities allowed to their fullest extent. The superintendent, Dr. Hessel, was directed to prevent the crowd from coming upon the island in the west pond, on which tanks and hatching apparatus were located, but was authorized to allow ladies and children to enter the house, a privilege gladly embraced, and to such an extent that sometimes as many as sixty persons were in the building at one time. A few days of incessant skating cut up the ice so that several applications were made by the public to have the surface of the pond flooded, and thereby make a new skating surface. It was found impossible, however, to meet the request of the petitioners, as there was no plug of sufficient size in the west pond to produce any effect.

The Cod (*Gadus morrhua*).

The Gloucester Station.—A most important increase in the range of the work of the United States Fish Commission, in the way of the propagation of food fishes, was made during the year in connection with

the various species of the cod family, especially of the true codfish. While engaged in the prosecution of researches into the condition of the fisheries at Gloucester, my attention was called to the fact, in the early autumn, of the approaching ripeness of the cod, haddock, &c., and it was determined, after conference with Mr. Milner, to institute experiments looking towards the artificial propagation of the cod, it being known from the researches of Sars that the eggs of that fish are non-adhesive and that they are discharged in the open sea, and float freely at the surface. With this information as a basis, preparations were made to utilize a portion of the wharves and buildings leased by the Commission at Gloucester for the erection of the necessary cod-hatching apparatus. A steam-engine, pumps, and other appliances were ordered on from the shad-hatching barges at Baltimore, and the work of fitting up was vigorously prosecuted under the direction of Capt. H. C. Chester and Mr. Sauerhoff, the whole work being under the charge of Mr. Milner.

The cones, so serviceable in the hatching of shad, were first tried; but did not work satisfactorily, in consequence of the changed conditions, the eggs being lighter and floating at the surface instead of sinking to the bottom as with the shad. After numerous trials to overcome this principal difficulty, a device was hit upon by Captain Chester, which, in a great measure, answered the desired object; and as it became possible to secure an ample supply of eggs, the experiment was prosecuted vigorously and ultimately crowned with success. Several millions of cod were hatched out and turned into the harbor of Gloucester, where, in the ensuing summer, they could be readily observed around the wharves, and even taken with a hook, the unwonted sight attracting the greatest interest of the fishermen and residents.

Mr. Frank N. Clark, who had had charge of the shad-hatching work at Havre de Grace, also supervised the hatching of cod at Gloucester, and introduced some important improvements in the apparatus.

Mr. Milner was obliged to return to Washington by illness, and Captain Chester having also been incapacitated from a similar cause, the establishment was broken up in the early part of January, 1879, and the apparatus dismantled and boxed, ready to be returned to the southern stations.

Other species of *Gadidæ*, as the haddock, etc., were experimented with upon a small scale, and the feasibility of artificial propagation of the species of the cod family fully established.

The only very serious difficulty experienced during these experiments was that from the turbidity of the water, this being necessarily taken from the harbor, and more or less polluted, especially in stormy weather, by the dock mud.

It is confidently believed that if a vessel can be constructed and anchored in the proper quality of water an enormous propagation of fish can be accomplished. There is apparently no limit to the number of

eggs that can be secured, in view of the fact that a mature cod will furnish from two to nine millions, and the number of spawners taken in the vicinity of Cape Ann almost every day being very great. Of course it requires special conveniences to do this work, particularly during the inclement season of winter. The season during which the eggs can be obtained, however, is a very long one, extending from November to March and April.

For a detailed account of the whole experiment and of the observations made during its progress, I refer to the article by Mr. R. E. Earll, in the appendix. This may justly be claimed as perhaps the most important contribution ever made to our stock of information respecting the natural history of our principal food-fish.

In connection with the work upon the codfish, satisfactory experiments were also made in regard to hatching the sea herring, as detailed elsewhere.

The Sole (*Solea vulgaris*).

Reference has been made heretofore to a wish to meet the oft-expressed desire of citizens of the United States that the European sole might be introduced into American waters; and not daunted by the essential nonsuccess of the work of last year (by which only two were successfully transported to our shores), arrangements were made with Mr. C. L. Jackson and Mr. Long, of the aquarium at Southport, in England, to secure a supply of young fish and hold them in readiness for further action. In accordance with this, over eleven hundred were brought in during the season. Many deaths occurred in this number in a few days after being captured, but 165 surviving were kept alive in the tanks for a considerable period of time.

Mr. Mather, of whose visit to Europe in connection with the transportation of the eggs of the California salmon mention has been made on another page, went to Southport, on his return to the United States, and took charge of the fish. Unfortunately, however, the necessarily crowded quarters, and, possibly, the fact that they were brought in tin cans, which rusted very rapidly, proved adverse to a successful experiment, and the entire lot died, one after another, before the return voyage was completed.

A portion of this ill success was thought by Mr. Mather to be due to a pump in use for aërating the water, the packing of which had been saturated with some chemical substance which exerted a deleterious influence. In this, as well as in the previous experiment, the United States Fish Commission is indebted to the courtesy of the Cunard Steamship Company for important facilities.

The Sponge of commerce.

Among the more recent enterprises in the way of artificial propagation of aquatic animals is that relating to the artificial propagation of the sponge of commerce. Prof. Oscar Schmidt, of the University of Gratz,

has been so successful in his preliminary efforts in this direction, that the Austrian Government has authorized him to attempt the development of this industry on the coast of Dalmatia. The process is very simple, consisting in selecting the proper season in the spring, and dividing a living, marketable sponge into numerous pieces, and fastening them to stakes, which are driven into the sea bottom so as to submerge them. These fragments at once begin to grow out, and at the end of a certain time each one becomes an entire sponge.

According to Dr. Schmidt, three years is a sufficient length of time to obtain from very small fragments sponges worth several cents apiece. In one experiment the cost of raising 4,000 sponges amounted to about $45, including the interest for three years on the capital employed. The sales amounted to $80, leaving a profit of $35.

It was my intention to give a detailed account of the practical results of the work prosecuted by the Commission from the beginning, showing the aggregate of work done and the promise of future success, by the reappearance as adults of the young fish which had been planted in their localities. Owing, however, to necessary delay in the preparation and the publication of this report, it has been thought expedient to keep this history for the report of 1879, when it is hoped that sufficient evidence will be given to show that all reasonable anticipations of a successful outcome have been realized, and that the future holds in store great possibilities of ever-increasing food resources, which, so far as the United States is concerned, is to have a very important economical bearing.

It must be borne in mind, too, that the United States Fish Commission is only one of many in operation in the same direction in the country, very many states now having commissioners devoted to their work, and all more or less successful either in the artificial propagation of fishes in extending the distribution of species already occurring in the waters, or in the introduction and enforcement of protection of fishes during the critical periods, without which the most extensive efforts in fish culture will fail of their object.

D.—HUMAN AGENCIES AS AFFECTING THE FISH SUPPLY, AND THE RELATION OF FISH CULTURE TO THE AMERICAN FISHERIES.*

6.—INFLUENCE OF CIVILIZED MAN ON THE ABUNDANCE OF ANIMAL LIFE.

It may safely be said that wherever the white man plants his foot and the so-called civilization of a country is begun the inhabitants of the air, the land, and the water, begin to disappear. The bird seeks a new

* This article, exactly in its present form, was written for presentation elsewhere, but not published. It was intended to constitute a popular exposition of the subject to the end of 1878, and consequently includes to a considerable extent data contained in the previous pages.

abiding place under the changed conditions of the old, but the return of the season brings him again within the dangerous influence, until taught by several years of experience that his only safety is in a new home. The quadruped is less fortunate in this respect, environed as he is by more or less impassable restrictions, such as lofty mountains, deep rivers and lakes, and abrupt precipices, and sooner or later reaches the point of comparative extinction, or reduction to such limited numbers as not to invoke any continuance of special attack.

The fish, overwhelmingly numerous at first, began to feel the fatal influence in even less time than the classes already mentioned, especially such species as belong to the fresh waters and have a comparatively limited range.

The cause of this rapid deterioration is not to be found in a natural and reasonable destruction for purposes of food, of material for clothing, or other needs. The savage tribes, although more dependent for support upon the animals of the field and forest than the white man, will continue for centuries in their neighborhood without seriously diminishing their numbers. It is only as the result of wanton destruction for purposes of sport or for the acquisition of some limited portion only of the animal that a notable reduction is produced and the ultimate tendency to extinction initiated.

Of the abundance of animal life in North America, in the primitive days of its occupation by the European immigrant, we have an ample history in the accounts of the earlier travelers. Buffaloes in enormous hordes reached almost to the Atlantic coast, wherever extensive plains existed. The antelopes rivaled in numbers those of Central and South Africa. The deer of various species were distributed over the entire continent from the Arctic regions southward, and from the Atlantic to the Pacific. The moose existed far south of its present limit. The elk was a familiar inhabitant of Pennsylvania and Virginia. Wild fowl, such as ducks, geese, swans, &c., of many species, were found during the winter in countless myriads in the Chesapeake and other Southern bays and sounds.

Now what remains of this multitude? The buffalo has long since disappeared from the vicinity of the Mississippi River, the deer is nearly exterminated in many localities, though still holding its own under favorable circumstances, and the antelope is restricted to limited areas. The wild fowl, congregated at one time in bodies miles in extent, are now scarcely to be seen, although still proportionably more abundant in the winter season on the coast of California and towards the mouth of the Rio Grande in Texas than anywhere else.

Perhaps a still more striking illustration is seen in the fishes. It is still within the recollection of many old people (showing how plentiful the fish must have been) that the apprentice and pauper, in the vicinity of the Connecticut River, protested against eating salmon more than twice a week. This noble fish abounded in all the waters of New England

as far west as the Connecticut and even to the Housatonic, though we have no evidence that they ever occurred in the Hudson River or farther to the south. The shad was found in every stream of the coast from Georgia to the Gulf of Saint Lawrence, and, although still ascending most of these waters during the spring, has been sadly reduced in abundance. Within even fifty years no waters of the same extent in the world could show such numbers of shad and herring as the Potomac River below the Great Falls. Martin's Gazeteer of Virginia, published in 1834, at Alexandria, states that the preceding year twenty-five and a half millions of shad were taken by the various Potomac fisheries, as well as seven hundred and fifty millions of fresh-water herring. This, by a moderate estimate, would amount to six hundred millions pounds of fish secured in six weeks in this single system of waters. This Gazeteer also states that during the same year nearly one million barrels of fish were packed on the Potomac, requiring as many bushels of salt. These were consumed in the United States or shipped to the West Indies and elsewhere. What is the condition of things at the present time? In 1866 the catch of shad on the Potomac had dwindled to 1,326,000, in 1878 to 224,000, the latter not 1 per cent. of the yield of 1833. The catch of herring in 1833, estimated, as stated, at 750,000,000, had been reduced in 1866 to 21,000,000, in 1876 to 12,000,000, and in 1878 to 5,000,000; again less than 1 per cent. of the yield of the first-mentioned period.

A similar reduction has taken place in the abundance of the striped bass or rock-fish, a species inferior to none in its excellence and economical value for food. John Josselyn, gent., in 1660, says that three thousand bass were taken at one haul of the net in New England. Thomas Morton, in 1632, says, of the Merrimac, that he has seen stopped in the river at one time as many fish as would load a ship of a hundred tons, and that at the going out of the tide the river was sometimes so full of them that it seemed if one might go over on their backs dryshod.

Mr. Higginson, in 1630, says that the nets usually took more bass than they were able to land. Even so recently as 1846, one hundred and forty-eight tons are said to have been taken on Martha's Vineyard at two hauls of the seine. *Per contra*, the catch in the Potomac in 1866 amounted to 316,000 pounds; in 1876, to 100,000; in 1878, to 50,000.

Many more instances of the enormous abundance of the anadromous fishes (marine species running up from the ocean into fresh waters for the purpose of spawning) in different parts of the country in former times could easily be adduced. Similar illustrations of the former abundance of fishes exclusively inhabitants of the salt water can be brought forward to any extent. In the early days of the Republic the entire Atlantic shore of the United States abounded in fish of all kinds. Where cod, mackerel, and other species are now found in moderate quantities, they occurred in incredible masses.

The halibut, one of the best of our fishes, was so common along the New

England coast as not to be considered worthy of capture, and was considered a positive nuisance when taken. It is only within a few years that our people have come to learn their excellence and value, but they have already disappeared almost entirely from the inshores of New England, and have even gradually become exterminated in nearly all waters of less than five hundred feet in depth.

The inquiry now arises as to the causes of the terrible depletion of the inhabitants of the water, and one so detrimental to human interests. The question relates in part to an actual extermination, and in part to a disappearance from accessible fishing-grounds. The practical result to the fishing interest is about the same in either case.

It is quite safe to assume that most species of the ocean fishes, in their abundance and ability to escape the pursuit of man, are less amenable to destructive influences than those of the interior waters, the halibut being perhaps one of the few exceptions of a species that may be considered actually exterminated over a certain area. That the supply of nearly all other kinds in the inshore fisheries of America everywhere has diminished in enormous ratio is unquestioned. What were and are the causes, and what the remedy?

One most plausible solution of the problem is to be found in the very close relationships between the so-called anadromous fishes and those permanently resident in the ocean. The anadromous species are represented by the salmon, the shad, the fresh-water herring or alewife, and some other kinds, which, although spending the greater part of their life in the ocean, periodically enter the fresh waters, in greater or less numbers, and ascend as high as they can for the purpose of finding suitable places wherein to deposit their spawn. This done, the parent fish soon returns, leaving the young to follow. The young shad or herring remain in the rivers three or four months and then go down to the ocean. The salmon is more persistent, the young remaining from one to two years, after which they too descend to the sea, and, like the shad and herring, for the most part there attain their entire growth. It is not thought that either the parent fish or the young go to any great distance from the mouths of the rivers, and it is believed that the fish born in one stream never think of entering any other than that in which they first made their appearance.

Bearing in mind the countless myriads of these fishes formerly entering our rivers—the shad and herring along the entire coast of the United States to the Bay of Fundy, the salmon from the Connecticut eastward—and noting the extent to which they are preyed upon by the more rapacious inhabitants of the sea, we may understand why such multitudes of the larger fish formerly approached the shores in pursuit until deterred by the increasing shoalness or freshness of the water. Even then, however, they would remain near the shore, lying in wait for the parents and their young returning in such vast quantities during the later months of the year. In all probability these constituted

a chief inducement to the movement of the predacious fish to the coast in such numbers during the spring and summer. In autumn and winter the sea-herring and the fish of the cod family visit the shores for quite another purpose, namely, to deposit their eggs. But from whatever motive, the fact remains that years ago throughout the twelve months an ample supply of the finest fishes was within the reach of everyone, so that a fisherman with a small hand-line and an open boat was able to support his family without any difficulty.

Now, with the continued reduction in abundance of the salmon, shad, and fresh-water herring, the summer fisheries have dwindled and nearly disappeared, leaving only those of winter with its inclement weather to furnish occupation to the fishermen, and compelling him in the most dangerous season of the year to betake himself to the Georges, La Have, Quereau, and other banks, especially to the Grand Banks of Newfoundland, to prosecute his work in expensive vessels, and exposed to perils and privations of a terrible character.

Assuming, then, that the chief agency in the decrease of the ocean-shore fisheries has been the reduction in the number of the anadromous fish, *i. e.*, those passing up from the ocean into the fresh waters to spawn, let us inquire into the causes of the diminution of the latter. They certainly were very plentiful in the early days of European colonization in America, but at that period all the rivers were open to the sea, without dams or other artificial obstructions. Few or no saw-mills cast into them sawdust and other refuse; no gas-works polluted them with coal-tar, creosote, &c., and paper-mills, factories, &c., running off poisonous compounds, were unknown. The fishing apparatus was confined to lines and nets of no great extent, not sufficient to barricade the streams and impede the upward movement of the fish.

After the settlement of the country began, these possible dangers came to have an actual existence. It is probably to the erection of dams, however, that the first great diminution was due. The salmon, the shad, and the herring proceeding from the ocean to the headwaters of their native stream, were met by an impassable barrier, which they were unable to surmount, cutting them off from their favorite spawning-ground, and, indeed, in many cases, from the only localities where the operations of reproduction could be properly performed. They wore themselves out in fruitless attempts to overcome these obstructions, and were compelled finally to return to the ocean without depositing, or at least utilizing, their spawn. A second year, a third, and even a fourth would probably make but little difference in the number making the attempt to ascend, this being due to the fact that four years is the average period from birth at which most fish are mature and able to exercise the reproductive act. By the end of the fourth year, the last crop of young fish hatched in the upper waters of the river will have made its appearance as mature males and females. After this the diminution takes place with increasing rapidity until, five or six years afterwards,

the fish are found to have disappeared entirely from the stream. So much for the dams. As for the other causes, sawdust and other refuse matter get into the gills of fish and produces irritation and subsequent death. Coal-tar refuse is known to be a very great detriment to the healthful condition of water so far as fish are concerned, and it is probable that a part, at least, of the decrease of shad and herring in the Potomac is due to the discharge from the gas-works of Washington and Alexandria.

The rapid increase in the size and number of the nets, whether pounds, seines, drift or gill nets, that has manifested itself within the last twenty years has doubtless had a similar effect with the dams in producing a decrease. The fish are harassed and worried by them, and hindered in an equal degree from reaching their spawning-ground, and thus another drain on the supply is added to the many already in operation.

What, now, are the remedies to be applied to recover from this lamentable condition of the American fisheries (a condition which, we may remark, has existed in all countries of Europe, but which in some of them has already been greatly lessened by the proper measures)? These are twofold. One consists in the enactment and enforcement of legislation protecting what we have, and allowing natural agencies to play their part in the recovery; the other consists in the application of the art of artificial propagation of the fish. Either, alone, in some circumstances, will answer a very good purpose. The two combined constitute an alliance which places at our command the means of recovering our lost ground to a degree which, but for the experience of the last ten years, would hardly be credible.

7.—POLITICAL AND SOCIAL IMPORTANCE OF INCREASE OF FISH SUPPLY.

Now let us glance at the importance in the political economy of the United States of an increase in the supply of fish for food. We are at present a people of 49,000,000 souls, which, by the end of the present century, will probably amount to double the number. The production of animal food on land depends in large part upon the amount of soil available for grazing; but, with the increase of population, the necessity of a more lucrative yield makes it imperative to prosecute the cultivation of the cereals or other articles of direct food to man, thus restricting the area of pasture-lands. Many countries of Europe have already reached that period when they look to foreign nations for their supply of animal food. America furnishes a great part; the less populated regions of Europe the remainder. The increase in the price of what is called "butcher's meat," though gradual, is inevitable, and every year a larger and larger percentage of the population will be unable to secure it. In this emergency we must look to the water for the means of supply. In former days the inhabitants of the sea-coast and rivers obtained a very large portion of their animal food from the water; and in proportion as this state of affairs is restored will the condition of the future population

be improved. The legislation required consists in the enactment of laws for the introduction of fish-ladders, by means of which the spawning-fish can reach the headwaters of the rivers; in a prohibition against discharging sawdust, gas-refuse, chemicals, &c., into the water; in a limitation as to the pounds, number, and size of mesh of nets, and especially in the establishment of close seasons during the week, during which the capture of fish by nets shall be forbidden, and an absolute prohibition of their capture after a certain date in the year. These dates will necessarily vary with the kinds of fish to be protected.

8.—MODE OF INCREASING THE SUPPLY OF FISH.

Even, however, with all these regulations, supposing them to be thoroughly enforced, there remains much to be done. Our rivers, capable of accommodating very many tons of fish, must be restocked, or there will be no result from our labors. This is not to be accomplished by the transfer of the parent fish from one point to another, especially as the shad and alewife will not survive a few moments removal from the water. It is through artificial propagation that the restoration of certain species of fish to their former place of abode, and the introduction of fish to waters where they were before unknown, is to be accomplished.

Fish-culture and fish-rearing, in a certain sense, are nothing new. The Chinese and other Oriental nations have practiced a form of the art for ages. In Europe it has been prosecuted for centuries. The transfer of fish from one sea to another was accomplished by the Romans of old. The bringing of fish into restricted waters, where they are supplied with food and allowed to grow and multiply, or even the gathering of eggs after they have been laid and impregnated by the fish, represents the so-called fish-culture of China. The young fish hatched under favorable circumstances are supplied with food and reared carefully, sometimes even in tubs or jars, and in the course of a few years furnish a remunerative return to their owners. Such nurture or maintenance of fish, under circumstances when they can multiply and attain their growth, is, however, not fish-culture proper in its modern sense. This is based upon the artificial impregnation of the fish and is practiced by stripping the eggs from mature females; by fertilizing these eggs by the milt of the male; by placing the eggs thus fertilized in a condition favorable for their development, and by the protection of the resultant fish until they are able to take care of themselves; they may be then kept indefinitely in ponds or turned out at once into suitable waters. It is this operation which has constituted the basis of recent effort, and which has been crowned with such triumphant success.

At first sight it would seem impossible for man with his limited opportunities and means to compete with or even to supplement nature in the process of maintaining or increasing the supply of a certain species by artificial impregnation, but a consideration of the subject will show what really can be claimed. The process of natural impregnation of

fishes is, for the most part, external; that is to say, the eggs of the female and the milt of the male are discharged at or about the same time into the water, the two being close together, so that, as far as they come in contact with the milt, the eggs become fertilized. Observation, however, has shown that a very small proportion of the eggs are actually fertilized, possibly 10 per cent. being a liberal estimate. Again, these eggs, some of which remain three months before they are developed, some but a few days, or even hours, are exposed continually to the attacks of vast hordes of animals of all sizes, especially minnows, crabs, frogs, birds, &c., by which still another large percentage is consumed.

Still further: The young fish when hatched out is almost as helpless as the egg, being unable to defend itself from danger, and is devoured with great eagerness by the same class of enemies, as being an especial delicacy. As a general rule it is believed that a yield of five young fish, with the yolk-bag absorbed, and the fins fully formed, and able to take care of themselves, is a liberal allowance for each thousand eggs. By the artificial method of propagation, 90 per cent. of the eggs should be thoroughly fertilized, and when the fish is hatched out it is kept from its adversaries until able to look out for itself. It may safely be assumed that eight hundred and fifty fish out of a thousand eggs are produced artificially as compared with the five in a thousand produced naturally. The ratio of production may, in round numbers, be claimed to be nearly two hundred to one in favor of artificial production, possibly much more.

A few words in regard to the history of this wonderful art may not be amiss. Among the first to practice artificial hatching was a German named Jacobi, who, about the middle of the last century, announced the success of experiments with the German trout. There are vague rumors of something earlier, but they are not matters of history. In 1844, Remy and Gehin, two illiterate Frenchmen, rediscovered the art and brought it to the notice of the French Government, by which they were liberally rewarded, and steps were taken to exercise it, although with but little result, notwithstanding the efforts were directed by eminent naturalists, such as Quatrefages and Coste. At a later day, however, the practice of artificial impregnation of fish-eggs in Europe became more and more common, until at the present time there are several national and a large number of state and private establishments occupied, for the most part, in hatching and rearing the various species belonging to the trout and salmon family.

In America, the first practical action in the way of artificial production of fish was begun in 1853 with the trout. The experimenters were Drs. Garlick and Ackley, of Cleveland, Ohio; and to them we owe the initiation of actual fish-culture in this country. With the proof of success attending their efforts, as shown by these gentlemen in their fish-ponds near Cleveland, it was not long before many persons entered the same field, the trout, as before, being at first the exclusive object of attention.

In 1867, the attention of the New England commissioners of fisheries was directed to the possibility of increasing by artificial means the abundance of the shad, the enormous diminution of which was felt to be a serious evil. It is to Seth Green, of New York, that we owe the idea of the possibility of reproducing shad and the initiation of the steps necessary to carry it into effect. While the methods of stripping the parents and of impregnating the eggs were essentially the same, the devices employed for hatching out the eggs of the trout were all found to be unavailable, not only unfit in themselves, but powerless to accomplish the work on a sufficiently large scale to make it of any economical value. A floating box with a wire-cloth bottom first suggested itself to Mr. Green. This was filled with impregnated eggs, and anchored in the river, where it occupied a horizontal position, and a partially successful result obtained. It was found, however, that in a horizontal box the eggs were not sufficiently exposed to the action of the water and that they collected in the ends and corners, where the larger number perished. The idea then occurred to Mr. Green that by nailing two parallel strips of wood obliquely across the opposite sides of the box, the bottom would be maintained obliquely to the water. The experiment worked like a charm, and from that time until very recently the Green floating box has been the apparatus almost universally employed for this purpose.

It is impossible here to go into any further account of the numerous modifications of fish-hatching apparatus for special cases and particular kinds of fish, although I shall refer hereafter to certain improved devices now employed by the United States Fish Commission as superior to all others known to it.

As already stated, the successes of Drs. Garlick and Ackley induced great numbers of people to take part in the work, but it was not until about the time that Seth Green obtained a patent for his invention that any State action was brought into play on a large scale in hatching shad, although something had previously been done with salmon. It was about this time that the New England States appointed commissioners of inland fisheries to see that certain legislation was enforced, and to take measures for the improvement of the general supply. Other States followed, and now there are nearly thirty having fish commissioners appointed to attend to the subject.

9.—OPERATIONS OF THE UNITED STATES FISH COMMISSION.

A new era in the history of fish culture was entered upon in the establishment of the United States Fish Commission in 1871. Its original object, as authorized by law of Congress, was an investigation into the causes of the alleged decrease of the fishes of the sea-coast and lakes, and the recommendation of measures for their restoration. The Commission was organized by the appointment of Spencer F. Baird, then assistant secretary of the Smithsonian Institution, as Commissioner, and his first work was prosecuted during the summer of 1871,

along the New England coast. Many investigations were made and a rational theory in regard to the condition and improvement of certain coast fisheries was prepared and published by him in the following year.

In 1872, a committee of the American Fish Culturists Association urged upon Congress the importance of an appropriation to supply useful food-fishes to such rivers and lakes of the country as were the common property of the nation, but which, not being under the jurisdiction of one State, had been left unattended to. An appropriation was ultimately made and put at the command of the United States Commissioner. These appropriations have been made year by year, and year by year new varieties of fish have been taken into consideration, and the field of operations extended, although still confined almost exclusively to species of national importance, and their introduction into rivers and lakes which State or private enterprise cannot cover.

Among the more important species now cared for by the United States Fish Commission, may be mentioned the shad, the fresh-water herring, or alewives, the striped bass, the salmon of Maine, the land-locked salmon of Maine, the salmon of California, and the German carp.

The importance of increasing the supply of shad already existing in a given river is easily appreciable, and the desirability of introducing them into rivers where they had been previously unknown is equally evident. As the result, partially or entirely, of the efforts of the United States Commission, the Sacramento River, and many streams of the Mississippi Valley and of the Gulf of Mexico, where this fish was previously unknown, have been largely stocked with it, and it is hoped that in a few years it will constitute a very important element of the food supply of the country. A statement of what has been done in this connection will be found in the reports of the Commission. Thus, in the year 1873, about 200,000 dimunitive fish, averaging a quarter of an inch in length, were placed in the headwaters of the Alleghany River, in Wesern New York. These fish, or such of them as escaped the perils of infancy, passed down to the Gulf of Mexico and there obtained their growth. In 1877, or at the end of the four years required for their full development, they re-entered the Mississippi on their return to the place whence they had started in 1873. On their passage upward they passed Louisville at a time when the river seines were in full operation, and the fishermen were surprised to find among their hauls large numbers of fine-looking fish of a kind entirely unknown to them. It was soon shown, however, by those familiar with this famous fish, that they were the genuine white shad, of which it is estimated that no less than 600, from three to five pounds in weight, were taken during the run past Louisville. Additional captures were recorded at other points of the Ohio and its tributary rivers. Specimens of these shad are now carefully preserved in the National Museum.

The eastern salmon has for many years been unknown in the waters of the United States, except to a limited degree in the Kennebec, Pe-

nobscot, and other streams of Maine. The work of restocking the original haunts with this fish was commenced in 1866, by the State of New Hampshire, and followed subsequently by several of the New England States, and in 1872 with the very important co-operation of the United States Fish Commission, which of late years has borne the chief expenses of the outlay.

What, now, has been the result, and especially in the Connecticut River, which formerly abounded in large numbers of the salmon, and which has been the principal scene of operations? Young salmon in greater or less numbers have been introduced by the States of Massachusetts, Connecticut, Vermont, and New Hampshire, beginning in 1867, but not in any considerable quantity, until supplemented and strengthened by the United States Commission in 1873, which from that time took the lead in the production.

Great incredulity had been manifested by most persons as to any practical result from artificial propagation, and, as year after year passed without bringing the expected run of salmon into the Connecticut, sneers and jokes at the expense of the United States and State commissions multiplied. The occurrence, however, of one or two large salmon in the Connecticut in 1876, and of a dozen in 1877, interfered with this skepticism, which was changed into enthusiastic appreciation by the appearance in 1878 of large numbers of fine, fat salmon, such as have not been seen in the river for many years. No less than 500 fish, each of from ten to twenty pounds in weight, were captured at the mouth of the river, and sold in the New York market for the most part, at prices ranging from 75 cents to a dollar per pound. This, in all probability, did not represent anything like the number of fish that entered the river, but merely those that were taken in the shad-nets, apparently very imperfectly and ill-adapted to the capture of so heavy a fish. Increasingly larger and larger yields may be expected in the future, at least up to 1880; their continuance beyond that time may depend upon the legislation of the States through a part of which the Connecticut river flows.*

The California salmon has great advantage over the ordinary species in much greater hardiness and capacity for existence in waters warmer by many degrees than those to which the eastern salmon is habituated. It has been introduced by millions in the tributaries of the Mississippi, the Gulf of Mexico, and the Atlantic Ocean. It has been transported to Australia, New Zealand, and the Sandwich Islands, to Germany, France, and the Netherlands, where the eggs have been thankfully received, hatched out with perfect success, and successfully planted. Wherever taken it has been looked upon as one of the most important subjects of fish-culture. Without any exception, the distribution of the

* The experience in the Merrimac and the Delaware Rivers, and to a like degree on the Susquehanna is much the same as that mentioned for the Connecticut. Specimens of salmon from all these rivers are preserved in the National Museum.

California salmon has been made under the auspicies of the United States Fish Commission.

The German carp, one of the latest species that has occupied the attention of the United States Commission, is one of the most important. There are many varieties, three in particular being best known. Of these, one is covered with large scales, something as in the goldfish; another has lost all the scales, except along the lateral line, while the third is entirely destitute of scales. These are known respectively as the scale, mirror, and leather carp.

The carp has been domesticated in Europe from time immemorial, and represents among the finny tribe the place occupied by poultry among birds. It is a fish adapted to the farmers' ponds and to mill-dams, less so to clear gravelly rivers with a strong current. Where there is quiet water with a muddy bottom and abundant vegetation, there is the home for the carp; there it will grow with great rapidity, sometimes attaining a weight of three to four pounds in as many years. It is a vegetable-feeder and not dependent upon man for its sustenance. As an article of food the better varieties rank in Europe with the trout, and bring the same price per pound.

I have already referred to the use of the Seth Green floating box for the hatching out of shad. I now call attention to the very important improvement, in greater part the invention of Mr. Ferguson, fish commissioner of Maryland, by which the floating box has been superseded by a new apparatus worked by steam, in which a thousand shad can be produced with the same facility as a single one by the old method.

As the result of the first year's experiments with the new apparatus, in 1878, of the United States Fish Commission, 16,000,000 shad were hatched out, and in large part deposited in streams all over the country by the Commission's messengers.

During the past winter of 1878–'79, the United States Fish Commission has, however, made a step far in advance of its previous efforts, and of the most novel and striking character. While the establishment and increase of the fresh-water fisheries has been of the utmost importance, especially those of the anadromous species, the Commission has of late been considering the possibility of artificially multiplying the marine species, confident that by this measure a vastly greater sphere of usefulness will be entered upon. The first experiments have been made with the cod, a fish which is the staple of American marine industry, and which involves the investment of a large sum of money and the labor of many thousands of men. This visits the coast of New England in the winter for the purpose of spawning; Cape Ann, Mass., being an especially favorite ground for the purpose.

A temporary establishment was fitted up in the autumn of 1878, in Gloucester Harbor, Massachusetts, for the purpose of a series of preliminary experiments looking towards the artificial propagation of the cod, commencing in November. During these trials many difficulties were

encountered and overcome. It was found that the principle on which the work was to be done was diametrically opposite to that used in connection with the fresh-water varieties, as the egg of the cod floats on the top of the water instead of sinking to the bottom. This obstacle was finally surmounted, and many millions of the young cod were hatched out and planted in the ocean adjacent to Gloucester Harbor. A number of these fish were sent to Washington.

It is now believed to be possible not only to greatly increase the supply of the cod where it is at present found, but, by carrying the young to new localities, to establish cod fisheries as far south as the coast of North Carolina, where the fishermen may find regular occupation during the winter—now his poorest season—in capturing these fish in large quantities and supplying the adjacent markets or even exporting them.

The same apparatus and mode of treatment can be used for hatching mackerel, halibut, sea-herring, and other species, so that we have at our command the means of so improving and increasing the American fisheries as to obviate the necessity in the future of asking a participation in the inshore fisheries of the British provinces and thus enable us to dispense with fishery treaties or fishery relations of any kind with the British or other governments.

TABLE I.—*Distribution of shad, from April 11 to June 14, 1878, by the United States and Maryland Commissions Fish and Fisheries.*

Introduction of fish.				Date of transfer.	Transfer in charge of—	Number of fish.
State.	Stream.	Tributary of—	Town or place.			
Alabama	Tombigbee River	Mobile Bay	Demopolis	Apr. 13, 1878	J. F. Ellis	116,000
	Escambia River	Pensacola Bay	Pollard	May 24, 1878	F. A. Ingalls	100,000
	Tallapoosa River	Alabama River	Salisbury	June 8, 1878	J. M. Donaldson	50,000
Arkansas	Sabine River	Washita River	Benton	June 1, 1878	H. E. Quinn	50,000
	Caddo River	do	Arkadelphia	June 1, 1878	do	50,000
California	Sacramento River	Pacific Ocean	Teharra	June 11, 1878	F. N. Clark	150,000
District of Columbia	Potomac River	Chesapeake Bay	Washington	May 27, 1878	United States Fish Commission	400,000
Georgia	Ocmulgee River	Altamaha River	Macon	Apr. 25, 1878	H. E. Quinn	60,000
	Flint River	Appalachicola River	Albany	Apr. 25, 1878	do	60,000
	do	do	Montezuma	May 25, 1878	J. F. Ellis	150,000
	Etowah River	Coosa River	Cartersville	June 9, 1878	J. M. Donaldson	50,000
Illinois	Kaskaskia River	Mississippi River	Parlow	May 27, 1878	C. W. Scheurmann	100,000
	Rock River	do	Rickford	June 2, 1878	do	100,000
	Embarrass River	Wabash River	Charleston	June 9, 1878	W. H. Hines	50,000
	Missisinewa River	do	Marion	June 8, 1878	do	50,000
Indiana	Elkhart River	Lake Michigan	Elkhart	June 1, 1878	J. F. Ellis	100,000
	Wabash River	Ohio River	Terre Haute	June 9, 1878	H. E. Quinn	65,000
Iowa	Des Moines River	Mississippi River	Cedar Rapids	June 8, 1878	B. F. Shaw	24,000
	Boyer River	do	Logan	June 8, 1878	do	36,000
Kentucky	Cumberland River	Ohio River	Somerset	May 26, 1878	H. E. Quinn	60,000
	Green River	do	McKinney's Station	May 26, 1878	do	60,000
			High Bridge	June 1, 1878	F. A. Ingalls	175,000
	Green River	Ohio River	Bowling Green	June 3, 1878	William Russ	100,000
Louisiana	Amite River	Lake Ponchartrain	Tickfaw	May 27, 1878	W. M. Russ	100,000
Maryland	Potomac River	Chesapeake Bay	Various points	Apr. 21, 1878	William Hamlen	100,000
	do	do	Potomac Point	May 1, 1878	do	100,000
	Choptank River	do	Greensborough	May 17, 1878	Thomas Hughlett	100,000
	Potomac River	do	Neapsico Creek	May 23, 1878	United States Fish Commission	50,000
	Nanticoke River	do	Federalsburg	May 24, 1878	Thomas Hughlett	100,000
	Potomac River	do	Glymont	May 24, 1878	United States Fish Commission	75,000
	Susquehanna River	do	Havre de Grace	May 25, 1878	do	150,000
	North East River	do	Bull's Mount	May 26, 1878	do	350,000
	Susquehanna River	do	Havre de Grace	May 28, 1878	do	100,000
	Spesutie Narrows	do	do	May 27, 1878	do	200,000
	do	do	do	May 28, 1878	do	400,000
	Potomac River	do	Fort Washington	May 28, 1878	do	100,000
	do	do	Glymont	May 23, 1878	do	300,000
	Wicomico River	do	Salisbury	May 29, 1878	Thomas Hughlett	175,000
	Manokin River	Tangier Sound	Princess Anne	May 29, 1878	do	75,000
	Spesutie Narrows	Chesapeake Bay	Havre de Grace	May 29, 1878	United States Fish Commission	1,500,000
	do	do	do	May 30, 1878	do	500,000
	Chester River	do	Millington	May 31, 1878	Thomas Hughlett	250,000

	Tread Haven	Choptank River	Easton	June 1, 1878	S. M. Rixey	50,000
	Miles River	Eastern Bay	Near Easton	June 1, 1878	..... do	75,000
	Spesutie Narrows	Chesapeake Bay	Havre de Grace	June 1, 1878	United States Fish Commission	500,000
	..... do	..... do	... do	June 3, 1878	... do	500,000
	Choptank River	..... do	Greensborough	June 3, 1878	S. M. Rixey	100,000
	Tuckahoe River	Choptank River	Hillsborough	June 3, 1878	..... do	50,000
	Patuxent River	Chesapeake Bay	Laurel	June 5, 1878	J. M. Donaldson	150,000
	..... do	..... do	..... do	June 6, 1878	David Scott	130,000
	Spesutie Narrows	..... do	Havre de Grace	June 6, 1878	United States Fish Commission	500,000
	Pocomoke River	..... do	Snow Hill	June 10, 1878	S. M. Rixey	150,000
	Bush River	..... do	Railroad crossing	June 10, 1878	W. F. Page	150,000
	Spesutie Narrows	..... do	Havre de Grace	June 10, 1878	United States Fish Commission	100,000
	..... do	..... do	..... do	June 11, 1878	..... do	185,000
	Gunpowder River	..... do	Cockeysville	June 14, 1878	U. Simmons	80,000
	Spesutie Narrows	..... do	Havre de Grace	June 14, 1878	United States Fish Commission	120,000
Mississippi	Big Black River	Mississippi River	Vaughn Station	Apr. 13, 1878	C. W. Schuermann	144,000
	Sunflower River	Yazoo River	Friar's Point	Apr. 23, 1878	J. F. Ellis	100,000
	Cold Water River	..... do	Holly Springs	Apr. 23, 1878	C. W. Schuermann	40,000
	Tallahatchie River	..... do	Railroad crossing	Apr. 23, 1878	..... do	40,000
	Yalabusha River	..... do	Grenada	Apr. 23, 1878	..... do	40,000
	Tombigbee River	Mobile Bay	Fulton	May 15, 1878	J. F. Ellis	90,000
	..... do	..... do	Aberdeen	May 15, 1878	..... do	60,000
	Okatibee Creek	Chickasawha River	Meridian	May 23, 1878	R. E. Earle	100,000
Missouri	Shoal Creek	Arkansas River	Neosha	May 20, 1878	C. W. Schuermann	120,000
	Mississippi River	Gulf of Mexico	Saint Louis	June 8, 1878	F. A. Ingalls	100,000
North Carolina	Salmon Creek	Chowan River	Avoca	Apr. 11, 1878	United States Fish Commission	2,500
	Roanoke River	Albemarle Sound	Weldon	Apr. 11, 1878	W. G. Williamson	130,000
	Neuse River	Pamlico Sound	Neuse Station	Apr. 12, 1878	S. G. Worth	100,000
	Meherrin River	Chowan River	Railroad crossing	Apr. 12, 1878	W. G. Williamson	150,000
	Salmon Creek	..... do	The Mill	Apr. 15, 1878	United States Fish Commission	120,000
	Neuse River	Pamlico Sound	Raleigh	Apr. 20, 1878	H. E. Quinn	50,000
	Tar River	..... do		Apr. 22, 1878	Thomas Taylor	100,000
	Salmon Creek	Chowan River	Avoca	Apr. 24, 1878	United States Fish Commission	800,000
	Cape Fear River	Atlantic Ocean	Lockville	Apr. 24, 1878	Col. L. L. Polk	100,000
	Salmon Creek	Chowan River	Avoca	Apr. 25, 1878	United States Fish Commission	200,000
	Chowan River	Albemarle Sound	Colerain	Apr. 25, 1878	..... do	200,000
	Albemarle Sound	Atlantic Ocean	Scotch Hall Fishery	Apr. 25, 1878	..... do	115,000
	Roanoke River	Albemarle Sound	Plymouth	Apr. 26, 1878	..... do	250,000
	Chowan River	..... do	Avoca	Apr. 26, 1878	..... do	25,000
	Albemarle Sound	Atlantic Ocean	Scotch Hall	Apr. 26, 1878	..... do	70,000
	Blackwater River	Chowan River	Franklin	Apr. 26, 1878	Thomas Taylor	200,000
	Salmon Creek	..... do	Avoca	Apr. 28, 1878	United States Fish Commission	300,000
	..... do	..... do	..... do	Apr. 29, 1878	..... do	18,000
	..... do	..... do	..... do	May 1, 1878	..... do	45,000
	..... do	..... do	..... do	May 2, 1878	..... do	200,000
	Yadkin River	Great Pedee River	Salisbury	June 7, 1878	S. G. Worth	50,000
	Catawba River	Santee River	Catawba Station	June 7, 1878	..... do	50,000
Ohio	Sandusky River	Lake Erie	Fremont	June 9, 1878	H. E. Quinn	60,000
South Carolina	Great Pedee River	Winyan Bay	Railroad crossing	June 1, 1878	S. G. Worth	50,000
	Broad River	Santee River	Columbia	June 1, 1878	..... do	50,000

TABLE I.—*Distribution of shad from April 11 to June 14, 1878, &c.*—Continued.

Introduction of fish.				Date of transfer.	Transfer in charge of—	Number of fish.
State.	Stream.	Tributary of—	Town or place.			
Tennessee	Middle fork of Forked Deer River.	Forked Deer River	Humboldt	May 18, 1878	H. E. Quinn	50,000
Virginia	South fork of Obion River	Mississippi River	Huntingdon	May 18, 1878	do	50,000
	Nottoway River	Chowan River	Nottoway Mills	Apr. 11, 1878	W. G. Williamson	111,000
	James River	Chesapeake Bay	Richmond	Apr. 13, 1878	do	115,000
	South branch Nansemond River	James River	Seaboard and Roanoke Railroad crossing.	Apr. 22, 1878	H. B. Nicholas	40,000
	Roanoke River	Albemarle Sound	Salem	Apr. 24, 1878	W. F. Page	100,000
	Appomattox River	James River	Petersburg	Apr. 25, 1878	H. B. Nicholas	60,000
	Mattapony River	York River	Milford Station	Apr. 30, 1878	do	90,000
	do	do	do	May 1, 1878	H. D. Johnson	90,000
	Little River	South Anne River	Taylorsville	May 1, 1878	W. F. Page	100,000
	Blackwater River	Chowan River	Franklin	May 2, 1878	Thomas Taylor	150,000
	do	do	do	May 2, 1878	do	100,000
	South branch Nansemond River	James River	Seaboard and Roanoke Railroad crossing.	May 3, 1878	Page & Johnson	50,000
	Potomac River	Chesapeake Bay	Freestone	May 23, 1878	United States Fish Commission	50,000
	Shenandoah River	Potomac River	Riverton	May 28, 1878	W. F. Page	200,000
	Rivanna River	James River	Shadwell	June 1, 1878	do	175,000
	South River	Shenandoah River	Waynesborough	June 4, 1878	do	150,000
						15,700,500

TABLE II.—*Distribution of California salmon reared from eggs collected in 1878.*

States.	Where finally hatched.	Waters stocked.	Tributaries in which fish were placed.	Locality.	Date of transfer.	Number of fish.
California	United States hatchery	Sacramento River	McCloud and Little Sacramento Rivers.	McCloud and Sacramento, Cal	Oct. —, 1878	2,000,000
Illinois	Geneva Lake hatching-house	Fox River	Geneva Lake	Geneva, Wis	1879	200,000
	do	do	Crystal Lake	Crystal Lake, Ill	1879	20,000
	do	Illinois River	Rock River	Rockford, Ill	1879	50,000
	do	do	Fox River	Cacy, Ill	1879	20,000
Iowa	Anamosa, Iowa	Missouri River	Sioux River		Jan. 27, 1879	4,000
	do	Mississippi River	Mud Lake		Jan. 31, 1879	10,000
	do	do	Skunk River		Jan. 31, 1879	10,000
	do	do	Wall Lake		Jan. 31, 1879	10,000
	do	do	Towner's Lake		Jan. 31, 1879	7,000
	do	do	Iowa River		Jan. 31, 1879	7,000
	do	do	Des Moines River		Feb. 12, 1879	10,000
	do	do	East Coon River		Feb. 12, 1879	10,000
	do	do	Middle River		Feb. 12, 1879	10,000
	do	do	Wall Lake		Feb. 12, 1879	20,000
	do	do	Maple River		Feb. 12, 1879	10,000
	do	do	Magnoketa River		Feb. 20, 1879	10,000
	do	do	Turkey River		Mar. 20, 1879	3,000
	do	do	Lisborn River		Mar. 24, 1879	4,000
	do	do	Wapsee River		Mar. 10, 1879	10,000
	do	do	Big Rock River		Mar. 17, 1879	8,000
	do	do	Boone River		Mar. 22, 1879	10,000
	do	do	Upper Des Moines River		Mar. 22, 1879	10,000
	do	Missouri River	Plymouth River		Mar. 22, 1879	15,000
	do	Mississippi River	Cedar River		Mar. 28, 1879	5,000
	do	do	East Skunk River		Apr. 1, 1879	2,500
	do	do	West Skunk River		Apr. 1, 1879	2,500
	do	do	Maltby Kellogg		May 14, 1879	2,500
	do	do	Streams along C. B. and Q. R. R.		May 19, 1879	12,000
	do	do	Independence River		May 20, 1879	4,000
	do	do	Volga River		May 20, 1879	5,000
	do	do	Turkey River		May 20, 1879	5,000
	do	do	Cedar River		May 30, 1879	10,000
	do	do	Spring Branch		May 30, 1879	5,000
Kansas	Cedar Rapids, Iowa	Missouri River	Stranger River	Stranger, Kans	1879	2,500
	do	do	Verdigris River	Independence, Kans	1879	2,500
	do	do	Delaware River	Delaware, Kans	1879	3,000
	do	Kansas River	Red Vermillion River	Centralia, Kans	1879	2,000
	do	do	Spring Creek	Wetmore, Kans	1879	1,000
	do	Big Blue River	Mill Creek	Washington, Kans	1879	1,000
	do	do	Black Vermillion River	Frankford, Kans	1879	2,000
	do	Kansas River	Clear Creek	Barretta, Kans	1879	1,000

TABLE II.—*Distribution of California salmon reared from eggs collected in 1878*—Continued.

States.	Where finally hatched.	Waters stocked.	Tributaries in which fish were placed.	Locality.	Date of transfer.	Number of fish.
Kansas	Cedar Rapids, Iowa	Kansas River	Big Blue River	Blue Rapids, Kans	1879	5,000
	do	Big Blue River	Little Blue River	Waterville, Kans	1879	2,000
	do	Kansas River	Republican River	Concordia, Kans	1879	5,000
	do	do	Solomon River	Beloit, Kans	1879	5,000
	do	do	Soldier River	Topeka, Kans	1879	1,000
	do	do	Silver Lake	Silver Lake, Kans	1879	500
	do	do	Vermillion River	Wamego, Kans	1879	2,500
	do	do	Big Blue River	Manhattan, Kans	1879	5,000
	do	do	Republican River	Junction City, Kans	1879	3,000
	do	do	Chapman's Creek	Chapman's Creek, Kans	1879	2,000
	do	do	Solomon River	Solomon City, Kans	1879	2,000
	do	Smoky Hill River	Saline River	Saline, Kans	1879	3,000
	do	do	Spring Creek	Brookville, Kans	1879	1,000
	do	Kansas River	Smoky Hill River	Ellsworth, Kans	1879	5,000
	do	Smoky Hill River	Big Creek	Hayes City, Kans	1879	5,000
	do	do	do	Ellis, Kans	1879	5,000
	do	Kansas River	Wakasa River	Ottawa, Kans. (?)	1879	2,000
	do	Missouri River	Osage River (?)	Redding, Kans	1879	2,500
	do	Arkansas River	Neosho River	Emporia, Kans	1879	5,000
	do	Neosho River	Cottonwood River	Florence, Kans	1879	2,000
	do	Arkansas River	Walnut River	Eldorado, Kans	1879	8,000
	do	do	Little Arkansas River	Halstead, Kans	1879	2,500
	do	Little Arkansas River	Lake Inman	McPherson, Kans	1879	2,000
	do	Arkansas River	Cow Creek	Hutchinson, Kans	1879	3,000
	do	do	Walnut River	Great Bend, Kans	1879	3,000
	do	do	Pawnee Creek	Larned, Kans	1879	5,000
Maine	Pembroke hatching-house	Saint Croix River	Keen's Lake Stream	Keen's Lake, Me	Feb. 6, 1879	9,700
	do	Bay of Fundy	Penmaquan River	Pembroke, Me	Feb. 13, 1879	3,000
Maryland	Druid Hill hatching-house	Bush River	Winter's Run	Wilna, Md	Feb. 1, 1879	4,000
	do	Chesapeake Bay	Patuxent River	Savage Station, Md	Feb. 1, 1879	10,000
	do	do	Chester River	Millington, Md	Feb. 12, 1879	12,000
	do	do	Choptank River	Henderson, Md	Feb. 21, 1879	8,000
	do				Feb. 24, 1879	7,000
	do	Tangier Sound	Black Water	Cambridge, Md	Feb. 26, 1879	3,000
	do	Transquaking River	Chicacomico		Feb. 26, 1879	3,000
	do	Tangier Sound	Transquaking River	Airey's Station, Md	Feb. 26, 1879	3,000
	do	Chesapeake Bay	Patapsco and Patuxent Rivers	Hood's Mill and Airey, Md	Feb. 28, 1879	12,000
	do				June 6, 1879	236
Michigan		Lake Michigan	Paw Paw River	Berrien County, Michigan	Jan. 8, 1879	25,060
		Dowagiac River	Pokagon Creek	Cass County, Michigan	Jan. 9, 1879	10,000
		do	Peccanic River	do	Jan. 10, 1879	5,000
		Pine Lake	Dowagiac River	Van Buren County, Michigan	Jan. 10, 1879	10,000
		Saint Joseph River	Walron Creek	Saint Joseph County, Michigan	Jan. 23, 1879	10,000
		do	Fates Creek	do	Jan. 23, 1879	10,000

	.....	Lake Michigan	Grand River	Jackson, Mich	Jan. 30, 1879		30,000
	.....	do	Manistee River	Wexford County, Michigan	Feb. 6, 1879		25,000
	.....	Lake Erie	Raisin River	Monroe, Mich	Feb. 13, 1879		30,000
	.....	Saginaw River	Cass River	Tuscola County, Michigan	Feb 13, 1879		30,000
	.....	White River	Round Lake	Oceana County, Michigan	Apr. 18, 1879		500
	.....	do	Crystal Lake	do	Apr. 18, 1879		500
	.....	.....	Private ponds	Romeo, Mich	July 12, 1879		220
Minnesota	Red Wing, Minn	Mississippi River	Lakes	Goodhue County, Minnesota	1879		5,000
	do	Saint Croix River	Silver Lake	Washington County, Minnesota	1870		1,000
	do	Mississippi River	Mary's Creek	Mower County, Minnesota	1879		1,000
	do	Minnesota River	Cedar Lake	Wantonwan County, Minnesota	1879		1,000
	do	do	Chain Lake	do	1879		1,000
	do	do	Lake Alloy	Renville County, Minnesota	1879		2,000
	do	do	Lake Prescott	do	1879		2,000
	do	Blue Earth River	Chain Lake	Martin County, Minnesota	1879		5,000
	do	Missouri River	Lake Letook	Lesour County, Minnesota	1879		2,500
	do	do	Lake Takota	do	1879		2,500
	do	Minnesota River	Lake Elysian	Waseca County, Minnesota	1879		5,000
	do	do	Lakes	Douglas County, Minnesota	1879		3,000
	do	Mississippi River	do	Wright County, Minnesota	1879		3,000
	do	Saint Croix River	Lake Elmo	Washington County, Minnesota	1879		2,000
	do	.....	Lake Koronis	.....	1879		3,000
Missouri	California	Pomme de Terre River	Lake Foss	Stevens County, Minnesota	1879		2,000
	do	Mississippi River	Meramec River	Franklin, Mo	Dec. —, 1878		75,000
Nevada	McCloud River Station	Arkansas River	Spring River	Carthage, Mo	Dec. —, 1878		75,000
	do	Bear River	Truckee River	Reno, Nev	Mar. —, 1879		199,000
New Hampshire	Plymouth, N. H	Carson River	Mexican Dam	Carson City, Nev	Mar. —, 1879		10,000
	do	Merrimac River	Pemigewasset River	Campton and Plymouth, N. H	Feb. 1, 1879		317,000
	do	Salmon Falls	Newechewannock Lake	Wakefield, N. H	Mar. 14, 1879		5,000
	do	do	Tri-Echo Lake	Milton, N. H	Mar. —, 1879		5,000
	do	do	Lorewell's Pond	Wakefield, N. H	Mar. —, 1879		5,000
	do	do	Cook's Pond	Brookfield, N. H	Mar. —, 1879		5,000
	do	Lake Winnipiseogee	Smith's Pond	Wolfeborough, N. H	Mar. —, 1879		10,000
	do	Merrimac River	Contoocook	Hillsborough Bridge, N. H	Mar. —, 1879		20,000
New Jersey	Bloomsburg, N. J	Delaware River	Shumaker's Eddy	Eighty miles north of Trenton	1879		150,200
	do	Great Egg Harbor	Great Egg Harbor River	Atlantic County, New Jersey	1879		50,000
	do	Delaware River	Alloway's Creek	Salem County, New Jersey	1879		25,000
	do	do	Maurice River	Cumberland County, New Jersey	1879		25,000
	do	do	Racoon Creek	Gloucester County, New Jersey	1879		25,000
	do	Great Bay	Mullica River	do	1879		25,000
	do	Raritan River	North Branch	Somerset County, New Jersey	1879		30,000
	do	Passaic River	Rockaway River	do	1879		30,000
	do	Hackensack River	Hackensack River	Bergen County, New Jersey	1879		30,000
	do	Lake Hopatcong	Lake Hopatcong	Morris County, New Jersey	1879		5,000
	do	Shawngum Lake	Shawngum Lake	.....	1879		5,000
	do	Silver Lake	Silver Lake	.....	1879		3,000
	do	Greenwood Lake	Greenwood Lake	Passaic County, New Jersey	1879		22,000
	do	Swartswood Lake	Swartswood Lake	Sussex County, New Jersey	1879		10,000
	do	Verona Lake	Verona Lake	.....	1879		3,000
	do	Cline's Pond	Cline's Pond	.....	1879		10,000

TABLE II.—*Distribution of California salmon reared from eggs collected in 1878*—Continued.

States.	Where finally hatched.	Waters stocked.	Tributaries in which fish were placed.	Locality.	Date of transfer.	Number of fish.
New York		Hudson River	Tributaries of Hudson River	Green County, New York	Dec. 5, 1878	20,000
		Genesee River	Spring Creek	Monroe County, New York	Dec. 31, 1878	10,000
	Caledonia, N. Y	Lake Ontario	do	Livingston County, New York	Jan. 15, 1879	10,000
	do	Hemlock Lake	Spring Brooks	Ontario County, New York	Feb. 20, 1879	36,000
	do	Summer Hill Lake	do	Cayuga County, New York	Mar. 1, 1879	9,000
	do	Lake Ontario	Spring Creek	Livingston County, New York	Mar. 11, 1879	1,000
North Carolina	Henry's, N. C	Cape Fear River	North Fork, Deep River	Friendship, N. C	Jan. 2, 1879	18,000
	do	Catawba River	Johns River and Upper Creek	Morgantown, N. C	Jan. 10, 1879	30,000
	do	do	Linville River	Bridgewater, N. C	Jan. 11, 1879	30,000
	do	Roanoke River	Doe River	Danbury, N. C	Jan. 13, 1879	20,000
	do	Broad River	Broad River	Hickory-nut Gap, N. C	Jan. 15, 1879	45,000
	do	Roanoke River	Town Fork River	Germantown, N. C	Jan. 18, 1879	15,000
	do	Pee Dee River	Yadkin River	Patterson's (Caldwell Co.), N. C	Dec. 16, 1878	30,000
	do	do	do	do	Dec. 18, 1878	30,000
	do	Broad River	North Pacolet River	Near Hendersonville, N. C	Dec. 20, 1878	5,000
	do	do	Green River	do	Dec. 20, 1878	20,000
	do	Cape Fear River	Bull Run Creek	Near Jamestown, N. C	Dec. 27, 1878	20,000
	do	do	North Fork, Deep River	do	Dec. 31, 1878	24,500
Total						4,460,356
Canada	Newcastle hatchery	Lake Ontario	Wilmot's Creek	Province of Ontario	Spring, 1879	1,000
	do	Lake Huron	Saugeen River	do	Spring, 1879	500
	do	Lake Ontario	River Trent	do	Spring, 1879	200

TABLE III.—*Distribution of land-locked salmon reared from eggs collected in 1878.*

N. B.—These eggs were for the most part hatched out and planted by the State Commissioners of Fisheries. The returns, however, are so imperfect that it has been thought best to defer giving the record until the next report.

TABLE IV.—*Distribution of whitefish reared from eggs collected in 1878.**

States.	Where finally hatched.	Waters stocked.	Tributaries in which fish were placed.	Locality.	Date of transfer.	Number of fish.
New Jersey	Bloomsburg, N. J	Shepherd's Pond		Morris County, New Jersey	Feb. 17, 1879	45,000
	do	Lake Hopatcong		do	Feb. 17, 1879	45,000

* The eggs were collected by Frank N. Clarke, Northville, Mich., and hatched and planted by the New Jersey Commissioners of Fisheries.