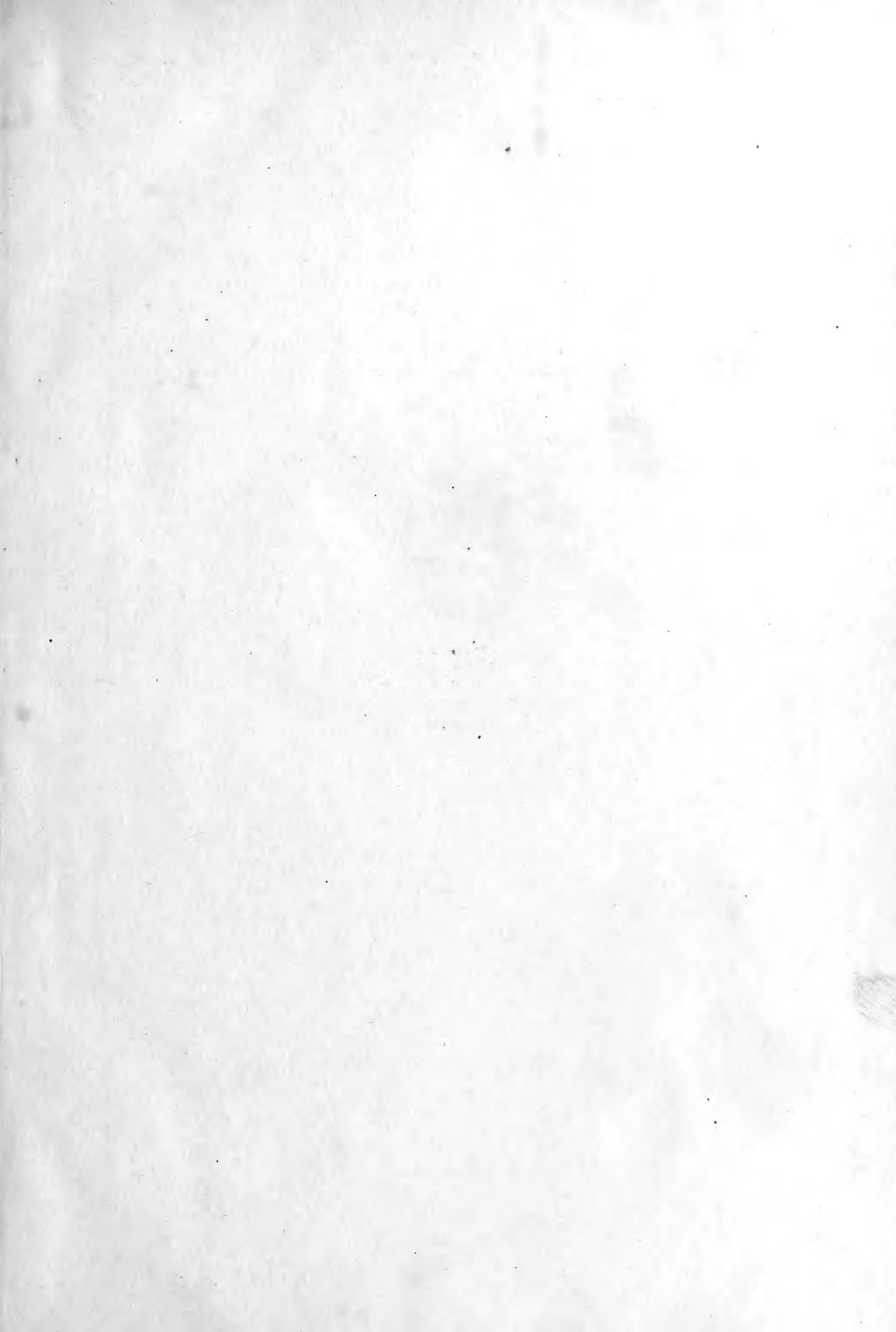


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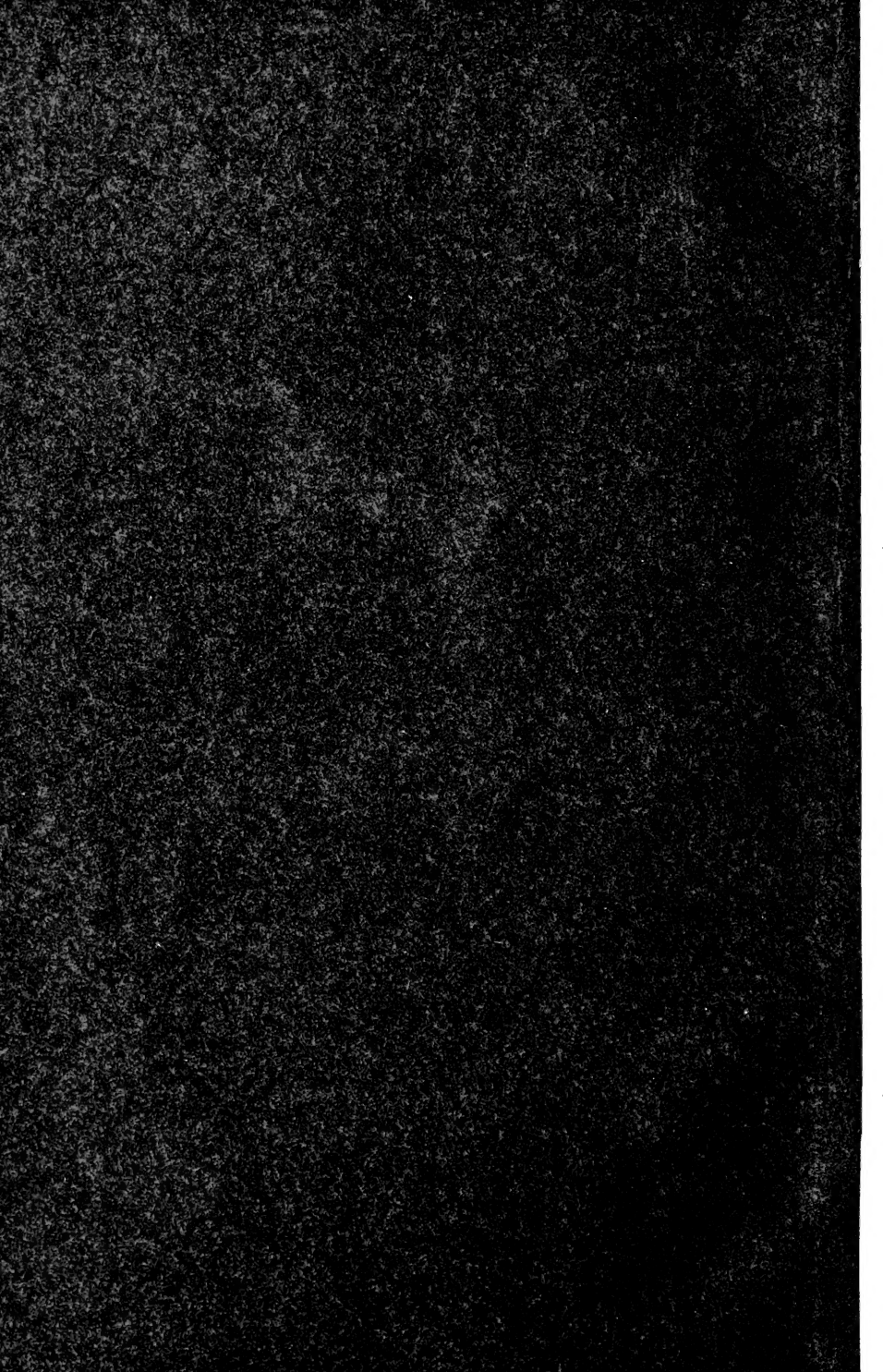
Washington, 1908

The United States Bureau of Fisheries

Its Establishment, Functions, Organization,
Resources, Operations, and Achievements



Washington
Government Printing Office
1908



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UNITED STATES COMMISSIONERS OF FISHERIES

G. BROWN GOODE
1887-1888

JOHN J. BRICE
1896-1898

SPENCER F. BAIRD
1871-1887

MARSHALL McDONALD
1888-1895

GEORGE M. BOWERS
1898 to date

International Fishery Congress

Washington, 1908

The United States Bureau of Fisheries

Its Establishment, Functions, Organization,
Resources, Operations, and Achievements



Washington
Government Printing Office
1908

U. S. DEPARTMENT OF COMMERCE AND LABOR

SECRETARY

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WILLIAM R. WHEELER

BUREAU OF FISHERIES

COMMISSIONER OF FISHERIES

GEORGE M. BOWERS

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THE UNITED STATES BUREAU OF FISHERIES

ITS ESTABLISHMENT, FUNCTIONS, ORGANIZATION, RESOURCES
OPERATIONS, AND ACHIEVEMENTS



BY HUGH M. SMITH

Deputy Commissioner of Fisheries



ESTABLISHMENT AND FUNCTIONS

PRIOR TO 1871 there was no branch of the United States Government especially charged with the consideration of fishery affairs, although fishery questions of greater or less import, some domestic, some foreign, had been arising ever since the achievement of national independence. Several of the States had already established fish commissions, and there arose among the State fishery authorities and the members of the American Fish Cultural Association (now the American Fisheries Society) an urgent demand for a national bureau devoted to fishery interests. Congress was thus influenced to action, and in the year named passed a joint resolution creating the office of Commissioner of Fish and Fisheries, whose duties were specified as follows:

The commissioner of fish and fisheries shall prosecute investigations and inquiries on the subject, with the view of ascertaining whether any and what diminution in the number of the food-fishes of the coast and the lakes of the United States has taken place; and, if so, to what causes the same is due; and also whether any and what protective, prohibitory, or precautionary measures should be adopted in the premises; and shall report upon the same to Congress.

It was further provided that the Commissioner should be a civil officer of the Government, of proved scientific and practical acquaintance with the fishes of the coast, who should serve without additional compensation. The man generally regarded as preeminently qualified for the new position was Spencer Fullerton Baird, then Assistant Secretary of the Smithsonian Institution, who received the appointment, at once entered on his duties, and continued the efficient and highly respected head of the Commission until his death, in 1887.

Professor Baird was succeeded by one of his ablest assistants, Dr. George Brown Goode, eminent as administrator, ichthyologist, and fishery expert, who,

however, voluntarily relinquished the Commissionership after less than a year's incumbency in order to devote his entire time to the National Museum, of which he was Director. Next came Commissioner McDonald, practical fish-culturist and inventor of important mechanical appliances now used in the hatching of fish all over the world, who served until his death, in 1895, and was the first salaried Commissioner. He was followed by Capt. John J. Brice, a retired naval officer, who held the office for two years and was succeeded in 1898 by the present Commissioner, Hon. George Meade Bowers, under whose ten years' administration the service has grown in all its branches.



MEMORIAL TO COMMISSIONER BAIRD

This granite boulder with bronze tablet in honor of the first United States Commissioner of Fisheries was placed at the Woods Hole station in 1902 by the American Fisheries Society, "in recognition of his inestimable services to ichthyology, pisciculture, and the commercial fisheries."

From the very outset of its career, the fishery service has had the active support and cooperation of many of the leading biologists, fish-culturists, and fishery experts of the country, whose volunteer assistance has been an important factor in its development and efficiency. The early years of the Bureau were devoted to an active investigation of the condition of the fisheries of the Atlantic coast, Great Lakes, and other sections; to studies of the interior and coastal waters and their inhabitants, and to exploration of the offshore fishing banks. The cultivation of useful fishes was soon taken up throughout the country, and quickly attained large proportions. The natural expansion of the work was materially augmented from time to time by acts of Congress, and in

a comparatively short time the operations came to have a very wide scope. In more recent years the work has been still further extended, so that at present there is scarcely a phase of aquiculture, of the fishing industry, or of biological and physical science as connected with the waters that does not come within the purview of the Bureau.

For many years the Bureau was without any executive control in fishery affairs. Under the Constitution the States legislate for themselves in such matters and the Federal Government has assumed no jurisdiction. The Bureau thus had no direct voice in the making or enforcing of any measures for the protection or preservation of aquatic animals, and its position, compared with the fishery service of other countries, was anomalous. In its advisory capacity, however, the Bureau has acquired an influence upon fishery legislation, and has now been given executive powers in Alaska for the enforcement of a comprehensive code of laws affecting the salmon fisheries. In the interests of the fur-seal fisheries the Bureau has since 1893 been called on to study the life history and migrations of the seals, to inspect conditions on the islands, and to submit recommendations concerning the killing of the animals.

ORGANIZATION

Until 1903 the Bureau was known as the "United States Commission of Fish and Fisheries," and was an independent institution of the Government, responsible directly to Congress. In that year it was included in the new Department of Commerce and Labor, becoming the United States Bureau of Fisheries, as known at present.

The work at the outset naturally fell under the three general heads of scientific investigation, fishery inquiry, and fish-culture. This classification has been extended and perfected, and enters into the organization at the present time.

The permanent personnel of the service includes 325 persons, of whom 83 are on duty in Washington and 242 are at outside stations, at laboratories, and on vessels. The officials under the Commissioner are a Deputy Commissioner, a chief clerk, and a chief of each of the three divisions before referred to. All subordinates are appointed, after passing the prescribed examinations, from the registers maintained by the Civil Service Commission.

The Deputy Commissioner is the executive next to the Commissioner, and acts with full powers in the latter's absence. The Commissioner's office, which represents the administrative division of the Bureau and has the chief clerk at its head, has under it the accounting office, the office of the architect and engineer, and the office of vessels, in addition to the library, records, correspondence, and property. In this division there is a technical and clerical force of 18 persons, not including messengers, watchmen, janitors, engineers, firemen, and laborers, and the 34 civil employees in the vessel service.

The Chief of the Division of Fish Culture, with an office force of 7, directs the operations at the hatcheries and the planting of fish. Each hatchery has a force consisting of a superintendent, fish-culturist, skilled laborers, etc., the number of employees for all the stations reaching a total of 168. In addition to these there are 13 superintendents, fish-culturists, and other employees at large. During the busy seasons the hatchery force is increased by the temporary employment of many spawn-takers and laborers as the work requires. For the distribution of eggs and young fish there are 6 transportation cars permanently



HEADQUARTERS OF THE BUREAU OF FISHERIES, WASHINGTON, D. C.

provided with crews of messengers, numbering in all 26 men. The car and messenger service is under the immediate direction of a superintendent.

The Division of Scientific Inquiry includes besides its chief 6 scientific assistants and a number of clerks. Three special agents are employed in the Alaska inspection service, which is under this division, and 3 persons are permanently employed at the biological laboratory at Beaufort, North Carolina. Numerous investigators and assistants are also employed temporarily as needed for the study of special problems at the laboratories and in the field.

RESOURCES AND INVESTMENT

The only funds available for the operation of the Bureau are the moneys voted annually by Congress. The comparatively large sums collected yearly in the Alaska salmon-inspection service are covered intact into the Treasury. From its very modest beginning, with \$5,000 allowed for its work, the Bureau has won such recognition from Congress that the appropriations for its maintenance have increased steadily, and for the current fiscal year, ending June 30, 1909, reached the substantial amount of \$803,920, apportioned as follows:

Administration:	
Salaries.....	\$45,380
Miscellaneous expenses.....	8,000
Propagation of food fishes:	
Salaries—	
Office.....	11,820
Stations and field service.....	156,420
Car and messenger service.....	23,100
Miscellaneous expenses.....	275,000
Inquiry respecting food fishes:	
Salaries—	
Office.....	13,640
Biological station at Beaufort, N. C.....	2,700
Miscellaneous expenses.....	30,000
Statistical inquiry:	
Salaries.....	17,140
Miscellaneous expenses.....	7,500
Vessel service:	
Salaries.....	29,420
Miscellaneous expenses.....	70,000
Alaska salmon-inspection service (salaries.....)	6,300
Special:	
Establishment of station for propagation of fresh-water mussels in Mississippi Valley.....	25,000
Construction of new steam vessel for Alaska service.....	20,000
Improvements and repairs at stations.....	44,500
Repairs to steamer Albatross.....	18,000
Total.....	803,920

The land owned and occupied by the Bureau at its fish-cultural and biological stations has an aggregate area of over 12,000 acres, with a value of \$240,000. The improvements and equipments at these stations represent an investment of more than \$1,000,000. Other property of the Bureau includes 4 seagoing steam and sail vessels, 20 steam launches, and 150 small sail, power, and row boats, which, with equipment, have a value of \$300,000. Its 6 fish-transportation cars are valued at \$45,000. The aggregate investment of the Federal Government in property devoted to the fishery service is thus about \$1,585,000.

CULTIVATION AND DISTRIBUTION OF FOOD FISHES

The artificial propagation of fishes was not contemplated at the time the Bureau was formed, but was instituted by an act of Congress in 1872 at the instigation of the American Fish Cultural Association, which had been organized

General Importance
and Extent

two years before and had taken a leading part in the establishment of the Bureau. The fishes to which attention was given first were the shad, the Atlantic salmon, and the whitefish. This work proved so popular that it was extended annually, was supplemented by efforts in acclimatization, and soon overshadowed all other branches.

The Bureau has labored to make its operations commensurate with the extent of the fisheries in public waters, and with the inevitable exhaustion of the native fish life in the smaller lakes and streams incident to the development of the country and the increase of population. The policy, as enunciated by Doctor Goode, has been to carry out the idea that it is better to expend a small amount of public money in making fish so abundant that they can be caught without restriction and serve as cheap food for the people at large than to expend a much larger sum in preventing the people from catching the few fish that still remain after generations of improvidence.

From this standpoint it is perhaps fortunate that up to the present the Bureau has not had to devote its major energies to the formulation and enforcement of fishery legislation, but has been able to work directly for the increase of fish life. Public or Government fish-culture has in America attained tremendous proportions, and exceeds in extent and importance that of all other countries combined. However, the neglect of some of the States to provide the minimum protection to certain species inhabiting interstate and international waters has not only negated the fish-cultural work of the Bureau and of the States themselves, but has practically inhibited it by preventing the possibility of securing an adequate supply of eggs, thus making desirable and necessary the institution of a new policy placing interstate and international waters under the jurisdiction of the General Government.

In the work of the Bureau of Fisheries the United States Government has an especial and unique claim to the epithet "paternal." The stocking of waters with food fishes is a direct benefit to the public, not only increasing the very material that supports an enormous industry, but providing food itself for the individual who will use his hook and line. From year to year, as the importance of the work has become increasingly evident, additional hatcheries have been built, the capacity of existing hatcheries has been enlarged, the scale of the operations has been extended, new kinds of fishes have been added to the output, and new sections have been brought under the direct influence of the work.

At the end of the first ten years of the Bureau's existence the fishes that were being regularly cultivated were shad, carp, chinook salmon, Atlantic salmon, landlocked salmon, rainbow trout, brook trout, and whitefish, in addition to which the propagation of several others had been undertaken experimentally. The list now is six times as long, and the annual output is ten times the aggregate for the ten-year period ended in 1881. The main energies are devoted to the important commercial fishes—shad, whitefish, lake trout, Pacific salmon, white perch, yellow perch, cod, flatfish—and the lobster, which are hatched in lots of many millions annually. More widely popular, however, are the distributions of the fishes of the interior waters which are generally classed as game fishes. Although representing only about 10 per cent of the output of the hatcheries, this feature of the work is very important, for it supplies choice kinds of fish for public rivers, lakes, and ponds, and for fishing preserves and private ponds and streams in all parts of the United States. The fishes most in demand for these purposes are the landlocked salmon, the different species of trout, the grayling, the basses, the crappies, the sunfishes, and the catfishes, but various others are also handled. Following is a classified list of the native fishes artificially propagated during 1908:

THE CATFISHES (SILURIDÆ):

- Spotted cat, blue cat, channel cat (*Ictalurus punctatus*).
- Horned pout, bullhead, yellow cat (*Ameiurus nebulosus*).
- Marbled cat (*Ameiurus nebulosus marmoratus*).

THE SHADS AND HERRINGS (CLUPEIDÆ):

- Shad (*Alosa sapidissima*).

THE SALMONS, TROUTS, WHITEFISHES, ETC. (SALMONIDÆ):

- Common whitefish (*Coregonus clupeiformis*).
- Lake herring, cisco (*Argyrosomus aledæ*).
- Chinook salmon, king salmon, quinnat salmon (*Oncorhynchus tshawytscha*).
- Silver salmon, coho (*Oncorhynchus kisutch*).
- Blueback salmon, redfish, sockeye (*Oncorhynchus nerka*).
- Humpback salmon (*Oncorhynchus gorbuscha*).
- Steelhead (*Salmo gairdneri*).
- Rainbow trout (*Salmo irideus*).
- Atlantic salmon (*Salmo salar*).
- Landlocked salmon (*Salmo sebago*).
- Yellowstone Lake trout, cut-throat trout, black-spotted trout (*Salmo lewisi*).
- Colorado River trout, black-spotted trout (*Salmo pleuriticus*).
- Golden trout (*Salmo roosevelti*).
- Lake trout, Mackinaw trout, longe, togue (*Cristivomer namaycush*).
- Brook trout, speckled trout (*Salvelinus fontinalis*).
- Sunapee trout (*Salvelinus aurcolus*).
- Canadian red trout (*Salvelinus marstoni*).
- Hybrid trout (*Salvelinus aurcolus* + *fontinalis*).

THE GRAYLINGS (THYMALLIDÆ):

- Montana grayling (*Thymallus montanus*).

THE BASSES, SUNFISHES, AND CRAPPIES (CENTRARCHIDÆ):

- Crappy (*Pomoxis annularis*).
- Strawberry bass, calico bass (*Pomoxis sparoides*).

THE BASSES, SUNFISHES, AND CRAPPIES (CENTRARCHIDÆ)—Continued.

Rock bass, red-eye, goggle-eye (*Ambloplites rupestris*).

Warmouth, goggle-eye (*Chanobryttus gulosus*).

Small-mouth black bass (*Micropterus dolomieu*).

Large-mouth black bass (*Micropterus salmoides*).

Bluegill sunfish (*Lepomis pallidus*).

THE PERCHES (PERCIDÆ):

Pike perch, wall-eyed pike, yellow pike, blue pike (*Stizostedion vitreum*).

Yellow perch (*Perca flavescens*).

THE SEA BASSES (SERRANIDÆ):

Striped bass, rockfish (*Roccus lineatus*).

White bass (*Roccus chrysops*).

White perch (*Morone americana*).

Yellow bass (*Morone interrupta*).

THE DRUMS (SCLENIDÆ):

Fresh-water drum (*Aplodinotus grunniens*).

THE LABRIDS (LABRIDÆ):

Tautog, blackfish (*Tautoga onitis*).

THE CODS (GADIDÆ):

Cod (*Gadus callarias*).

Pollock (*Pollachius virens*).

Haddock (*Melanogrammus aeglefinus*).

THE FLOUNDERS (PLEURONECTIDÆ):

Winter flounder, American flatfish (*Parusdopleuronectes americanus*).

CRUSTACEANS:

American lobster (*Homarus americanus*).

In addition to the foregoing, various kinds of fishes are obtained from the overflows in the Mississippi Valley and are distributed. Among these are the small-mouth buffalo-fish (*Ictiobus bubalus*), the pike (*Esox lucius*), the pickerel (*Esox reticulatus*), and several sunfishes (chiefly *Eupomotis gibbosus*). From this same source are also collected large numbers of large-mouth black bass, crappies, rock bass, and bluegill sunfish. The following introduced species are cultivated to a limited extent:

Carp (*Cyprinus carpio*). Propagated chiefly for food for other fishes.

Goldfish (*Carassius auratus*). Propagated for ornamental purposes.

Tench (*Tinca tinca*). Cultivated varieties, green tench and golden tench; propagated for ornamental purposes.

Idé (*Leuciscus idus*). Cultivated variety, golden idé; propagated for ornamental purposes.

European sea trout (*Salmo trutta*).

Loch Leven trout (*Salmo trutta levenensis*).

Fish-cultural stations are established by special act of Congress, and their

The Hatcheries Operated

location and construction are determined by the Bureau after a careful survey of the available sites

in a given State. The plans and specifications for each station are prepared in the office of the architect and engineer with reference to the nature of the operations to be conducted and the topographical conditions, and the work of constructing buildings and ponds is usually done by contract. Sometimes, however, the Bureau takes direct charge of construction, as in the case of the salmon hatcheries in Alaska.

The usual buildings at a fish-cultural station are the hatchery proper, a residence for the superintendent and his family, and necessary outbuildings. At some stations there may be also power house, foreman's or fish-culturist's dwelling, mess hall, and stable. The superintendent's and other quarters are furnished gratis, but station employees provide their own subsistence.

All sections of the country are now familiar with Government fish-cultural work. In addition to the regular hatcheries, with their permanent personnel and living quarters, there are maintained numerous auxiliary hatcheries or

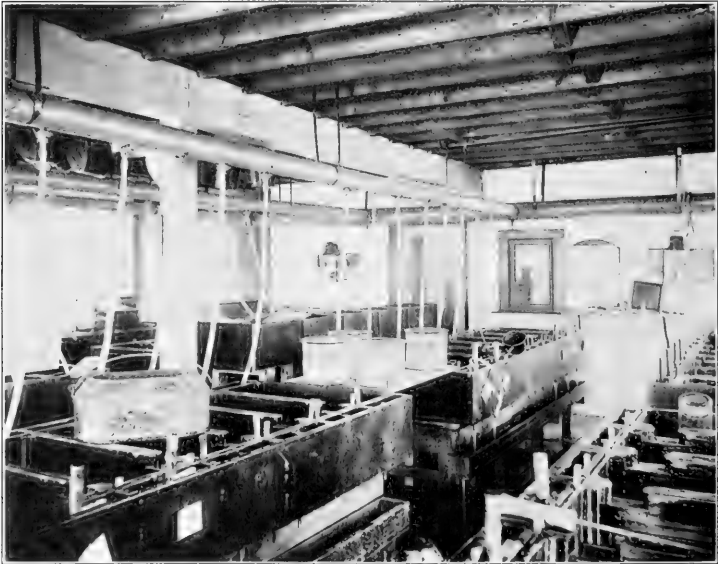


SUPERINTENDENT'S RESIDENCE AT A NEW ENGLAND TROUT-HATCHING STATION

substations which from the nature of their work do not require a permanent force and are therefore, for economic and administrative considerations, operated as adjuncts of nearby hatcheries. Some of the auxiliary stations, however, have more extensive operations than the hatcheries with which they are connected, and such will doubtless in time be made regular stations. There is also another class of stations, known as field or collecting stations, which serve as temporary headquarters for parties engaged in obtaining eggs from wild fishes. In 1908 the fish-cultural work was conducted in 27 States and Territories at 55 hatcheries and subhatcheries and 64 field stations.



MARINE HATCHERY AT GLOUCESTER, MASSACHUSETTS



VIEW OF INTERIOR OF THE GLOUCESTER HATCHERY

Showing automatic tidal boxes in which buoyant ova are incubated.

While marine operations have been conducted from time to time at various places on the Atlantic coast from Maine to Florida, and have been addressed to a large number of species, the only permanent marine hatcheries are in Maine and Massachusetts, with the species handled at each as indicated in the following table. The places shown under each station are the centers of egg-collecting operations. Other sea fishes that have in previous years been artificially propagated and may again come under the hand of the fish-culturist are the haddock, the scuppaug, the sheepshead, the sea bass, the mackerel, and the squeteague, some of which were hatched on the steamer Fish Hawk in Chesapeake Bay and Florida.

MARINE HATCHERIES.

LOCATION.	SPECIES HANDLED.
Boothbay Harbor, Me.....	Cod, lobster.
Pemaquid, Me.....	Lobster.
Portland, Me.....	Lobster.
Kittery Point, Me.....	Lobster.
Gloucester, Mass.....	Cod, pollock, flatfish, lobster.
Beverly, Mass.....	Lobster.
Boston, Mass.....	Lobster.
Cohasset, Mass.....	Lobster.
Hull, Mass.....	Lobster.
Marblehead, Mass.....	Lobster.
Plymouth, Mass.....	Cod.
Portsmouth, N. H.....	Lobster.
Rockport, Mass.....	Lobster.
Woods Hole, Mass.....	Cod, tautog, flatfish, lobster.
Chilmark, Mass.....	Lobster.
Dartmouth, Mass.....	Lobster.
East Greenwich, R. I.....	Flatfish.
Gay Head, Mass.....	Lobster.
Gosnold, Mass.....	Lobster.
Nantucket, Mass.....	Lobster.
Plymouth, Mass.....	Cod.
Sandwich, Mass.....	Lobster.
Waquoit, Mass.....	Flatfish.
Westport, Mass.....	Lobster.
West Tisbury, Mass.....	Lobster.
Yarmouth, Mass.....	Lobster.

The fish-cultural work on the eastern coast streams was centered at 6 hatcheries and subhatcheries in 1908. At 1 of these the principal species handled is the Atlantic salmon, at 4 the shad, at 3 the yellow perch, at 2



SHAD-HATCHING STATION ON ALBEMARLE SOUND, NORTH CAROLINA

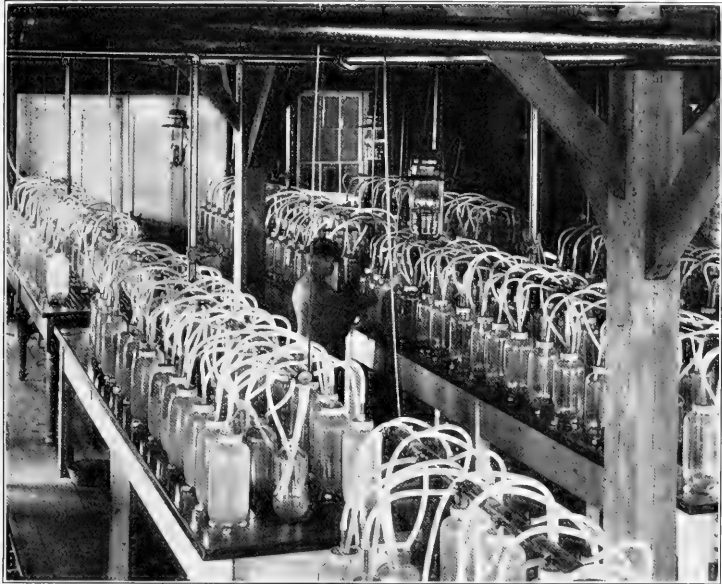
The recent passage by the State legislature of laws reducing the obstruction by nets in the waters through which the shad must run to reach their spawning grounds has made it possible for this station again to collect large numbers of eggs from fish caught for market, and practically to insure the perpetuation of a fishery that had previously been threatened with speedy extinction.



SHAD HATCHERY AT BATTERY ISLAND, MARYLAND

Situated at mouth of Susquehanna River, and one of the oldest and most successful hatcheries for shad. White perch and yellow perch also are hatched at this point.

the white perch, and at 1 the striped bass. In recent years the Bureau has operated a shad hatchery on the Delaware River, and has detailed the steamer Fish Hawk for shad hatching in Maine, New Jersey, North Carolina, and Florida. The Central Station, in Washington, is operated largely for ex-



INTERIOR OF SHAD HATCHERY AT BATTERY ISLAND, MARYLAND

perimental and exhibition purposes, but sometimes receives large numbers of eggs from the adjacent river stations, especially when the latter are overstocked.

HATCHERIES ON EAST COAST RIVERS.

LOCATION.	FISHES HANDLED.
Craig Brook, Penobscot River, Me.....	Atlantic salmon, landlocked salmon, hump-back salmon, brook trout.
Staceyville, Upper Penobscot River, Me.....	Atlantic salmon.
Havre de Grace, Susquehanna River, Md.....	Shad, yellow perch, white perch.
Bryans Point, Potomac River, Md.....	Shad, yellow perch.
Edenton, Albemarle Sound, N. C.....	Shad.
Weldon, Roanoke River, N. C.....	Striped bass.
Washington, D. C., Potomac River.....	Shad, yellow perch, white perch, etc.

In order to counteract the effect of the very exhausting fisheries of the Great Lakes, the Government has maintained hatcheries for many years, and in 1908 operated 6 belonging to the United States and 2 belonging to the State of Michigan. The fishes to which attention is given are those which enter most



HATCHERY AT NORTHVILLE, MICHIGAN

The principal station for lake trout; also operated for brook trout and small-mouth black bass.

largely into the catch of the fishermen, namely, the whitefish, cisco, lake trout, and pike perch, the annual output of which now exceeds $1\frac{1}{2}$ billions. Under arrangement with the Canadian authorities, 2 egg-collecting stations for whitefish, cisco, and lake trout are maintained at points in Ontario.

HATCHERIES ON THE GREAT LAKES.

LOCATION.	FISHES HANDLED.
Cape Vincent, Lake Ontario, N. Y.-----	Whitefish, lake trout, brook trout, steel-head, landlocked salmon, pike perch, yellow perch.
Put-in Bay, Lake Erie, Ohio.-----	Whitefish, lake cisco, lake trout, pike perch.
Kelleys Island, Ohio ^a -----	Whitefish.
Middle Bass Island, Ohio ^a -----	Whitefish.
Monroe Piers, Mich. ^a -----	Whitefish, pike perch.
North Bass Island, Ohio ^a -----	Whitefish, lake cisco.
Pelee Island, Ontario (Canada) ^a -----	Whitefish, lake cisco.
Port Clinton, Ohio ^a -----	Whitefish, lake cisco, pike perch.
Toledo, Ohio ^a -----	Pike perch.
Northville, Mich. ^b -----	Lake trout, etc.
Alpena, Lake Huron, Mich.-----	Whitefish, lake trout.
Beaver Island, Lake Michigan, Mich. ^a -----	Lake trout.
Charlevoix, Lake Michigan, Mich.-----	Whitefish, lake trout.
Detroit, Detroit River, Mich. ^c -----	Whitefish, pike perch.
Algonac, Lake Huron, Mich. ^a -----	Pike perch.
Bay City, Lake Huron, Mich. ^a -----	Pike perch.
Belle Isle, Detroit River, Mich. ^a -----	Whitefish.
Grassy Isle, Detroit River, Mich. ^a -----	Whitefish.
Sault Ste. Marie, St. Marys River, Mich. ^c -----	Whitefish, lake trout.
Duluth, Lake Superior, Minn.-----	Whitefish, lake trout, pike perch, etc.
Isle Royale, Mich. ^a -----	Lake trout.
Keweenaw Point, Mich. ^a -----	Lake trout.
Marquette, Mich. ^a -----	Lake trout.
Ontonagon, Mich. ^a -----	Lake trout.
Rosspoint, Ontario (Canada) ^a -----	Lake trout.

^a Egg-collecting stations.^b Interior station, headquarters of the fish-cultural work in Michigan, conveniently located, and place where most of the lake-trout eggs are hatched.^c Hatcheries belonging to State of Michigan, leased by Bureau of Fisheries.

The hatcheries on the rivers and lakes of the Pacific coast region are devoted almost exclusively to the various salmons. In California, where the Bureau established a salmon hatchery as early as 1872, there is one central or main station, at Baird, on the McCloud River, with important collecting and eyeing stations on two other tributaries of the Sacramento. In Oregon a central hatchery at Oregon City, on the Willamette River, has 3 subhatcheries on tributaries of the Columbia in Oregon and Washington, and 3 subhatcheries on tributaries of the Rogue River, Oregon, in addition to several egg-collecting stations. The interests of the large salmon fisheries of the Puget Sound region are safeguarded by a hatchery on Baker Lake, on the Skagit River, Washington,

with an important auxiliary at Birdsvew. The two latest additions to the western salmon hatcheries are at Yes Bay and Afognak, in Alaska, at which points immense numbers of blueback or sockeye salmon are now being put forth. A significant feature of artificial propagation on the Pacific seaboard is that in the Columbia basin the hatching of the acclimatized shad has begun on a small scale, and in the Sacramento basin the cultivation of the acclimatized striped bass has commenced under conditions which indicate that more eggs of this species may be obtained in California than in any of the States to which the fish is native.

HATCHERIES ON THE PACIFIC COAST STREAMS AND LAKES.

LOCATION.	FISHES HANDLED.
Baird, Sacramento River, Cal.	Chinook salmon.
Battle Creek, Cal. ^a	Chinook salmon.
Bouldin Island, Cal.	Striped bass.
Mill Creek, Cal. ^a	Chinook salmon.
Yreka, Sacramento River, Cal. ^b	Rainbow trout.
Baker Lake, Wash.	Chinook salmon, blueback salmon, humpback salmon, silver salmon.
Birdsvew, Wash.	Chinook salmon, blueback salmon, humpback salmon, silver salmon, steelhead trout.
Oregon City, Willamette River, Oreg.	Chinook salmon, silver salmon, steelhead trout, etc.
Big White Salmon, Columbia River, Wash.	Chinook salmon.
Eagle and Tanner creeks, Columbia River, Oreg. ^a	Chinook salmon.
Eagle Creek, Clackamas River, Oreg. ^b	Steelhead trout.
Little White Salmon, Columbia River, Wash.	Chinook salmon.
Rogue River, Oreg.	Chinook salmon, steelhead trout, silver salmon.
Applegate Creek, Oreg. ^b	Chinook salmon, steelhead trout, silver salmon.
Findley Eddy, Rogue River, Oreg.	Chinook salmon, silver salmon.
Illinois River, Rogue River, Oreg.	Chinook salmon, steelhead trout.
Willamette Falls, Willamette River, Oreg.	Shad.
Yes Bay, Yes Lake, Alaska.	Blueback salmon.
Afognak, Afognak Island, Alaska.	Blueback salmon.

^a Stations where eggs are collected and eyed.

^b Collecting stations.

The hatcheries in the interior regions constitute the most numerous class, and their output reaches the largest number of people. Their operations are addressed chiefly to the so-called "game" fishes, which, while caught mostly by anglers, nevertheless constitute an important element of the food supply. At these stations large numbers of fish are reared to the fingerling or yearling sizes

before being released; for this purpose more or less extensive pond areas are required. A peculiar kind of station which is included in this general class is that devoted to the collection of fishes of various kinds obtained from the overflows in the upper Mississippi Valley. In the lowlands along the streams in this region the spring floods receding leave disconnected sloughs and pools, which either become dry during the summer or, if they remain until the winter, freeze



ARTIFICIAL SPAWNING POND AND RACEWAY

Used in culture of rainbow trout at the Wytheville, Virginia, station.

solid, and the immense numbers of bass, cruppy, and other desirable species therein are lost in the ordinary course of events. By seining these waters the Bureau thus obtains large numbers of fish that would otherwise perish, returning some of them to their native streams and distributing others to adjacent waters. In the autumn of 1908 six cars were employed in moving the fishes thus rescued.

The following table, giving the interior fish-cultural stations and their auxiliaries, shows that in 1908 there were operated 23 of these stations and substations

where hatching operations were conducted and 21 others where eggs or fish were simply collected:

HATCHERIES IN INTERIOR STATES.

LOCATION.	FISHES HANDLED.
Bozeman, Mont.	Brook trout, rainbow trout, black-spotted trout, golden trout, steelhead trout, landlocked salmon.
Redrock, Mont.	Grayling.
Bullochville, Ga.	Black basses, sunfishes, rock bass, catfish, etc.
Erwin, Tenn.	Black basses, sunfishes, rock bass, yellow perch, rainbow and brook trouts, catfish, and minor species.
Green Lake, Me.	Landlocked salmon, brook trout.
Branch Pond, Me. ^a	Landlocked salmon, brook trout.
Grand Lake Stream, Me.	Landlocked salmon, brook trout.
Leadville, Colo.	Rainbow trout, golden trout, black-spotted trout, brook trout, landlocked salmon, grayling.
Cheesman Lake, Colo. ^a	Rainbow trout.
Darrah, Colo. ^a	Brook trout.
Edith Lake, Colo. ^a	Brook trout.
Eldora Lake, Colo. ^a	Brook trout.
Englebrecht Lake, Colo. ^a	Brook trout.
Grand Lake, Colo.	Black-spotted trout.
Grand Mesa Lakes, Colo.	Black-spotted trout, rainbow trout, brook trout.
Musgrove Lake, Colo. ^a	Brook trout.
Ridgway Lake, Colo. ^a	Brook trout, rainbow trout.
Twin Lakes, Colo. ^a	Brook trout.
Wellington Lake, Colo. ^a	Brook trout.
Zoebler Lake, Colo. ^a	Brook trout.
Mammoth Spring, Ark.	Black basses, rock bass.
Manchester, Iowa	Black basses, crappies, sunfishes, rock bass, pike perch, yellow perch, brook trout, lake trout, rainbow trout, black-spotted trout, catfish.
Bellevue, Iowa ^b	Large-mouth black bass, crappies, sunfishes, yellow perch, fresh-water drum, buffalo-fish, catfish.
La Crosse, Wis. ^b	Large-mouth black bass, crappies, sunfishes, rock bass, yellow perch, white bass, pike, buffalo-fish, catfish.
North McGregor, Iowa ^b	Large-mouth black bass, crappies, sunfishes, yellow perch, drum, pike, buffalo-fish, catfish.
Nashua, N. H.	Lake trout, brook trout, Sunapee trout, rainbow trout, hybrid trout, landlocked salmon, chinook salmon, small-mouth black bass.
Cumberland Center, N. H. ^c	Brook trout.
Lake Sunapee, N. H. ^a	Brook trout, Sunapee trout.

^a Stations for the collection of eggs

^b Stations for the rescue of young and adult fishes from overflowed lands of Mississippi River and tributaries.

^c Stations where eggs are collected and eyed but not hatched.

HATCHERIES IN INTERIOR STATES—Continued.

LOCATION.	FISHES HANDLED.
Neosho, Mo.	Black basses, crappies, sunfishes, rock bass, rainbow trout.
Northville, Mich. ^a	Brook trout, Loch Leven trout, steelhead trout, small-mouth black bass, and minor species.
Quincy, Ill.	Pike perch, black bass, and minor species.
Meredosia, Ill. ^b	Large-mouth black bass, crappies, sunfishes, pike perch, yellow perch, catfish, and minor species.
St. Johnsbury, Vt.	Small-mouth black bass, landlocked salmon, steelhead trout, lake trout, brook trout.
Arlington, Vt.	Brook trout.
Chittenden, Vt. ^c	Brook trout.
Darling Pond, Vt. ^c	Brook trout.
Lake Mansfield, Vt. ^c	Brook trout.
Lake Mitchell, Vt. ^c	Brook trout.
Swanton, Vt.	Pike perch, yellow perch.
San Marcos, Tex.	Large-mouth black bass, crappies, sunfishes, rock bass, warmouth bass.
Spearfish, S. Dak.	Rainbow trout, black-spotted trout, Loch Leven trout, brook trout.
Schmidts Lake, S. Dak. ^c	Brook trout.
Yellowstone Park, Wyo.	Black-spotted trout.
Tupelo, Miss.	Large-mouth black bass, sunfishes, yellow bass.
White Sulphur Springs, W. Va.	Black basses, rainbow trout, black-spotted trout, brook trout.

^a See also in list of Great Lakes hatcheries.

^b Stations for the rescue of young and adult fishes from overflowed lands of Mississippi River and tributaries.

^c Stations for the collection of eggs.

The fish-cultural work of the Federal Government has now attained a magnitude that can not readily be comprehended, and is increasing at an exceedingly rapid rate. Especially marked has been the increase in the hatchery product during the past ten years, owing in part to the establishment of new stations, in part to the extension of operations at existing stations, and in part to greater efficiency of methods and appliances. The work during the fiscal year ended June 30, 1908, reached larger proportions than ever before, notwithstanding a shrinkage in the operations addressed to several important species. In the following summary by species of the fecundated ova, the fry, and the fingerlings, yearlings, and adults distributed in the past year it will be noted that several fishes included in the list of species cultivated do not appear in this table, for the reason that the entire stock was retained for breeding purposes. Ornamental species are likewise omitted from the table.

THE UNITED STATES BUREAU OF FISHERIES

SUMMARY OF DISTRIBUTION OF FISH AND EGGS DURING THE FISCAL YEAR 1908.

SPECIES.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Catfish			277,601	277,601
Carp			350	350
Buffalo-fish			40,500	40,500
Shad	760,000	79,316,600		80,076,600
Whitefish	139,266,000	384,480,000		523,746,000
Lake cisco	12,790,000	3,200,000		15,990,000
Chinook salmon	68,385,550	24,998,185	2,231,797	95,615,532
Silver salmon	296,000	13,420,714	57,932	13,774,646
Blueback salmon	75,000	69,883,305		69,958,305
Humpback salmon		7,185,748		7,185,748
Steelhead trout	333,725	1,123,146	59,000	1,515,871
Rainbow trout	830,000	253,650	2,713,600	3,797,250
Atlantic salmon		2,079,514	30,003	2,109,517
Landlocked salmon	190,000	441,281	151,526	782,807
Black-spotted trout	768,380	4,230,540	1,442,376	6,441,296
Loch Leven trout			55,012	55,012
Lake trout	2,734,000	25,267,078	3,182,080	31,183,158
Brook trout	1,473,400	6,307,048	3,471,292	11,251,740
Sunapee trout		191,736		191,736
Grayling	200,000	1,047,000		1,247,000
Pikes			17,550	17,550
Crappy and strawberry bass			200,268	200,268
Rock bass			25,090	25,090
Warmouth bass			1,638	1,638
Small-mouth black bass		232,312	78,940	311,252
Large-mouth black bass		23,900	588,047	611,947
Sunfishes			202,810	202,810
Pike perch	218,725,000	193,438,000		412,163,000
Yellow perch	2,080,000	382,576,000	68,045	384,724,043
Striped bass		4,333,500		4,333,500
White perch	5,740,000	321,670,000		327,410,000
White bass			500	500
Fresh-water drum			26,000	26,000
Cod	3,000,000	235,365,000		238,365,000
Pollock		66,454,000		66,454,000
Tautog		794,000		794,000
Flatfish		389,642,000		389,642,000
Lobster		180,932,000	1,011	180,933,011
Total	457,647,055	2,398,886,257	14,922,968	2,871,456,380

While the Bureau does not lay undue stress on mere numbers and considers the vitality of the fish and the conditions under which they are planted as of paramount importance, the foregoing figures are certainly very suggestive; and as a further statement of the magnitude of the fish-cultural work it may be of interest to record that the aggregate output of the hatcheries from 1872 to 1908 was about 22,365,200,000, of which about 10,341,700,000 represents the work of the past five years.



BUILDINGS AND REARING PONDS OF TROUT STATION AT SPEARFISH, SOUTH DAKOTA

The first consideration in the distribution of fishes is to make ample return to the waters from which eggs or fish have been collected. The remainder of the product is consigned to suitable public or private waters. All applications for fish for private waters and many of those for public streams and lakes are transmitted through and receive the indorsement of a United States Senator or Representative. The fish are carried to their destination in railroad cars or by messengers who accompany the shipments in baggage cars. During the fiscal year 1907 the Bureau received 6,346 applications for fish, nearly all for game species. The demand, especially for the basses, crappies, and catfishes, is greater than can be met with present resources.

The supply of particular fishes available for distribution, and consequently the number allotted to individual applicants, is largely determined by the difference in methods of hatching the different species and the present facilities therefor. The area and character of the water to be stocked must likewise be considered. The water area that would receive a million pike perch fry would perhaps be assigned no more than 200 or 300 black bass 3 or 4 inches long, or four to eight times that many if the bass were planted as fry. The explanation is in the fact that pike perch can be propagated by the hundred million, while



INTERIOR OF A TYPICAL TROUT HATCHERY

black bass, hatched by other methods or collected from overflowed lands, can be produced only in comparatively small numbers. The Bureau does not attempt to assign any applicant more than a liberal brood stock of the basses or sunfishes. With brook trout, which are distributed both as fry and fingerlings, allotments of fry are many times larger than allotments of fingerlings 3 to 4 inches long.

Fishes are distributed at various stages of development, according to the species, the numbers in the hatcheries, and the facilities for rearing. The com-

mercial fishes, hatched in lots of many millions, are necessarily planted as fry. It is customary to distribute them just before the umbilical sac is completely absorbed. Atlantic salmon, land-locked salmon, and various species of trout, in such numbers as the hatchery facilities permit, are reared to fingerlings from 1 to 6 inches in length; the remainder are distributed as fry. The basses and sunfishes are distributed from the fish-cultural stations and ponds from some three weeks after they are hatched until they are several months of age.



A FISH TRANSPORTATION CAR

Six cars of this kind are in constant use by the Bureau. Live fish are carried safely for long distances, and eggs may be incubated while on trains traveling 60 miles an hour.

When the last lots are shipped the basses usually range from 4 to 6 inches and the sunfishes from 2 to 4 inches in length. The numerous fishes collected in overflowed lands—basses, crappie, sunfishes, catfishes, yellow perch, and others—are 2 to 6 inches in length when taken and distributed. Eggs are distributed only to State hatcheries or to applicants who have hatchery facilities.

The varying usage in the classification of young fish as to size has caused such confusion and difficulty that the Bureau has adopted the following uni-

form definitions, which have been approved by the American Fisheries Society and represent the general sentiment of State and private fish-culturists:

Fry—fish up to the time the yolk sac is absorbed and feeding begins.

Advanced fry—fish from the end of the fry period until they have reached a length of 1 inch.

Fingerlings—fish between the length of 1 inch and the yearling stage, the various sizes to be designated as follows: No. 1, a fish 1 inch in length and up to 2 inches; No. 2, a fish 2 inches in length and up to 3 inches; No. 3, a fish 3 inches in length and up to 4 inches, etc.

Yearlings—fish that are 1 year old, but less than 2 years old, from the date of hatching; these may be designated No. 1, No. 2, No. 3, etc., after the plan prescribed for fingerlings.

Fish are delivered to applicants free of charge at the railroad station nearest the point of deposit, and for this purpose is maintained a special car and messenger service, which is one of the most important branches of the fish-cultural work. In the early days baggage cars were employed, but these have now been supplanted by an equipment which not only affords more comfort to fish and attendants, but makes it possible to transport the fish much greater distances and with smaller percentage of loss. The cars, of which there are now 6, are of standard size, and are attached to regular express and local passenger trains. Each car has 20 or more large water tanks along the sides in which to carry fish, compartments holding more than 1,000 gallons of reserve water, a boiler room, and a plant for pumping both water and air into the fish tanks. There are also an office, kitchen, pantries, refrigerator, and 6 Pullman sleeping berths, with other facilities for the convenience and comfort of the crew of 5 men (including a cook) who live on the car throughout the year. The Government furnishes the cook, fuel, and utensils, but the men provide their own food. For small shipments of fish and for supplying places off the main railway lines messengers detached from the cars carry fish in 10-gallon cans in baggage cars. The distributions last year required travel amounting to 83,840 miles by the Bureau's 6 cars, and 263,196 miles by detached messengers—a total of 347,036 miles—of which 11,826 for cars and 80,816 for messengers were furnished by the railroads free of charge.

There are few enterprises undertaken by the United States Government that are more popular, meet with more general and generous support, and have contributed more to the prosperity and happiness of a larger number of people than its fish-cultural work, an evidence of which fact is afforded by the attitude and action of Congress. The comparatively large budget for the various branches of the Bureau's work is voted each year without any opposition whatever, and the appropriations are increasing yearly. When special needs arise and their merit is presented to Congress, special appropriations can usually be obtained; and Government fish-culture is so popular in the country at large and the demand for new hatcheries is so widespread that an extraordinary number of hatchery

bills have been introduced and favorably considered in recent sessions of Congress. The Bureau advocates the building of new hatcheries as one of the best and most remunerative measures that can possibly be undertaken by the Federal Government, but it rarely has to take the initiative, and on several occasions the establishment of a hatchery has been proposed by Congress before the necessity for it has actually developed. During each of the recent sessions of Congress, had all the bills providing for new hatcheries become laws the Bureau



INTERIOR VIEW OF FISH TRANSPORTATION CAR

Showing rows of covered tanks where fish are carried, and Pullman sleeping berths for attendants.

would have been seriously handicapped in designing and constructing the new buildings and ponds and in supplying competent persons to operate them. In the first session of the Sixtieth Congress, which began in December, 1907, and ended in May, 1908, there were introduced 101 distinct bills, carrying an aggregate appropriation of \$2,142,000 and providing for 74 hatcheries and 4 laboratories in 43 States and Territories.

While the manifold operations of the Bureau touch directly or indirectly practically the entire population of the United States, they appeal with special

force to the commercial fisherman, the fish dealer, the amateur angler, the student of aquatic biology and physics, the owner of small ponds, lakes, or streams, and the professional cultivator of fishes, mollusks, and other water creatures.

SCIENTIFIC INQUIRY

The first duties undertaken by the Bureau after its organization involved biological investigations, and the operations up to the present time have con-



MARINE HATCHERY AND LABORATORY, WOODS HOLE, MASSACHUSETTS

Established twenty-five years ago, and devoted to the culture of cod, flounders, and lobsters, the output of which in 1907-8 was 337 millions. Also the headquarters of important biological investigations of the east-coast fauna, the laboratory privileges being accorded gratuitously to qualified students.

tinued to have a distinctly scientific basis. In making his original plans for the systematic investigation of the waters of the United States and the biological and physical problems they present, Commissioner Baird insisted that to study only the food fishes would be of little importance, and that useful conclusions must needs rest upon a broad foundation of investigations purely scientific in character. The life history of species of economic value should be understood from beginning to end, but no less requisite is it to know the his-

ories of the animals and plants upon which they feed or upon which their food is nourished; the histories of their enemies and friends and the friends and foes of their enemies and friends, as well as the currents, temperatures, and other physical phenomena of the waters in relation to migration, reproduction, and growth.

In pursuance of this policy the Bureau has secured the services of many prominent men of science, and much of the progress in the artificial propagation



RESIDENCE AT THE MARINE STATION, WOODS HOLE, MASSACHUSETTS

Formerly the summer headquarters of the Bureau, and now occupied by the officials of the laboratory and hatchery and by temporary assistants engaged in special work.

of fishes, in the investigation of fishery problems, and in the extension of knowledge of our aquatic resources has been due to men eminent as zoologists who have been associated with the work temporarily. Among such men recently have been Alexander Agassiz, Hermon C. Bumpus, Gary N. Calkins, Bashford Dean, Charles H. Gilbert, Theodore Gill, C. Judson Herrick, Francis H. Herrick, David Starr Jordan, A. D. Mead, George H. Parker, Jacob Reighard, Henry B. Ward, William M. Wheeler, and Henry V. Wilson. Their services have been

the services of specialists for particular problems, and through them the Bureau has not only been able to give to the public the practical results of applied science, but has contributed to pure science valuable knowledge of all forms of aquatic life.

The small permanent staff of the Bureau concerns itself more directly with studies of fishes and their environment, with the conservation of diminishing commercial species, and the development of new or improved methods of increasing the supply. Such lines of work are undertaken as the need appears or as assistance is asked for, and keep the scientific assistants in the field for extended



MARINE BIOLOGICAL LABORATORY AT BEAUFORT, NORTH CAROLINA

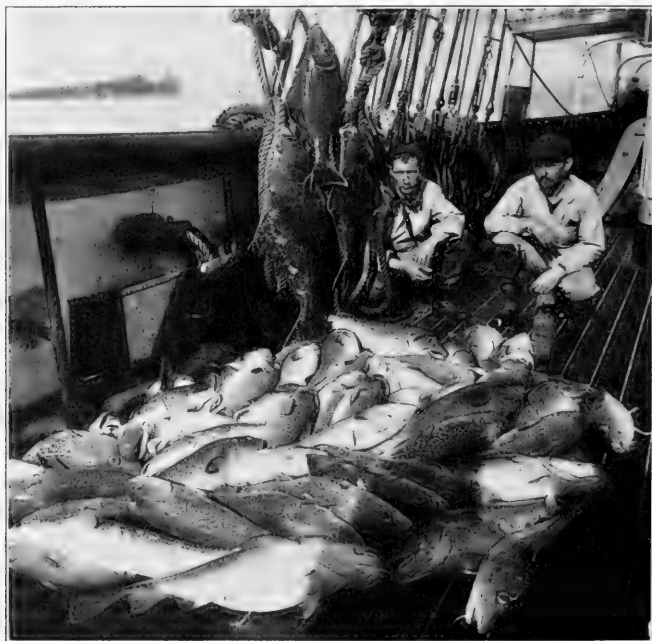
This station, built in 1901, is favorably located for the study of the aquatic fauna of the southeast coast. The laboratory building is 174 feet long and 42 feet wide in the main portion, has a large museum and aquaria, and accommodates about 30 workers. Adjoining the laboratory building are a power plant and a mess house and kitchen.

periods each year. The most important work in hand at present concerns aquatic products other than fishes—namely, oysters, fresh-water mussels, sponges, and the diamond-back terrapin, in all of which cases the problem is to find means to offset the results of long-continued overdraft upon the natural supply. The Bureau has also the services of a fish pathologist—a position specially created by Congress at the solicitation of the Commissioner. This assistant has devoted most of his time to the study of diseases among fishes at the hatcheries of the Government and of various States, and has added greatly to the existing knowledge of the causes and prevention of many of the affections which often prove so serious in fishes under cultivation. His field includes also the investigation of conditions due to pollution of waters.

Two seaside laboratories are maintained by the Bureau for the prosecution of investigations in pure and applied science. One of these is located at Woods Hole, Massachusetts, the scene of the first biological work undertaken after the establishment of the Bureau. It was built in 1883, and is in conjunction with a marine fish hatchery. Here also are extensive wharves, at which the largest vessels may lie, and protected harbors for small craft. A large residence building at this station was for a number of years occupied as the summer headquarters of the Bureau, the entire executive and office force being transferred from Washington. The other laboratory is situated on a small island near Beaufort, North Carolina, and was constructed in 1901. The land for both of these stations was donated by private individuals. In addition to their function in the investigations of the Bureau itself, these laboratories are open to the public for study and scientific research. Students and professors in colleges and any other qualified investigators may have the facilities of the laboratories upon request, and these opportunities are largely availed of each year.

For the survey of offshore fishing grounds, the study of pelagic fishes, and the general exploration of the seas, the Bureau has had, since 1882, the steamer *Albatross*, which was specially designed and built for this work and has contributed more to the knowledge of the life and physics of the sea than any other vessel. The *Albatross* is a twin-screw iron steamer, rigged as a brigantine, of 1,074 tons displacement and 384 net tonnage, and was built at a cost of \$190,000, including original equipment. The complement of officers and men, numbering about 80, is furnished by the Navy; there is in addition a small civilian staff, including a resident naturalist and a fishery expert, to whom the practical work of the ship is intrusted. After spending several years in the investigation of the fishing grounds of the Atlantic coast of North America, the *Albatross* was dispatched to the Pacific Ocean in 1888 and has since confined her operations to those waters. The vessel has made three extended cruises to the southern and eastern parts of the Pacific, several cruises to the Hawaiian Islands and Japan, and many visits to Alaska, in addition to numerous surveys on the coast of the Pacific States, all having for their object the investigation of the physics and biology of the regions visited, the determination of their aquatic resources, and the study of their fisheries. In 1907 the vessel began a biological survey of the waters of the Philippine Archipelago, and is now engaged on that work. The deepest sounding made by the *Albatross*—near the island of Guam—was 4,813 fathoms; the greatest depth at which the vessel found life was 4,173 fathoms; the greatest known ocean depth is 5,269 fathoms, near Guam, ascertained by the U. S. S. *Nero* while using *Albatross* apparatus.

Work similar to that done by the Albatross is conducted by the steamer Fish Hawk on the Atlantic coast. This vessel, built for the Bureau in the winter of 1879-80, is of 441 gross tons burden, and has a naval crew of 45 men; it is equipped for sounding and dredging, and has recently been employed chiefly in the exploration of the coastal waters and inshore fishing grounds of New England while attached to the laboratory at Woods Hole. The vessel is convertible into a hatchery, and has been engaged in the hatching of shad and other fishes along the entire coast from Maine to Texas.



TRIAL FISHING ON THE ALBATROSS

This experimental catch of cod and halibut was taken in twenty minutes by the Albatross while exploring a new "bank" off the coast of Alaska.

The Bureau's large collections of natural-history specimens are deposited in the United States National Museum. The duplicates, however, are not retained for Government purposes, but are distributed upon request to public schools and colleges. In this way hundreds of thousands of specimens representing all groups of aquatic animals have been supplied for educational purposes.



DEEP-SEA EXPLORING STEAMER ALBATROSS

Built by the Bureau and for twenty-five years engaged in surveying fishing grounds and in deep-sea exploration in the Atlantic and Pacific oceans. The Albatross has contributed more to the knowledge of marine biology than any other vessel.

STATISTICS AND METHODS OF THE FISHERIES

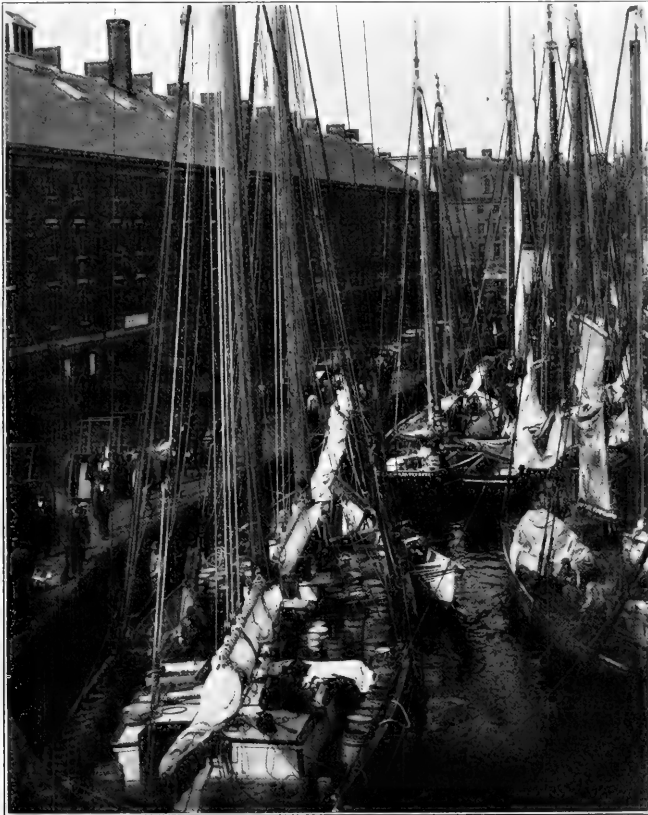
The first duty to which the Bureau of Fisheries was assigned, namely, the investigation of the reported decrease of food fishes in New England, necessarily involved the collection of statistics of production, personnel, and capital. Since that time this branch of the work has been conducted without interruption, and in it have naturally been included the various other subjects affecting the economic and commercial aspects of the fisheries. Among its functions



FISHING A NEW ENGLAND POUND-NET

are (1) a general survey of the commercial fisheries of the country; (2) a study of the fishery grounds with reference to their extent, resources, yield, and condition; (3) a study of the vessels and boats employed in the fisheries, with special reference to their improvement; (4) a determination of the utility and effect of the apparatus of capture employed in each fishery; (5) a study of the methods of fishing, for the special purpose of suggesting improvements or of discovering the use of unprofitable or unnecessarily destructive methods; (6) an inquiry into the methods of utilizing fishery products, the means and methods of transportation, and the extent and condition of the wholesale trade; (7) a census of the fishing population, their economic and hygienic condition, nativity, and

citizenship; (8) a study of international questions affecting the fisheries; (9) the prosecution of inquiries regarding the fishing apparatus and methods of foreign countries.



MACKEREL VESSELS AT A BOSTON DOCK

The mackerel schooners are among the fastest and handsomest vessels of the Atlantic coast, and Boston is the principal market for the catch. Fishing is done chiefly with purse seines, to manage which large crews are required. The yield of mackerel on our coast has been uninterruptedly small for twenty-two years, preceded by a period of almost unprecedented abundance.

The collection of statistics of the commercial fisheries and the industries dependent thereon constitutes the major part of this work. The information is required in great detail, and is obtained by the personal inquiries of a

small corps of agents, who visit all the fishing communities and interview fishermen, fish dealers, vessel owners, factory proprietors, and others. While the Bureau is not authorized by law to enforce demands for data, it very rarely happens that information is refused; on the contrary, the objects and value of the work being now well understood, many thousands of fishermen keep accurate records for the special use of the Bureau, and dealers, transportation companies, preparators, etc., permit free access to their books.

The relatively small force available for the collection of statistics, the magnitude of the territory to be covered, and the extent of the fisheries prevent the canvass of more than one section of the country during one season; and it has been found impossible to cover the entire coastwise and interior fisheries oftener than once in four or five years. Herewith are the latest available statistics gathered by the Bureau for the general fishing industry. These figures show that 219,534 persons were engaged in the fisheries, \$94,254,839 were invested in vessels, boats, apparatus, and other property, and the products had a value of \$61,047,909.

STATEMENT OF THE PERSONS ENGAGED AND THE CAPITAL INVESTED IN THE FISHERIES OF THE UNITED STATES.

ITEM.	Atlantic and Gulf States.		Pacific Coast States and Alaska.	
	Number.	Value.	Number.	Value.
Persons employed.....	161,923		32,410	
Vessels fishing.....	4,584	\$8,170,256	121	\$621,017
Tonnage.....	85,432		8,250	
Outfit.....		3,006,425		289,897
Vessels transporting.....	1,686	1,847,469	334	2,771,022
Tonnage.....	29,737		62,255	
Outfit.....		295,257		68,055
Boats.....	61,489	3,981,761	10,155	1,528,911
Seines.....	3,888	534,227	772	282,244
Gill nets and trammel nets.....	143,824	782,338	8,611	1,095,282
Pound nets, trap nets, and weirs.....	7,384	1,540,835	680	1,444,510
Fyke nets.....	19,033	94,180	446	4,610
Beam trawls and paranellas.....	66	1,696	41	6,371
Wheels and slides.....	37	775	49	168,000
Eel and lobster pots.....	228,086	248,974		
Dredges, tongs, rakes, scrapes, etc.....		411,424		7,131
Lines.....		347,079		44,421
Other apparatus.....		55,347		45,075
Shore and accessory property.....		20,571,131		10,473,781
Cash capital.....		15,013,676		7,205,650
Total.....		\$56,902,850		\$26,055,977

STATEMENT OF THE PERSONS ENGAGED AND THE CAPITAL INVESTED IN THE FISHERIES OF THE UNITED STATES—Continued.

ITEM	Great Lakes and interior waters.		Total.	
	Number.	Value.	Number.	Value.
Persons employed.	25,201		219,534	
Vessels fishing.....	194	\$634,450	4,899	\$9,425,723
Tonnage.....	3,506		97,188	
Outfit.....		147,402		3,443,724
Vessels transporting.	18	69,400	2,038	4,687,891
Tonnage	500		92,492	
Outfit		8,154		371,466
Boats	12,156	529,766	83,800	6,040,438
Seines	992	76,612	5,652	893,083
Gill nets and trammel nets.....	102,604	657,804	255,039	2,535,424
Pound nets, trap nets, and weirs.....	4,848	617,063	12,912	3,602,408
Fyke nets	40,724	261,379	60,203	360,169
Beam trawls and paranzellas.....			107	8,067
Wheels and slides	4	480	90	169,255
Eel and lobster pots			228,086	248,974
Dredges, tongs, rakes, scrapes, etc		13,683		432,238
Lines.....		24,994		416,494
Other apparatus		16,215		116,637
Shore and accessory property.....		4,809,022		35,853,934
Cash capital		3,429,588		25,648,914
Total.....		\$11,296,012		\$94,254,839

Note.—The years to which these figures pertain are 1905 for New England, 1904 for the Middle Atlantic States, 1902 for the South Atlantic and Gulf States, 1904 for the Pacific States, 1907 for Alaska, 1903 for all interior waters.

STATEMENT OF THE PRODUCTS OF THE FISHERIES OF THE UNITED STATES.

PRODUCT.	Atlantic and Gulf States.		Pacific States and Alaska.	
	Pounds.	Value.	Pounds.	Value.
Fishes:				
Alewives.....	52,061,580	\$473,811		
Barracudas.....	35,435	1,253	2,159,282	\$51,820
Black basses.....	1,201,135	90,956	93,500	2,910
Bluefish.....	16,575,661	781,802		
Bonito	1,019,032	41,818	212,062	3,075
Buffalo-fish	3,006,610	26,556		
Butterfish	4,184,363	138,761		
Catfish	5,252,858	168,102	923,144	27,292
Cod	77,498,674	2,101,119	7,694,944	193,966

THE UNITED STATES BUREAU OF FISHERIES

STATEMENT OF THE PRODUCTS OF THE FISHERIES OF THE UNITED STATES—Continued

PRODUCT.	Atlantic and Gulf States.		Pacific States and Alaska.	
	Pounds.	Value.	Pounds.	Value.
Fishes—Continued.				
Crappy and strawberry bass ..	253,506	\$7,154		
Croaker.....	6,910,903	138,931	121,340	\$3,145
Cusk.....	9,079,866	139,964		
Drum, fresh-water	5,550	131		
Drum, salt-water	4,063,230	109,055		
Eels.....	3,636,964	212,160		
Flounders.....	9,676,172	290,186	8,418,145	155,512
German carp	1,328,271	78,778	90,374	1,607
Haddock.....	77,065,441	1,258,763		
Hakes.....	35,928,627	419,384		
Halibut	3,715,776	237,876	12,091,000	358,930
Herrings.....	83,390,554	692,854	4,455,729	35,407
Mackerel	16,323,612	1,106,741	134,992	3,666
Menhaden	562,427,449	1,452,062		
Mullets	41,734,178	709,067	12,952	423
Perch, white.....	2,674,763	160,875		
Perch, yellow.....	587,885	25,547		
Pike perches.....	31,200	1,505		
Pike and pickerel.....	154,359	10,045		
Pollock	29,033,093	305,436		
Pompano.....	876,305	56,905	33,850	4,502
Rockfish.....			1,896,467	63,409
Salmons	86,368	20,161	267,389,335	12,589,958
Scup.....	9,216,731	250,320		
Sea bass.....	4,282,313	183,219		
Shads.....	28,065,130	1,688,352	489,505	13,146
Sheepshead.....	2,634,046	68,060		
Silver hake	5,549,935	37,866		
Smelts.....	628,860	69,710	2,762,202	79,973
Snapper, red.....	13,763,653	418,360		
Snappers, other.....	401,349	11,419		
Spanish mackerel.....	2,965,381	160,270	708,465	11,704
Spot.....	2,023,476	65,759		
Squeteagues.....	43,794,980	1,233,959	988,524	31,548
Striped bass	2,601,354	259,926	1,570,404	92,116
Sturgeons	1,475,925	137,311	137,981	4,271
Suckers.....	451,426	17,364		
Sunfishes.....	751,655	18,757	11,343	554
Swordfish.....	3,311,369	205,567		
Tautog.....	847,756	28,298		
Trouts.....			3,080,670	129,253

STATISTICS AND METHODS OF THE FISHERIES

STATEMENT OF THE PRODUCTS OF THE FISHERIES OF THE UNITED STATES Continued.

PRODUCT.	Atlantic and Gulf States.		Pacific States and Alaska.	
	Pounds.	Value.	Pounds.	Value.
Fishes—Continued.				
Whiting and kingfish.....	1, 178, 650	\$56, 107		
Other fish.....	8, 245, 417	210, 136	3, 748, 766	\$74, 186
Fish oil.....	26, 325	856	718, 837	19, 191
Mollusks:				
Abalone.....			824, 948	9, 155
Clams, hard-shell.....	8, 193, 844	1, 320, 364	871, 008	65, 078
Clams, soft-shell and other.....	8, 130, 430	543, 722	308, 080	30, 280
Cockles, winkles, conchs, etc.....	93, 734	13, 510		
Mussels.....	1, 551, 850	6, 705	28, 215	1, 764
Oysters.....	215, 121, 914	17, 417, 581	2, 665, 666	1, 031, 523
Oyster and other shells.....	19, 975, 115	20, 488	8, 730	218
Scallops ..	1, 586, 151	297, 658		
Squid.....	1, 119, 369	17, 307	251, 360	10, 054
Crustaceans:				
Crabs.....	34, 137, 937	723, 845	6, 081, 606	181, 904
Crawfish.....	71, 664	3, 897	187, 200	12, 480
King crabs.....	2, 303, 000	8, 903		
Lobster ..	11, 898, 136	1, 364, 721		
Shrimp and prawn.....	16, 186, 905	288, 344	1, 311, 750	93, 544
Shrimp shells.....			950, 000	4, 390
Spiny lobsters.....			1, 078, 065	43, 406
Reptiles and batrachians:				
Alligator hides.....	349, 927	40, 779		
Frogs.....	9, 210	1, 289		
Terrapins and turtles.....	856, 936	94, 586	28, 095	2, 616
Mammals:				
Fur-seal pelts ..			92, 364	484, 649
Hair-seal pelts.....			75, 417	13, 354
Otter pelts ..	3, 283	18, 367	3, 562	16, 703
Whalebone.....	55, 950	193, 037	120, 191	529, 614
Whale oil.....	3, 933, 554	246, 565	408, 419	20, 796
Ambergris ..	94	16, 900		
Sea-elephant oil ..	590, 625	25, 000		
Sea-elephant skins.....	5, 000	600		
Walrus products.....			8, 749	5, 771
Minor products.....			7, 575	7, 791
Miscellaneous:				
Sponges.....	346, 889	364, 422		
Seaweeds.....	841, 000	34, 120	59, 320	2, 267
All other products ..	2, 886, 040	39, 926	1, 198, 589	34, 380
Total	1, 512, 283, 708	\$39, 482, 010	336, 521, 752	\$16, 553, 301

THE UNITED STATES BUREAU OF FISHERIES

STATEMENT OF THE PRODUCTS OF THE FISHERIES OF THE UNITED STATES—Continued.

PRODUCT.	Great Lakes and interior waters.		Total.	
	Pounds.	Value.	Pounds.	Value.
Fishes:				
Alewives.....			52,061,580	\$473,811
Barracudas.....			2,194,717	53,073
Black basses.....	644,936	\$56,605	1,939,571	150,471
Bluefish.....			16,575,661	781,802
Bonito.....			1,231,094	44,893
Buffalo-fish.....	11,527,531	313,841	14,534,141	340,397
Butterfish.....			4,184,363	138,761
Catfish.....	6,542,001	336,135	12,718,003	531,529
Cod.....			85,193,618	2,295,085
Crappy and strawberry bass.....	1,143,800	54,034	1,397,306	61,188
Croaker.....			7,032,243	142,076
Cusk.....			9,079,866	139,964
Drum, fresh-water.....	3,507,331	87,810	3,512,881	87,941
Drum, salt-water.....			4,063,230	109,055
Eels.....	178,952	11,409	3,815,916	223,569
Flounders.....			18,094,317	445,698
German carp.....	17,524,118	361,870	18,942,763	442,255
Haddock.....			77,065,441	1,258,763
Hakes.....			35,928,627	419,384
Halibut.....			15,806,776	596,806
Herrings.....			87,846,283	728,261
Herring, lake.....	32,177,689	816,046	32,177,689	816,046
Mackerel.....			16,458,604	1,110,407
Menhaden.....			562,427,449	1,452,062
Mullets.....			41,747,130	709,490
Paddlefish.....	1,432,257	53,565	1,432,257	53,565
Perch, white.....			2,674,763	160,875
Perch, yellow.....	6,492,885	156,727	7,080,770	182,274
Pike perches.....	10,868,404	456,470	10,899,604	457,975
Pike and pickerel.....	1,296,911	69,677	1,451,270	79,722
Pollock.....			29,033,093	305,436
Pompano.....			910,155	61,407
Rockfish.....			1,896,467	63,409
Salmons.....	125,858	5,629	267,601,561	12,615,748
Scup.....			9,216,731	250,320
Sea bass.....			4,282,313	183,219
Shads.....	8,750	875	28,563,385	1,702,373
Sheepshead.....			2,634,046	68,060
Silver hake.....			5,549,935	37,866
Smelts.....	23,600	2,720	3,414,662	152,403

STATEMENT OF THE PRODUCTS OF THE FISHERIES OF THE UNITED STATES—Continued.

PRODUCT.	Great Lakes and interior waters.		Total.	
	Pounds.	Value.	Pounds.	Value.
Fishes—Continued.				
Snapper, red.....			13,763,653	\$418,360
Snappers, other.....			401,349	11,419
Spanish mackerel.....			3,673,846	171,974
Spot.....			2,023,476	65,759
Squeteagues.....			44,783,594	1,265,507
Striped bass.....			4,171,758	352,042
Sturgeons.....	1,647,306	\$91,372	3,261,212	232,954
Suckers.....	9,087,213	178,940	9,538,639	196,304
Sunfishes.....	1,325,521	33,295	2,088,519	52,606
Swordfish.....			3,311,369	205,567
Tautog.....			847,756	28,298
Trouts.....	17,069,284	951,864	20,158,954	1,081,117
Whitefish.....	7,728,761	350,186	7,728,761	350,186
Whiting and kingfish.....			1,178,650	56,107
Other fish.....	1,657,805	29,513	13,651,988	313,835
Fish oil.....			745,162	20,047
Mollusks:				
Abalone.....			824,948	9,155
Clams, hard-shell.....			9,064,852	1,385,442
Clams, soft-shell and other.....			8,438,510	574,002
Cockles, winkles, conchs, etc.....			93,734	13,510
Mussels.....			1,580,065	8,469
Mussel shells.....	51,856,430	530,098	51,856,430	530,098
Oysters.....			217,787,610	18,449,104
Oyster and other shells.....			19,983,845	20,706
Scallops.....			1,586,151	297,658
Squid.....			1,370,729	27,361
Crustaceans:				
Crabs.....			40,219,543	905,749
Crawfish.....	244,464	7,897	503,328	24,274
King crabs.....			2,303,000	8,903
Lobster.....			11,898,136	1,364,721
Shrimp and prawn.....	190,884	11,808	17,689,539	393,696
Shrimp shells.....			950,000	4,390
Spiny lobsters.....			1,078,065	43,406
Reptiles and batrachians:				
Alligator hides.....			349,927	40,779
Frogs.....	336,049	24,788	345,259	26,077
Terrapins and turtles.....	524,283	17,292	1,409,314	114,494

THE UNITED STATES BUREAU OF FISHERIES

STATEMENT OF THE PRODUCTS OF THE FISHERIES OF THE UNITED STATES—Continued.

PRODUCT.	Great Lakes and interior waters.		Total.	
	Pounds.	Value.	Pounds.	Value.
Mammals:				
Fur-seal pelts.....			92,364	\$484,649
Hair-seal pelts.....			75,417	13,354
Otter pelts.....	16	\$40	6,861	35,110
Whalebone....			176,141	722,651
Whale oil.....			4,341,973	267,361
Ambergris.....			94	16,900
Sea-elephant oil.....			599,625	25,000
Sea-elephant skins.....			5,000	600
Walrus products.....			8,749	5,771
Minor products.....			7,575	7,791
Miscellaneous:				
Sponges.....			346,889	364,422
Seaweeds.....			900,320	36,387
All other products....	24,200	2,092	4,108,829	76,398
Total ...	185,187,239	\$5,012,598	2,033,992,699	\$61,047,909

SUPPLEMENTARY TABLE SHOWING CERTAIN OF THE ABOVE PRODUCTS IN BUSHELS, GALLONS, AND NUMBER.

PRODUCT.	Quantity.
Clams, hard-shell....	bushels 1,133,106
Clams, soft-shell and other.....	do 843,851
Mussels.....	do 48,946
Oysters.....	do 31,112,515
Oyster and other shells ^a	do 332,910
Scallops.....	do 264,358
Cockles and winkles.....	do 9,400
Oil, fish.....	gallons 99,375
whale.....	do 578,930
sea-elephant.....	do 78,750
Fur-seal pelts.....	number 15,394
Alligator hides.....	do 70,410
Otter skins.....	do 4,537

^a Exclusive of tortoise and mussel shells.

The two most important fishing ports on the Atlantic coast are Boston and Gloucester, from which places upward of 435 vessels, of 24,000 net tonnage, valued at \$2,150,000 and carrying over 6,000 men, are employed in the fisheries.



A BUSY DAY AT T WHARF, BOSTON

The daily arrival, unloading, baiting, refitting, and departure of the fresh-fish fleet make T Wharf one of the most animated and interesting spots in Boston.

Most of the vessels are schooner rigged, and engaged in fishing on the high seas or on the "banks" lying off the United States and the British provinces. In the year 1907 about 200,000,000 pounds of fish, having a first value of over

\$5,250,000, were landed in the ports named. For the purpose of keeping in close touch with the condition and extent of these fisheries, which afford a good criterion of the New England fisheries as a whole, two local agents are employed to collect daily statistics of receipts, and this information is incorporated into a special bulletin issued monthly and widely distributed to the trade. It is the expectation that this local statistical service will be extended to other important centers.

The Bureau has conducted several investigations of the fisheries of the Hawaiian Islands and Porto Rico, and is now engaged in a study of the fisheries of the Philippine Islands. The latest information obtained gives the following figures for Hawaii and Porto Rico; for the Philippines no complete data are available, but it is estimated that the industry yields annually products to the value of \$10,000,000 to \$15,000,000.

ITEM.	Hawaii (1903).	Porto Rico (1902).
Persons engaged in fishing.....	3, 241	748
Value of vessels, boats, and apparatus employed.....	\$309, 217	\$35, 826
Quantity of catch (pounds).....	6, 972, 735	2, 169, 770
Value of catch.....	\$677, 897	\$106, 022

ALASKA SALMON-INSPECTION SERVICE

The fishing interests in Alaska, representing an investment of \$9,000,000 and yielding last year a product valued at more than \$10,000,000, have received especial attention from the Government ever since the Territory was acquired, in 1867. The seal fisheries, at first considered the most valuable sources of revenue, were at once placed under protective legislation. Later there appeared a similar need of regulation of the salmon fisheries, which have now come to support industries many times more valuable than the seal fisheries and standing in large proportion to the total fishing interests of the whole United States. The Alaska salmon-inspection service has thus grown to be one of the most important branches of Government fishery work, and it is one of the few instances where the Government has assumed legislative powers over fishing.

Supervision of the salmon fisheries, as of the seal, was at first given to the Treasury Department, and it remained under that jurisdiction until 1903, when it was transferred to the Department of Commerce and Labor, by which it is administered through the Bureau of Fisheries. There are three agents in this field, whose duty it is to inquire into the methods by which fish are caught, prepared, and marketed, and into the conditions of supply, to report thereon and recommend legislation, and to enforce existing laws. For these purposes

the entire region is canvassed every year, the agents remaining on the ground throughout the fishing season, from June to September.

The protection of the Alaska salmon fisheries has been a difficult problem. The unheard-of magnitude of the resources invited a corresponding recklessness and improvidence. As the canning industry developed, every device that could be used for wholesale capture of fish was put into operation, and gradually all of the favorite streams of the salmon became so blocked with seines, gill nets, traps, and barricades that but a small proportion of the fish could find passage to the spawning grounds, and the future supply was thus most seriously endan-



SALMON TRAP IN AN ALASKAN RIVER

This form of trap is extensively used in the Bristol Bay region, and takes immense quantities of salmon for the canneries. The largest traps have leaders more than half a mile long, and cost upward of \$15,000.

gered. The Alaskan aborigines likewise conducted their fishing in a very destructive way, often placing impassable barriers in streams up which salmon were running, and, through ignorance or indifference, leaving the obstructions in place after the full supply of fish had been secured. It was soon apparent that the laws and regulations were inadequate to meet the special conditions prevailing, and were of such a nature as to make their enforcement very difficult.

In 1903 a special commission was appointed to make exhaustive study of the natural history of the salmons of Alaska and to submit recommendations for an improved regulation of the fisheries. As a result a new code of laws is now

in effect and promises to prevent the threatened decline in these enormous industries. With increased restrictions as to fishing methods, obstructions in streams, close seasons, etc., the Department of Commerce and Labor is empowered to set aside any streams as spawning preserves whenever such course shall be desirable, all fishing in such waters to be prohibited. A license tax is required on all salmon products; from the payment of this tax, however, all canning and



NATIVE METHOD OF SETTING GILL NETS, ALASKA

The nets are set thus on the shore of Nushagak Bay, and at low tide are left entirely bare.

salting establishments are exempted upon condition of their returning young salmon to the streams in the ratio of 1,000 fry to every 10 cases of salmon canned. Three private hatcheries, representing extensive canning interests, were in operation in 1907 and liberated a total of 119,000,000 young fish. The Government itself has undertaken extensive hatchery work, having now in operation a station at Yes Lake established in 1905 and one at Afognak Bay just completed. In the two years of its operations the Yes Bay hatchery has produced and liberated over 61,000,000 salmon fry.

The seal and salmon fisheries have hitherto overshadowed all other aquatic resources in Alaska, not only in commercial value but in revenue to the Government. The rental from the fur-seal islands alone has more than repaid the purchase price of the Territory, and the tax derived from the salmon fisheries now amounts to about \$90,000 a year. Some long-neglected products are gradually coming into importance, however, and the cod, halibut, and herring fisheries



ALASKAN FISH TRAPS AND RUNS

Used by natives on Chilkoot Stream for obtaining their winter supply of salmon.

especially have undergone remarkable development in the last few years. Since it became a part of the United States, Alaska has yielded fishery products amounting in value to \$158,000,000, of which about \$49,000,000 was derived from fur seals, \$86,000,000 from salmon, and the remaining \$23,000,000 from all other aquatic products. The sum paid by the United States to Russia for the Territory of Alaska was only \$7,200,000.

RELATIONS WITH THE STATES AND WITH FOREIGN COUNTRIES

From the beginning of its career the Bureau has maintained cordial relations with the fishery authorities of the various States. The policy has been to aid and supplement, never to supplant, the work of the States; and the field is so large and the objects in view have such importance and common interest that there should never arise cause for unfriendly rivalry. The cooperation in fish-cultural, biological, and fishery work has been extensive.



WHITEFISH AND PIKE-PERCH HATCHERY AT PUT-IN BAY, LAKE ERIE, OHIO

The aggregate output of this station in 1907-8 was over 564 million young fish, besides 72 million eggs sent to other hatcheries.

Twenty-seven of the States have hatcheries of their own, and to any of these the Bureau transfers eggs and fry when they are available and desired. This policy is not only an aid to the State work, but facilitates the hatching by relieving congestion at the Government stations, and it also permits the most judicious planting of the fish. The Bureau has in a number of cases taken over and operated hatcheries owned by the States, and in others the egg collections are made conjointly. In the Pacific salmon work there was for years cooperation between the California Fish Commission and the Bureau, and much of the whitefish and pike perch work on Lake Erie has been done by the Bureau working with the States of Ohio and Pennsylvania.

In the States that have no means for undertaking the fish-cultural work the Government is looked to for the stocking of both public and private waters; and, for that matter, the Bureau distributes young fish to applicants in all States without distinction. In the introduction of nonindigenous fishes, however, the Bureau responds to applications only with the approval of State authorities. The evil that may result from the indiscriminate planting of



PART OF INTERIOR OF PUT-IN BAY HATCHERY

The arrangement of the jars in the form of a "battery" economizes space and facilitates handling of eggs and fry.

new fishes, especially the predaceous species, is obvious, but as it is not generally recognized by applicants that the popular black basses and trouts, for instance, do not dwell together in amity, full precaution is taken to secure requisite information before the fish are supplied.

The extent of Government aid to State hatchery work may be judged from the following table, showing the numbers of eggs consigned gratis to State fish commissions during the year ended June 30, 1908.

THE UNITED STATES BUREAU OF FISHERIES

ALLOTMENTS OF EGGS TO STATE FISH COMMISSIONS, FISCAL YEAR 1908.

STATE AND SPECIES.	Number of eggs.	STATE AND SPECIES.	Number of eggs.
California: Chinook salmon.....	68,647,550	New York—Continued.	
Colorado:		Lake trout.....	300,000
Black-spotted trout.....	125,000	Ohio:	
Lake trout.....	50,000	Whitefish.....	^a 30,906,000
Idaho: Brook trout.....	100,000	Lake cisco.....	^a 2,070,000
Illinois: Pike perch.....	25,000,000	Oregon: Chinook salmon.....	1,485,000
Maine:		Pennsylvania:	
Landlocked salmon.....	100,000	Whitefish.....	^b 76,860,000
White perch.....	700,000	Lake cisco.....	10,720,000
Maryland:		Silver salmon.....	100,000
Rainbow trout.....	150,000	Black-spotted trout.....	126,000
Yellow perch.....	2,080,000	Lake trout.....	500,000
Massachusetts: Rainbow trout..	15,000	Pike perch.....	^b 144,725,000
Michigan:		Utah: Rainbow trout.....	50,000
Landlocked salmon.....	10,000	Vermont:	
Lake trout.....	500,000	Lake trout.....	300,000
Pike perch.....	43,000,000	Brook trout.....	84,500
Missouri:		Wisconsin:	
Brook trout.....	100,000	Whitefish.....	15,000,000
Grayling.....	50,000	Steelhead trout.....	50,000
Pike perch.....	5,000,000	Rainbow trout.....	100,000
Nevada:		Grayling.....	50,000
Lake trout.....	100,000	Wyoming:	
Brook trout.....	200,000	Steelhead trout.....	20,000
New Hampshire:		Black-spotted trout.....	63,000
Chinook salmon.....	100,000	Lake trout.....	50,000
Lake trout.....	504,000	Grayling.....	50,000
New York:		Total.....	440,161,950
Whitefish.....	15,000,000		
Landlocked salmon.....	20,000		

^a The Ohio Fish Commission cooperated by furnishing a vessel and crew, and defrayed the expenses of collecting these eggs.

^b The Pennsylvania Fish Commission contributed the cost of collecting these eggs.

In addition to the eggs distributed as above, 3,500,000 yellow-perch fry were consigned to Connecticut and 1,475,000 lobster fry to Massachusetts; and of rainbow-trout fingerlings, yearlings, and adults, 44,800 were donated to Maryland and 5,000 to Nebraska.

The oyster-producing States more than any others have asked for the assistance of the Bureau's scientific staff. In Alabama, Florida, Louisiana, Maryland, North Carolina, South Carolina, and Texas extensive surveys have

been made or are being made, the oyster grounds charted, biological and physical conditions studied, and the path to successful cultivation pointed out. In North Carolina the declining shad fishery was recently investigated in both its natural history and statistical aspects by the Bureau at the request of the State authorities. State hatcheries have frequently called for aid in the study and treatment of epidemics among the fry and young fish. The results achieved in these various instances will be referred to elsewhere.

International courtesy has prompted the donation of American fish eggs to foreign governments, and the hardiness of such eggs and the facility with which they may be transported out of water for long distances have resulted in the establishment of some of the best of our food and game fishes in distant lands. Thus the brook trout and other American salmonoids are now thriving in Argentina; the brook trout, the rainbow trout, and the black bass are widely distributed in Europe; the rainbow and brook trouts are found in several Japanese lakes; and some of the finest trout fishing in the world is afforded by the rainbow trout in New Zealand, where also the chinook salmon, the blueback salmon, and various other American fishes are now flourishing. During the past year about 4,000,000 eggs of salmon and trouts were shipped abroad. When the Bureau is unable to supply such requests from its own stock, it acts as agent in the purchase from private fish-cultural establishments, supervising the packing and the transportation to the point of embarkation.

PUBLICATIONS

The 65 large volumes which represent the United States Bureau of Fisheries on library shelves are not the mere routine report or annual statement of funds disbursed and duties discharged. The scientific study and the practical experiment which are the foundation of the Bureau's work yield results of manifold interest and far-reaching significance, and such results are correspondingly fruitful of discussion. The dissemination of the knowledge they afford is, moreover, a recognized function for which the periodical document issue is the established medium. The subject-matter of these volumes is thus coextensive with the scope of the operations of the Bureau—it is biological, fish-cultural, and commercial, treated from standpoints both technical and economic. The names of J. A. Allen, Baird, Bean, Bumpus, Dean, Farlow, Forbes, Gill, Gilbert, Goode, Jordan, Rathbun, Ryder, Verrill, and numbers of other well-known biologists give the publications authority in science; and the reports of Baird, again, and the pioneers, Atkins, Clark, Green, Hessel, McDonald, and Stone, and their successors, constitute practically a history of fish culture in America. The *Manual of Fish Culture*, first issued in 1897 and revised in 1900, is yet the only publication in English covering that subject. The seven-volume "*Fisheries and Fishery Industries of the United States*,"

by Goode and his associates—Clark, Collins, Earll, Elliott, McDonald, and True—though published about twenty years ago, remains a standard work of reference. Of special interest and value during recent years have been the numerous contributions of Evermann, either alone or in collaboration, on the fishes of Hawaii, Porto Rico, the interior and coastal waters of America, etc.; the reports of Benedict, Rathbun, and others on crustacean resources, of Herrick on the lobster, of Kunz on pearls, of Moore on oysters and oyster culture, of Parker and Herrick on the special senses in fishes, and various other papers by regular assistants of the Bureau on economic, biological, and fish-cultural subjects. In addition to the foregoing, the publications treat of the physical conditions in lakes and streams, the methods used in deep-sea investigation, and all forms of minute animal and plant life in their relation to fishes—reaching into the fields of oceanography, hydrography, geology, and chemistry, as well as biology. The Bureau is thus responsible for a literature which no bibliography of natural science could omit and which has an educational value and popular interest widely acknowledged and availed of.

For the first ten years of the existence of the Bureau its publications were comprised in a series of annual octavo volumes known as the Commissioner's Report. In 1881 another series was begun, likewise of annual issue, and designated "Bulletin of the United States Fish Commission." These two series endured as instituted until the year 1905, when new legislation brought about a change. So far as form is concerned, however, the change affects only the Commissioner's Report. This report is no longer a bound book containing a detailed discussion of the year's work with special reports appended, but is reduced to a brief administrative statement of results, occupying less than 50 octavo pages. The special reports formerly published as appendixes and making up the major portion of the original volume are now issued as separate, independent pamphlets under distinct title-pages and covers. These papers are in general fish-cultural and economic, being detailed accounts of special investigations or experiments briefly noticed in the Commissioner's Report and as a rule contemporary. The relationship of their subject-matter is recognized in their size and typographical style, which is such as to permit them to be bound, if desired, with the Commissioner's Report to which they pertain. They are issued at no fixed intervals, but from time to time according to quantity and character of material and the exigencies of printing, each annual group, however, being usually completed within the year the Commissioner's Report is issued.

The Bulletin remains as heretofore, composed of papers (chiefly technical) upon all phases of aquatic biology studied by the Bureau or its collaborators. The volumes are annual, in royal octavo, with continuous pagination and general index. The separates are issued at irregular intervals, as are the pamphlets just described, and a volume is ordinarily closed within the year following the date

in its title. The present volume of the Bulletin, which is nearing completion, is the twenty-seventh, for the year 1907.

The publications are distributed gratis to all persons or institutions that desire them. A permanent mailing list is maintained, and individual requests also are complied with as received. The change affecting the content of the annual report, however, carried with it a new plan in the general distribution of documents. The laws establishing the Report and Bulletin had contemplated their issue in the form of annual bound volumes only, though it was possible to obtain a small edition of special papers in advance as separates. The separates, of course, offered the advantage of promptness in publication, convenience to the reader interested in a particular subject, and economy to the Bureau where without them it would have been necessary to supply entire volumes to persons desiring only a part. Accordingly, when revision of the printing laws made a new course possible, the pamphlet form was adopted almost exclusively for general distribution, exception being made only in the case of reference libraries, Government Departments, public fishery organizations, institutions of learning, etc., for whose purposes the annual bound volumes were better suited. To all other addresses on the mailing list and to all subsequent correspondents the Bureau forwarded a circular announcement of the change which was to take effect, furnishing a classification of subject-matter, and asking to be advised what papers would be desired in future. To the extent of the edition provided, any or all of the documents published are now supplied in accordance with the wishes thus ascertained. The subjects covered in the papers may be classified as follows:

1. Annual Report of the Commissioner.
2. Fish-culture:
 - (a) Methods.
 - (b) Distribution of fish and eggs
 - (c) Fish diseases and parasites.
3. Aquatic biology:
 - (a) Economic investigations.
 - (b) Explorations and surveys, the methods, apparatus, etc.
 - (c) Descriptions of species and faunal lists.
 - (d) Morphological, physiological, and pathological studies.
4. Statistics and methods of the commercial fisheries.
5. Special subjects, such as oysters, sponges, pearls, fur seals, investigations of popular interest, etc., to be designated by applicant.

For convenience of reference all publications of the Bureau are given a serial number, document 635 being the last issued. A list of titles of all available documents, arranged by numbers and indexed by subjects, is kept up to date and can be had upon request. Most of the earlier numbers are now out of print, some of the most valuable works unfortunately being no longer obtainable from any source unless from second-hand book dealers. Of some important

recent works an edition of 2,000 was exhausted within a year, and several documents of particular public interest have run through eight or ten editions. It is now possible to supply only a few odd back volumes and some 300 different pamphlets.

The permanent mailing list, which is steadily growing, includes at present some 1,500 addresses, representing various National and State government departments, fishery organizations and biological societies, public libraries and museums, colleges, newspapers and magazines, numerous fish-culturists, educators, students, sportsmen, and other persons with related interests. It is in the daily requests for particular papers, however, that the public interest in the Bureau's work is most manifest. During the past year, which has shown an especially marked increase in this respect, 25,423 documents were sent out in response to special requests.

As already stated, the Bureau distributes its publications free upon request. The Commissioner's Annual Report and the Bulletin (but not the independent pamphlet reports) can also be obtained free from Members of Congress, each United States Senator and Representative receiving a quota from the edition provided for this purpose. The Bulletin in this edition is the cloth-bound volume, delivered annually. All of the documents can be purchased in pamphlet form from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a price representing ten per cent more than actual cost.

SOME RESULTS OF THE WORK

Much evidence can be adduced to show that the fish-cultural operations of the General Government are of direct financial benefit to the country at large. The results in the case of some species have been so striking and so widespread that it would be almost as supererogatory to refer to them as to discuss the utility of agriculture; in the case of other species there can be no doubt of the value of the work, although it may be possible only occasionally to distinguish the effects of human intervention on the fish supply from the effects of natural causes. The outcome of the Bureau's efforts to increase the food supply is naturally most evident in the case of small streams, lakes, and ponds, of which thousands have been successfully stocked with the most desirable food and game species. It is not necessary to refer further to this work, but a few of the important results of operations on public waters may appropriately be mentioned.

The leading river fish of the eastern seaboard is the shad. No other anadromous species has been more extensively cultivated and none is now so dependent on artificial measures for its perpetuation. Inasmuch as the principal fisheries are in interstate or coastal waters and the movements of the fish from the high seas to our rivers and back to the high seas place it beyond the

claim to ownership which might be urged by the various States were the shad a permanent resident within their jurisdiction, it seemed especially desirable and necessary that this species should be fostered by the General Government for the benefit of the entire country. For this reason, and owing to a serious decline that had already set in, the shad was one of the first species whose artificial propagation was taken up by the Bureau, and its cultivation is to-day a leading factor in fishery work, almost every large stream having been the site of hatching operations. The extent of the work may be gaged when it is stated that nearly



FISHERIES STEAMER FISH HAWK

Engaged in hydrographic and biological surveys on the New England coast, and often employed as a shad hatchery on east-coast rivers.

3,000 millions of young shad have been planted by the Bureau in coastal streams; and a very significant point is that the eggs from which these fish were hatched were taken from fish that had been caught for market, and hence would have been totally lost if the Bureau had not collected them from the fishermen.

The great multiplication of all kinds of fishing appliances on the coast, in the bays, in the estuaries, and along the courses of the rivers resulted in the capture of a very large part of the run each season before the shad reached the spawning grounds, and hence the natural increase was seriously curtailed, and,

in some streams, almost entirely prevented. Yet the shad catch increased, and for many years the fishery prospered in the face of conditions more unfavorable than confront any other fish of our eastern rivers. At length, however, the unrestricted fishing became greedy to an overwhelming extent. The mouths of the rivers and the lower waters through which the shad must pass became so choked with nets that fishing gear farther upstream could make but slender hauls; and for several years there has been a steady decline in catch, which



MAIN DECK OF STEAMER FISH HAWK

Showing arrangement of McDonald automatic jars for hatching shad

threatens to result in the extinction of the fishery. The Bureau has continued its efforts in propagation, but these are curtailed by the factor that is also destructive to the fishery. When they first enter the streams the shad are not ripe and are useless to the hatcheries, and the spawntakers must therefore wait for the run farther upstream; but with the recent exhaustive fishing in the salt waters so few fish have escaped that the egg collections have diminished to an alarming extent, being reckoned now in millions where formerly they were

hundreds of millions. Under such conditions it is impossible to propagate enough fish to offset the quantities taken, and the shad fishery is fast being deprived of its one support; while the present meager shad catch together with the enforced curtailment of propagation speaks even more convincingly of the value of artificial measures than did the preceding increase.



LARGEST SEINE IN THE WORLD

This seine, operated for shad and alewives at Stony Point, Virginia, on the Potomac River, was the longest net of the kind. The net proper was 9,600 feet in length, and the hauling ropes at the ends were 22,400 feet long, giving 32,000 feet as the total sweep of the seine, only one end of which shows in the illustration. The seine was hauled by steam power and the labor of 80 men, and was drawn twice daily, at ebb tide, throughout the season. As many as 3,600 shad were taken at one haul, and 126,000 in one season, and 250,000 alewives were caught at one time. Recently the season's yield of shad fell to 3,000, and the fishery was consequently discontinued in 1905 after having been carried on for a century. This seine was a source of eggs for the Bureau's shad hatchery on this river.

The long continuance of the Penobscot as a salmon stream for many years after all other New England rivers had ceased to carry this fish is directly attributable to the work of the Bureau on that stream. So dependent on artificial measures has been the perpetuation of the salmon supply that it is believed the obliteration of the run and the wiping out of a long-established fishery would ensue within five years after the suspension of fish-cultural opera-

tions. Physical conditions in the Penobscot have become so unfavorable for the passage of salmon to the spawning grounds that natural reproduction is now almost if not altogether inhibited; and the only noteworthy source of young salmon is the eggs obtained by the Bureau from salmon purchased from the fishermen.



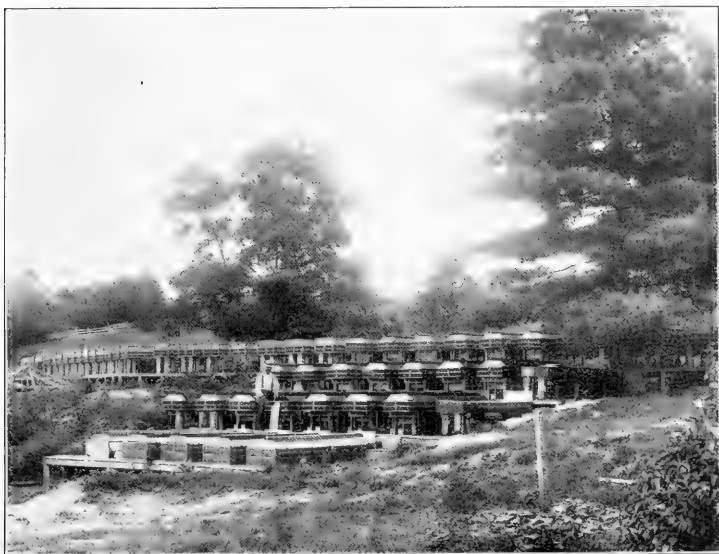
A PENOBSCOT RIVER SALMON WEIR

Large numbers of these traps are set in the Penobscot during the short season, and they intercept practically the entire run of salmon. The fish thus caught are the sole source of eggs for the hatchery on Craig Brook, a small tributary of the Penobscot.

Evidence is not lacking to show that the long-continued and increasingly extensive fish-cultural operations on the Great Lakes have prevented the depletion of those waters in the face of the most exhausting lake fisheries in the world. The luscious whitefish, the splendid lake trout, the excellent pike perch, or wall-eyed pike, may be hatched in such numbers as to assure their preservation without serious curtailment of the fisheries. The absence of concerted protective measures, however, on the part of the various States interested has the tendency

to minimize the effects of cultivation and would seem to justify, if not imperatively demand, the assumption of jurisdiction by the Federal Government.

The magnitude of the salmon fisheries of the Pacific States has required very extensive artificial measures to keep up the supply. The operations of the Bureau, in combination with those of the States, have been gradually extended in both scale and scope until they have now attained a tremendous extent and are addressed to all the species whose cultivation is as yet demanded.



OPEN-AIR SALMON-REARING TROUGHS

These troughs are used at the Craig Brook (Maine) hatchery for rearing Atlantic and landlocked salmon.

The quantity of Pacific salmon eggs collected by the Bureau in 1908 was over 200,000,000, equivalent to 1,700 bushels.

A remarkable fact in the history of the Pacific salmons—of which there are five species—is that without exception all fish which enter any stream on the entire coast die after once spawning, none surviving to return to the sea. This wise provision of nature to prevent the overstocking of streams has been made foolish by the appearance of man on the scene; he not only catches the salmon in the coast waters and the lower courses of the rivers with gill nets, seines, and pound nets, in the upper waters with the same appliances supplemented by the

fish wheels, and on the spawning grounds with all sorts of contrivances, but in certain sections even carries his foolhardy greed to the extent of barricading



SALMON HATCHERY AT BAIRD, CALIFORNIA

The pioneer salmon hatchery on the Pacific coast, located on the McCloud River, a swift stream formed by the melting snow on Mount Shasta. The station can accommodate 25 million eggs at one time, and in 1907-8 produced about 5 million young chinook or quinnat salmon and 15 million eyed eggs. Operations of this hatchery and its auxiliaries at Battle Creek and Mill Creek (where 743 million eggs of the chinook salmon were taken in 1907) have been the prime factor in maintaining the salmon run in the Sacramento River.

the streams so that no fish can reach the waters where their eggs must be deposited. Natural reproduction, thus so seriously curtailed, is not sufficient to keep

up the supply in many of the streams where fishing is most active, for many of the eggs escape fertilization, many more are eaten by the swarms of predaceous fishes that haunt the spawning beds, and many are lost in various other ways during the long hatching period; while the helpless fry and alevin fall a ready prey to the same fishes in the upper waters and the young salmon have to run the long gauntlet of the rivers only to meet new foes in the estuaries, on the coast, and in the open sea.



RACK AT BATTLE CREEK, CALIFORNIA

Erected by the Bureau each year to intercept salmon on their way to spawning grounds and supply eggs for the hatcheries.

It is, therefore, no wonder that artificial propagation on a large scale is imperatively demanded in the western salmon streams, and is actively urged and highly commended by fishermen, canners, business men, and the public at large. The beneficial influence of the work of the Government, supplemented by that of the three coast States, has been unmistakable in some sections and can not be doubted in general; but it is of course very difficult to distinguish definitely the increase due to natural from that due to artificial propagation.

The history of the salmon fishery in the Sacramento River in California, and the recent increase in the catch notwithstanding most unfavorable physical conditions in that stream, afford unmistakable evidence of the value of cultivation. Some very suggestive though not altogether conclusive information relative to the benefits of salmon culture in the Columbia River has been furnished by marking young salmon before releasing them from the hatcheries. The number of marked salmon that returned as mature fish and were captured and reported



COLLECTING COD EGGS ON A FISHING VESSEL

One source of cod eggs hatched at the New England stations is the catch of the market fishermen. Spawntakers board the fishing boats, overhaul the fish, and save the eggs of such as are ripe.

indicates a very large percentage of survivals and suggests the growing dependence on artificial propagation for the maintenance of the runs.

In the case of marine hatching operations it is so difficult to prove beneficial results that their utility is doubted by some people. When the Bureau began the cultivation of the cod and the lobster many years ago, it proceeded on the principle that the effects of the fishermen's improvidence could be counteracted by artificial propagation. The ultimate success of cod and lobster cul-

ture on the Atlantic coast was therefore confidently expected, and the expectations have been more than realized. Practical results of an unmistakable character were first manifested nearly twenty years ago, since which time a very lucrative shore cod fishery has been kept up on grounds that were entirely depleted or that had never contained cod in noteworthy numbers in the memory of the oldest inhabitants. There is much unsolicited testimony on this point from many people who have profited from the operations of the Maine and Massachusetts stations. The benefits have not been confined to the immediate



LOBSTER AND COD HATCHERY AT BOOTHBAY HARBOR, MAINE

vicinity of the hatcheries, but have extended westward and southward along the Middle Atlantic coast and eastward along the whole coast of Maine. The benefits of lobster culture have been slower in appearing, owing, in part at least, to the less extensive operations and the excessive mortality to which the young are liable; but from all parts of the New England coast there are being received reports of more lobsters, particularly of small size, than have been seen for many years, and there is reason to believe that the long-continued decline of the lobster fishery has been arrested.

Economic results of great value have come from the transplanting of native aquatic animals into waters in which they are not indigenous and from the introduction of fishes of foreign countries into the United States. The supply of food and game fishes of every section of the country has thus been increased and enriched, fisheries of vast extent have been established, and the pleasures of angling have been greatly enhanced.

Acclimatization



BIRD'S-EYE VIEW OF LEADVILLE, COLORADO, HATCHERY

This station, 10,000 feet above sea level, in the Rocky Mountains, is devoted to the culture of the black-spotted, rainbow brook, and other trouts.

In all the waters of the eastern, central, and southern parts of the United States the range of every important native food and game fish has been extended artificially. Especially extensive work has been done with the black basses (*Micropterus*), the crappies (*Pomoxis*), the rock bass (*Ambloplites*), the sunfishes (*Lepomis*), the brook trout (*Salvelinus fontinalis*), the lake trout (*Cristivomer namaycush*), the landlocked salmon (*Salmo sebago*), and the catfishes (*Ameiurus* and *Ictalurus*). Among the more conspicuous examples of this class of work has been the stocking of the Potomac River with black basses, crappies, and catfishes.

Among the eastern fresh-water fishes that have been established and more or less widely colonized in the Rocky Mountains or in transmontane regions are the large-mouth black bass, the crappie, the yellow perch, several catfishes and sunfishes, and the brook trout. Sportsmen of all the Western States can now find excellent black-bass and brook-trout fishing. Colorado, which has known the brook trout only a few years, is thoroughly stocked and affords unsurpassed opportunities for anglers. So successful has been the work in that State that the Government now draws most of its supply of brook-trout eggs therefrom,



CATCHING AND SORTING THE BROOD FISH AT A TROUT-CULTURAL STATION IN THE ROCKY MOUNTAINS

and the progeny of Colorado fish are used for replenishing eastern waters from which the original stock was taken for introduction into Colorado.

The most noteworthy results of the introduction of native fishes into new regions have been seen in the Pacific States and represent two contributions from the Atlantic seaboard—the shad and the striped bass. The economic outcome of the acclimatization of these fishes is without parallel in the entire history of migratory species.

The colonizing of the shad on the Pacific coast was one of the greatest achievements in fish acclimatization. Aside from the important financial

results, the experiment was noteworthy because of certain changes that have occurred in the habits of the species, and because the feat of transporting shad fry across the continent at that early day was justly regarded as remarkable, and had a marked influence on the development of fish transportation, which has now attained such perfection. With the experiment were associated two of the pioneer fish-culturists of America, whose name and fame are known the world over—Seth Green and Livingston Stone. Relatively small plants of shad fry were made in the Sacramento River, California, in 1871, 1873, 1876,



STRIPPING AND FERTILIZING TROUT EGGS AT A STATION IN THE ROCKY MOUNTAINS.

1877, 1878, and 1880, and in the Columbia River, between Oregon and Washington, in 1885 and 1886, the aggregate for each stream being less than one million and only one-hundredth of the plants sometimes made in an east-coast river in a single season.

In April, 1873, the first shad was taken in California, and shortly thereafter many more were caught in the vicinity of San Francisco; by 1879 the fish had become numerous, and by 1886 it had become one of the most abundant food fishes of the State. In 1876 or 1877 shad were first taken in the

Columbia, so it is evident that an offshoot from the California colony soon migrated northward and had already established itself when the new emigrants arrived from the east eight or nine years later. By 1881 the fish seems to have become distributed along the coast of Washington, and in 1882 reached Puget Sound. It was nine years later, however, when the first pioneer was recorded from Fraser River, British Columbia, and the same year there was a report of shad in Stikine River, southeast Alaska. In 1904 a fine roe shad, caught at Kasilof, on Cook Inlet, was the first known arrival in that remote region. To the southward the fish is found as far as Los Angeles County, and the present range of the species thus extends along about 4,000 miles of coast. It is not improbable that the migrations of the shad will extend still farther.

The two great centers of the shad's abundance are the Sacramento basin and the lower Columbia River, and it has been asserted that in either of these waters more shad could be taken than in any other water course in the country. The catch affords an inadequate criterion of the shad's abundance, for fishermen and dealers report that it would be easily possible, should the demand warrant it, to treble or quadruple the present yield, as most of the fish are now taken incidentally in apparatus set primarily for other species. Viewed from the purely business standpoint, the transplanting of shad to the Pacific coast has been a remarkably good investment. From the best information obtainable, the entire cost of the experiment was less than \$4,000, while the aggregate catch for market in California, Oregon, and Washington to the end of 1907 was approximately 15,000,000 pounds, for which the fishermen received \$330,000.

The history of the introduction of the striped bass on the western seaboard is quite similar to that of the shad, and the result has been equally striking. In 1879, 135 young striped bass from New Jersey were deposited in San Francisco Bay, and in 1882 a plant of 300 small fish from the same State was made in the same place. These meager colonies found the waters of California fully as congenial as did the shad, and the fish has shown an almost uninterrupted increase in abundance to the present time. From the San Francisco region the species has gradually spread up and down the coast, and its range may eventually equal that of the shad. Up to 1896 the fish had not been reported outside of California, but several years thereafter it began to run in some of the coast rivers of Oregon, and in the fall of 1906 half a dozen fine specimens were caught in traps at the mouth of the Columbia River, the first recorded from that stream.

The striped bass, far removed from its ancestral home, has maintained the enviable reputation it enjoys in the East, and is freely recognized by its new friends as one of the best food and game fishes of the Pacific coast. A number of years ago the catch in California exceeded that of any other State, while now it surpasses that of any group of States along the eastern seaboard. The fish has become a prime favorite with anglers, and it is now probably the leading game fish of California. While it always commands a high price in the East,

and is often to be ranked as a luxury, its abundance in California waters has so reduced the cost to consumers that even the most frugal can afford to eat it, and a comparison made some years ago showed that throughout the year the San Francisco dealers were underselling the New York dealers by many points. The economic importance of the introduction of the striped bass on the Pacific coast may be judged from the fact that the entire cost of transplanting was less than \$1,000, while the value of the catch to the end of 1907 was about \$925,000, a sum representing a yield of more than 16,500,000 pounds.

The only fishes which the Western States have given to the remainder of the country are two trouts; but the transplanting of several other trouts is now in progress, and systematic and extensive efforts are being made to establish several of the Pacific salmons in the New England rivers. The foremost contribution of the West to the East is the rainbow trout. The transplanting of this species in regions east of the Rocky Mountains has been a conspicuous success and has proved a decided boon to many communities. Its acclimatization by the General Government was first undertaken in 1880, although it is probable that some years prior thereto small plants had been made in new waters by State commissions or private persons. It has now been introduced into nearly every State and Territory, and has become one of the most generally known fishes in every part of the country. In Michigan, Missouri, Arkansas, Nebraska, Colorado, Nevada, and throughout the Allegheny Mountain region its transplanting has been followed by especially noteworthy results. Its position in the streams and lakes of the Eastern States is that of a substitute and not a rival of the brook trout. It is well adapted for the stocking of waters formerly inhabited by the brook trout, in which the latter no longer thrives on account of changed physical conditions; it is also suited to warmer, deeper, and more sluggish waters than the brook trout finds congenial.

The anadromous steelhead trout of the Pacific coast has been established in Lake Superior and other parts of the Great Lakes as a result of plants of young fish made in 1896, and has also obtained a firm hold in a number of New England lakes, proving a very acceptable addition to the supply of food and game fishes. It readily adapts itself to a strictly fresh-water existence, and soon reproduces in its new habitat.

The debt that sportsmen owe to the fishery service of the United States and the several States for their acclimatization work is heavy and increasing yearly, and the obligation is shared indirectly, but not the less actually, by hotel keepers, boatmen, merchants, landowners, and others. There could be cited numerous concrete examples of the varied benefits that have come to communities through the stocking of local waters with nonindigenous species. In some cases the improvement in the fishing has so increased the influx of people that land about the waters has increased several hundred per cent in value in a few years.

Quite a number of Old World fishes have been introduced into American waters, and some of them have become well known in various parts of the country. Two European trouts, the brown trout and the Scotch lake trout, have been cultivated here for a score of years, and are now found in many private waters. The acclimatization of the European sea trout and the Swiss lake trout has also been effected. None of these fishes, however, has any superiority over native species, and the demand for them is decreasing. The Asiatic goldfish and the European golden ide or orf and tench are now very familiar ornamental species in America, but have little commercial value; the tench, however, is found in a few streams and reaches the markets in small numbers. Of all the exotic fishes, however, none is so well known, so widely distributed, so abundant, and so valuable as the carp, which was introduced from Germany upward of thirty years ago. This fish has excited a great deal of criticism, mostly unfriendly, and it is to-day regarded with disfavor by many people, chiefly anglers, because of real or supposed habits that are reprehensible. As a commercial proposition, the bringing of the carp to America has been of immense benefit, for to-day it is one of the common food fishes of the country, it is regularly exposed for sale in every large city and innumerable small towns, it supports special fisheries in 15 States, and it is regularly taken for market in 35 States. The sales at this time amount to fully 20,000,000 pounds annually, for which the fishermen receive \$500,000.

The principal carp fishery is in Illinois, where fishermen have for years been reaping a golden harvest, finding a ready sale in the West and also sending large consignments to New York in special cars. The next important center is the western end of Lake Erie, in Ohio and Michigan, where large special ponds have been constructed and a peculiar form of cultivation has sprung up. Other important carp States are Colorado, Delaware, Iowa, Minnesota, Missouri, New Jersey, New York, Tennessee, Utah, and Wisconsin.

It is not as a great market fish, however, that the carp is destined to attain its highest importance among us, but as a fish for private culture and home consumption. The number of farmers and small landowners who are alive to the benefits of private fish ponds is increasing at a very rapid rate, and hundreds of thousands of such in all parts of the country, but particularly in the great central region, will find in the carp a fish well adapted to their needs and conditions.

It is probable that the commercial value of carp is insignificant compared with its importance as a food for other fishes. It is extensively eaten by many of our most highly esteemed food fishes and is the chief pabulum of some of them in some places. In a number of the best black-bass streams, like the Potomac and the Illinois, the carp is very abundant and is a favorite food of the young and adult bass, while in California the introduced striped bass has

from the outset subsisted largely on carp and may owe its remarkable increase to the presence of this food.

The consumption of carp is certainly destined to increase greatly; but even if the catch reaches no higher point, the introduction of the carp into the United States will remain the leading achievement in fish acclimatization in recent times, and, with the exception of the original introduction of the same fish into Europe from Asia, the most important the world has known.

Among the acclimatization experiments that have not yet been proved successful, but that there is every reason to believe will eventually become so, is the transplanting of the lobster (*Homarus americanus*) to the Pacific coast. There is probably no food animal of the eastern seaboard whose acclimatization on the Pacific coast would prove so great a boon as the lobster. As early as 1873 the Bureau made its first move to supply the deficiency, and up to 1889 five attempts to establish the species were made, the deposits being at various points from Monterey Bay to Puget Sound. No positive results having appeared, the experiment was renewed in the fall of 1906, when a special carload of brood lobsters, numbering more than all the previous plants combined, was dispatched to Puget Sound, and in 1907 a still more extensive plant, aggregating about 1,000 adult lobsters, was made in the same water. Further consignments will be made until the lobster is removed from the list of failures and recorded as a great financial as well as gastronomic success.

The long-continued and systematic field and laboratory work of the Bureau has resulted in a most thorough knowledge of the distribution, variation, abundance, habits, etc., of the fishes and other creatures of the interior, coast-

Biological Investigations
and Experiments

wise, and offshore waters of the United States, Hawaii, and Porto Rico—a knowledge which is indispensable to the Government in its fish-cultural work and to the various States and insular authorities in their legislative efforts to preserve their fishery resources. The practical results of this work are apparent in numerous specific instances.

For a number of years the Bureau has been engaged in an endeavor to develop a practical method of fattening oysters. It is the custom of many oyster growers to transplant their oysters, shortly before putting them on the market, to beds where the natural supply of food is luxuriant, and oysters fatten rapidly. In many localities such favorable places are few or entirely lacking, and the oystermen are compelled to put inferior stock upon the market, and thus forfeit the full measure of profit. The experiments which have been carried on are intended to develop a method of producing these fattening beds artificially in localities where they do not naturally exist. By the use of commercial fertilizers it has been found possible to produce the desired abundance of oyster food, and the only important problem yet awaiting solution is that of materially increasing the output of the artificial claire employed for the experiments. Con-

siderable progress toward this end has been made recently, the yield of the claire in 1907 being 176 barrels, against 125 barrels in the preceding year; and, as with a given equipment the expenses of operation are not materially increased whatever the product, this increase, if it can be carried further, as present conditions indicate, will result in sufficient margin between the cost of the treatment and the increased value of the fattened oysters to warrant its recommendation as a commercial process. The oysters fattened by this method are as fine as any placed on the market, and have been used with satisfaction at some of the best hotels and clubs of New York, Philadelphia, and Washington.

Upon two subjects in particular has the Bureau expended much energy and at last achieved results by persistently sounding the note of warning. The utmost efforts in artificial propagation can not save the shad fishery without the aid of laws to permit a certain number of spawning fish to reach the streams; while on the other hand no practicable protective laws can save the oyster supply without cultural work to keep up the beds. The Bureau has no power to do more than hatch fish in the one case, devise methods of culture in the other, and cry out the needs of both; and it lies solely with the States to provide for the needs.

North Carolina rose to the emergency of the shad situation a few years ago and asked the aid of the Bureau in determining the actual protection required by the shad, the actual condition of the fishery, and the possible remedies for a rapidly diminishing yield. The Bureau's recommendations were asked for by the State legislature, and a commission was appointed to draft salutary laws, which have since gone into effect, confining gear to prescribed areas and leaving clear channels for the passage of the fish. Immediate result was seen at the Government hatchery in the Albemarle region. The collection of shad eggs in these waters in five years had dropped from 75 millions to $6\frac{1}{2}$ millions. The next year, which was the first of enforcement of the new laws, the collection was $25\frac{1}{2}$ millions, and in 1908 the most successful shad hatchery was in this State, the egg collections exceeding 55 millions.

The oyster fishery has had a common history in all of the Southern States, of which Maryland, once the foremost in oyster production and the last to resort to systematic cultural measures, affords the most notable example. The laws controlling the fishery in Chesapeake Bay have been designed to protect the natural beds, but have not encouraged or protected the oyster planter, and the natural beds, thus practically the sole reliance, in time failed to sustain the tremendous draft upon them. Between 1880 and 1897 the product fell 31.6 per cent; in 1904 it was 39 per cent less than in 1897.

The Bureau had for many years pointed out the short-sighted policy that was resulting in the steady decline of the oyster industry, and was at length gratified to find that the State had taken heed of the warning and enacted a comprehensive law favoring oyster planting. The work that has now been under-

taken by the Maryland Shell Fish Commission to remedy the alarming condition of the oyster grounds will be the most complete and accurate of its kind. It consists of the survey and delimitation, by the aid of the United States Coast and Geodetic Survey and the Bureau of Fisheries, of all natural oyster beds in Maryland waters, to be marked and set aside as public fishing grounds operated under the existing protective laws. All other suitable grounds will then be



THE OYSTER FLEET AT BALTIMORE

Baltimore, at the head of Chesapeake Bay, is the leading oyster market of the world. Over 600 oyster vessels, carrying 1,600 men, land their catch here; and nearly 8,000 men on shore are engaged in handling, shucking, canning, and shipping the oysters. The quantity of oysters landed in Baltimore in a single season has sometimes reached nearly 7,000,000 bushels, worth about \$1,500,000.

reserved by the State to be leased to oyster planters, whose enterprise will be encouraged and their rights protected as was not possible heretofore.

Up to 1898 there were few planted beds of oysters in Louisiana waters. Investigation of the oyster grounds by the Bureau in that year, however, led to the passage of beneficial laws and proved a general stimulus to oyster culture in that State, as is shown by the fact that some 20,000 acres of bottom were soon under cultivation. In 1906 the State Oyster Commission, still further to promote the local industry, again asked the Bureau's assistance, and large

areas of unutilized bottom were examined to determine their productive capacity. The conditions were found to be exceptionally favorable, and experimental plants produced $3\frac{1}{2}$ to 4 inch oysters in quantities of 1,000 to 2,000 bushels per acre, within two years after the cultch was put down. In Baratavia Bay, where there had been no oysters whatever, such promising beds were established that several hundred acres of adjacent bottom were immediately leased by prospective planters. Other localities, though they have so far shown no such conspicuous commercial enterprise, may be expected to prove equally productive.

Experiments in sponge culture have been in progress for several years, and have now developed a practical system by which sponges may be produced from cuttings at a cost much less than that entailed in taking them from the natural beds. In view of the more rapid depletion of the natural beds which will undoubtedly result from recent changes in the methods of the fishery, the Bureau is convinced that the preservation of the American sponge industry will depend upon cultivation; and as it is estimated that about \$1,500,000 worth of sponges were taken in Florida during the past year, the failure of the fishery would be a serious commercial loss to the State.

In cooperation with the Rhode Island Fish Commission, the Bureau has developed new methods of lobster and soft-shell clam culture which are being applied with success in New England. Experiments with the hard-shell clam are now in progress at Beaufort.

Important work recently undertaken is an effort to establish mussel culture in the Mississippi Valley. The supply of mussels in those waters, on which is based a pearl-button industry valued at about \$5,000,000 per annum, with an investment of \$6,000,000, is being rapidly exhausted, and the mussel fishermen and manufacturers recognize that without scientific cooperation of the Government the business is doomed to early extinction. The Bureau in one season's work has practically, though not conclusively, shown a method by which the pearl mussels can be propagated, and is demonstrating that the work can be carried on at a comparatively small expense in connection with the already established operations in rescuing fishes from the overflowed lands, the fish reclaimed being employed, without injury to themselves, in the dissemination of the larvæ of the mussels. There have been liberated 25,000 fish, bearing about 25,000,000 young mussels ready to drop and begin their independent existence, and already past the stage when they are most subject to fatality. The work is also capable of application to waters under private control and will probably become a source of respectable revenue to farmers and others whose property embraces streams, ponds, and lakes. The importance of this work is urgently insisted upon by the National Pearl Button Manufacturers' Association, which embraces practically the entire capital invested in the business.

In the field of fish diseases great progress has been made in the extension of knowledge of the causes of many of the fatalities which sometimes make a clean sweep of the hatcheries and which heretofore could not be adequately coped with because their etiology was not understood. The services of the scientific staff in this regard have been not only of great benefit to the Government, but are highly regarded and frequently availed of by State and private fish-culturists. Among the direct material aids rendered to fish culture in the



THE FRESH-FISH FLEET AT T WHARF, BOSTON

Larger quantities of fresh sea fish are landed at Boston than at any other port in the United States. The principal species are cod, cusk, haddock, hake, pollock, halibut, swordfish, and mackerel, together with lobsters, oysters, and clams. A day's receipts of fresh fish from the grounds off the New England coast have sometimes exceeded 2,000,000 pounds.

past four or five years are the following: (1) Determination of the cause and remedy for the fatal malady known as the "gas disease," which at one station killed 1,200,000 brook-trout fry out of 1,300,000 on hand; (2) isolation of a bacterial organism producing a fatal disease in trout, and discovery of a possible remedy; (3) determination of the cause of a fatal protozoan disease in trout; (4) discovery of a remedy for the diatom disease of lobster eggs and larvæ; (5) studies of the causes for the death of fish in captivity and the determination

in a number of cases of responsible peculiarities in the water supply; (6) studies of the character of streams and the effects of various conditions on fishes, which have supplied much information on the subject to the public; (7) determination of the effects on fishes of galvanized iron and other metallic containers used in transportation of fish and fry, and (8) indication of certain undesirable types of vessels.



THE FISHING FLEET IN GLOUCESTER HARBOR

Gloucester, Mass., is the leading fishing port in the Western Hemisphere. Nearly 6,000 persons are employed on the fishing vessels and in the various shore industries dependent on the fisheries, and the entire population of 26,000 literally depends on the sea for its existence.

The importance to the fishing interests of the work of the Bureau in connection with the economic fisheries is widely appreciated and freely acknowledged. The statistical inquiries of the Bureau afford the only adequate basis for determining the condition and trend of the fisheries and the results of legislation, protection, and cultivation. Among the numerous special matters in which the Bureau has benefited the fisheries the following may be mentioned:

By bringing to the attention of American fishermen new methods and new apparatus, new fisheries have sometimes been established and new fields exploited.

By the introduction of gill nets with glass-ball floats for taking cod the winter cod fishery of New England was revolutionized. In a single season shortly after the use of such nets began a few Cape Ann (Gloucester) fishermen took by this means over 8,000,000 pounds of large-sized fish, and as much as \$50,000 has sometimes been saved annually in the single item of bait.

By the dissemination of information regarding new fishing grounds important fisheries have been inaugurated. Thus when the abundance of halibut off



SALT COD DRYING IN THE FLAKE YARD OF A GLOUCESTER FISH-PACKING ESTABLISHMENT

the coast of Iceland was made known by the Bureau a fishery was begun which yielded from \$70,000 to \$100,000 annually to the New England fishermen.

The Bureau has experimented with various unused or little-used products in order to determine their economic value and to suggest the best ways of utilizing them. Less than fifteen years ago there was practically no market for the silver hake or whiting (*Merluccius bilinearis*), and immense quantities incidentally taken in pound nets and other apparatus were thrown away. The Bureau pointed out the possibility of preparing a marketable salt whiting; and

it is a significant fact that in a few years the sales of this fish in New England have increased from about 100,000 pounds to 5,000,000 pounds.

Owing to the appalling mortality among the crews of the New England fishing vessels, owing in large part to the foundering of the vessels at sea, the Bureau many years ago undertook the introduction into the offshore fisheries of a type of craft which would combine large carrying capacity and great speed with enhanced safety. By correspondence, discussions in the daily press, personal interviews, exhibition of models, and finally by the actual construction of



FISHERY SCHOONER GRAMPUS

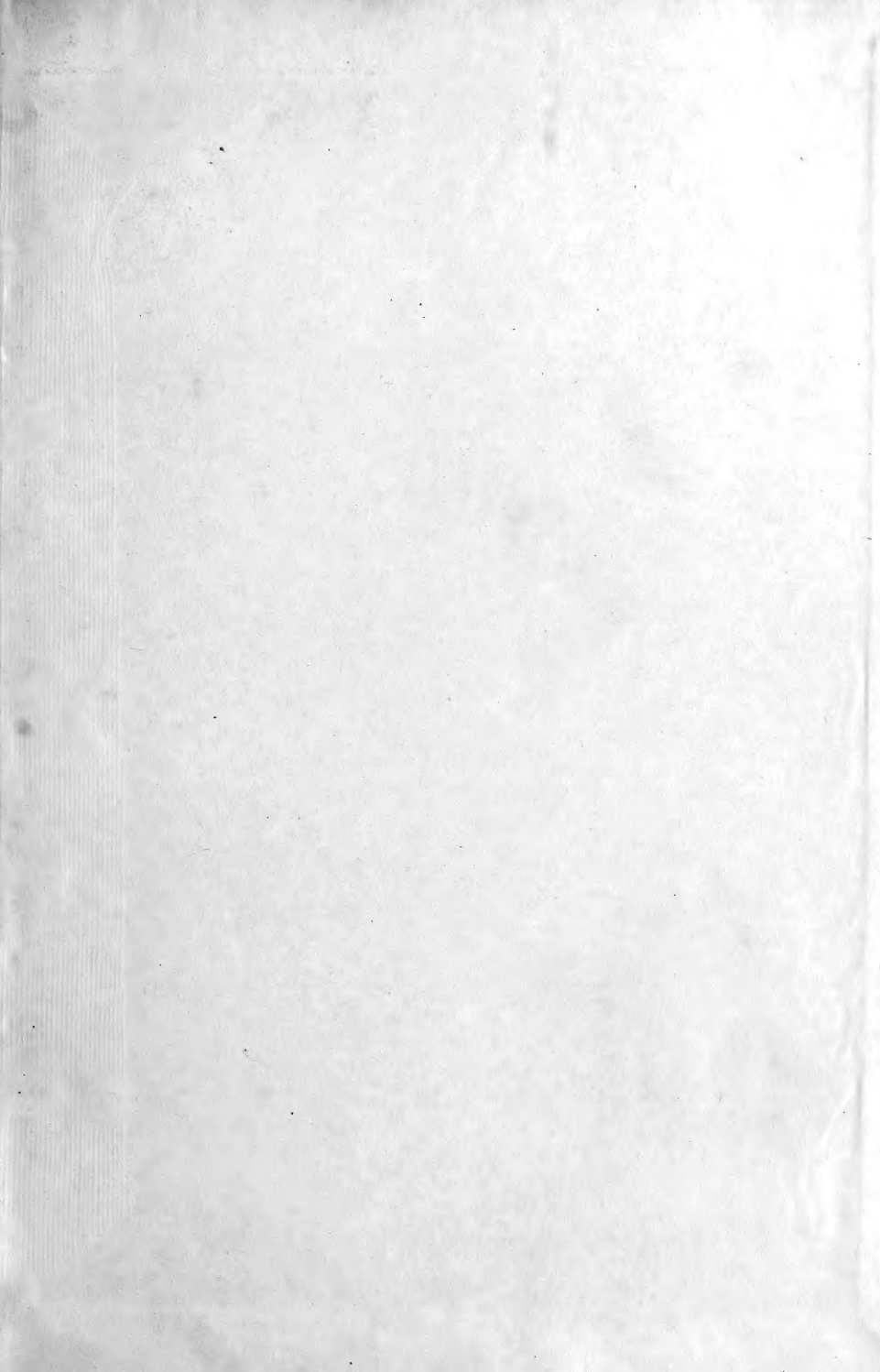
Built by the United States Government as an object lesson. The general adoption of this type of swift, safe vessel in the offshore fisheries has resulted in great saving of life and property, and has otherwise promoted the fisheries.

a full-sized schooner (the Grampus) with the requisite qualities, the Bureau was able to inaugurate a momentous change in the architecture of fishing vessels, so that for a long time the New England schooners have been constructed on the new lines, with a consequent minimizing of disasters and a decided increase in efficiency. For other fisheries and regions the Bureau has likewise advocated improved types of vessels and boats especially adapted to local conditions, and has published plans and specifications embodying the results of studies of the fishing flotilla of the world. The results of the Bureau's efforts in this line, in

saving life and property, in increasing the usefulness of the vessels, and in improving the quality of the catch as landed can not be estimated, but the beneficial effects may be partly appreciated when it is stated that during the ten years ended in 1883, when the old types of vessels were in use, there were lost by foundering from the port of Gloucester alone 82 vessels, valued at more than \$400,000, with their crews of 895 men; while during the ten years ending in 1907 the losses from this cause aggregated only a fourth as many vessels and men.







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