REPORT OF THE DIVISION OF SCIENTIFIC INQUIRY.

By Hugh M. Smith, *Assistant in Charge.*

Up to December 31, 1896, this division was under the charge of Mr. Richard Rathbun, who resigned to take effect on that date, when Dr. Hugh M. Smith was appointed to the vacancy. Other changes in the personnel of the division consisted in the promotion of Dr. H. F. Moore, scientific assistant, to the position of naturalist on the steamer *Albatross*, vice Mr. Charles H. Townsend, appointed assistant in charge of Division of Fisheries, and Mr. F. M. Chamberlain, scientific assistant, promoted to the position of general assistant on *Albatross*, vice H. B. Miller, deceased. Mr. M. C. Marsh, of Cornell University, was appointed a scientific assistant in conformity with civil-service regulations.

FIELD INVESTIGATIONS.

During the year numerous field inquiries were conducted in different parts of the country. Besides the usual investigations of fishes of the interior waters, which have been regularly carried on for a long series of years, many special inquiries of a diverse character were undertaken.

Extensive investigations in the waters of Idaho, Washington, and Oregon were prosecuted. These had for their object the study of the distribution, abundance, habits, and spawning of the salmon, trout, and other native fishes; the examination of various lakes with reference to the introduction of the common eastern whitefish, and the survey of streams with a view to ascertain their advantages and facilities for fish-cultural operations. The investigations were in immediate charge of Prof. Barton W. Evermann, who was assisted by Mr. A. B. Alexander, Dr. Seth E. Meek, Prof. Ulysses O. Cox, and Mr. A. G. Maddren.

A systematic examination of the short coast rivers of the Pacific Coast from San Francisco northward was begun. A number of interesting inquiries in Florida, Mississippi, Louisiana, and Texas were made pursuant to special requests.

Outlines of the more important inquiries are here given. Detailed accounts of some of them will be found in special printed reports.

LOWER COLUMBIA RIVER BASIN.

It being the intention of the Commission to establish a salmon hatchery on one of the tributaries of the Columbia River, in order to supplement the fish-cultural operations of the hatchery on Clackamas River, extensive investigations were made in August and September.

The streams visited were Lewis, Toutle, Hood, Big White Salmon, Little White Salmon, Des Chutes, and John Day rivers; the Columbia River at the Cascades and Celilo; Hamilton and Rock creeks near the Cascades, and Tanner and Eagle creeks.

The examinations were in the main limited to the lower parts of the streams on account of their greater accessibility, a reasonably close proximity to the railroad being a desirable feature of the proposed station. During the visits made to these streams early in August the inquiries consisted chiefly in determining their physical characters, the examination of possible sites for hatchery buildings, and the collection of information concerning the abundance of salmon. At that time the run of fish had not begun, and no authentic information regarding the spawning time and condition could be obtained. It was therefore necessary to revisit the different localities in September, when salmon were arriving upon the spawning-beds and it was possible by personal observation to determine the relative advantages of the different sites and streams for fish cultural purposes.

Salmon were found in some numbers in Big White Salmon and Little White Salmon rivers and in Tanner and Eagle creeks. No salmon were observed in Des Chutes, John Day, and Hood rivers, and it is doubtful whether, at the present time, these rivers contain any important spawning-grounds of the chinook salmon. Salmon were observed in greatest abundance in Little White Salmon River, and this stream was selected as the most desirable site for the contemplated hatching-station. Temporary buildings were hastily constructed and the station operated during the same fall. The number of eggs collected was comparatively large and warrants the belief that this is one of the best sites in the lower Columbia basin for fish-cultural work.

In September and October, 1896, Mr. A. B. Alexander spent considerable time at the canneries of Mr. I. H. Taffe and Messrs. Seufert Bros., at Celilo, Oreg., inspecting the catch of salmon made in their wheels and nets. Important data were obtained as to the relative abundance of chinook salmon, silver salmon, and steelheads, their sizes, spawning condition, relative numbers as to sex, and the time of run.

WALLOWA LAKE, OREGON.

A brief visit was made to this lake in August, 1896, by Messrs. Meek and Maddren for the purpose of ascertaining what facilities existed in that region for the study of the blueback salmon or redfish and the quinnat salmon, more especially their spawning habits and grounds and their condition after spawning. No large redfish were seen, but it was learned that this species formerly spawned in large numbers in an inlet of Wallowa Lake; the run has been rapidly decreasing in recent years. This region is also a spawning-ground of the small redfish, but they had not arrived at the time of this visit. Important spawning-grounds of the chinook salmon formerly existed in the west and main forks of Wallowa River, but during the last few years not many of this species have been seen.

LAKE PEND D'OREILLE, IDAHO.

The investigations begun on this lake in the latter part of June, 1896, by Messrs. Alexander and Cox were continued until July 16, when the requirements of the work on Puget Sound necessitated the suspension of the inquiries. The visit to this lake had for its object the search for survivors of the plant of whitefish made by the Commission in 1889, and the determination of the physical characters and the nature of the aquatic fauna. The results of the inquiries were not altogether satisfactory, owing to the shortness of the time devoted to them and to the unfavorable conditions then prevailing. The melting snows and heavy rains caused the water in the lake to rise from 10 to 17 feet higher than normal, and retarded the work.

An abundance of small crustaceans and insect larvæ suitable for fish-food was found, and the indications are that the lake is well adapted to the common whitefish. Although no specimens of this species were seen, and no reliable evidence was obtained showing that it has succeeded in establishing itself, further inquiries will be necessary in order to settle the matter conclusively. A party could profitably devote an entire summer and fall to an examination of this important lake.

THE REDFISH LAKES, IDAHO.

The studies of the spawning habits of the redfish or blueback salmon and the chinook salmon begun in these lakes in 1894 and continued in 1895 were resumed in the present year by Messrs. Evermann, Meek, and Maddren. The observations were confined chiefly to Alturas Lake, its inlet and outlet, and the upper course of Salmon River, although some examinations were made at Pettit and Big Redfish lakes. The work began July 10 and continued until October 5, the observations after August 15 being made by Mr. F. C. Parks, of Sawtooth, Idaho.

Among the most important facts established by the investigations of 1895 were the following: (1) Both the redfish and the chinook salmon reach these spawning-grounds in excellent condition, showing no mutilations or sores of any kind; the mutilations appear later, and are due to injuries received on the spawning-beds. (2) All of the fish of these two species coming to the headwaters of Salmon River for spawning purposes die immediately after spawning. (3) The young of each of these species remain in the vicinity of the spawning-beds for about one year. (4) The eggs of the redfish laid in September hatch in the following March.

The inquiries carried on in 1896 were, in the main, a repetition of those of 1895, and resulted in a complete verification of the more important points established that year. The season was unfavorable, however, for the study of the chinook salmon and the large redfish; only a few of the former and none of the latter were seen. This is doubtless to be attributed, in part at least, to their wanton destruction in these waters by men and boys. The small redfish were even more numerous than

in 1895. Upward of 2,000 were observed on their spawning-ground in the inlet to Alturas Lake. They were closely watched through the season and it was found that all died at the close of the spawning period. These fish were already in Alturas Lake when the observations began, July 10, and it is not yet certainly known whether they are anadromous or remain permanently in the lake.

TRIBUTARIES OF PUGET SOUND.

In 1889 a large plant of fry of the eastern whitefish (*Coregonus clupeiformis*) was made in Lake Washington, near Seattle, by the United States Fish Commission. In June, 1896, Mr. A. B. Alexander devoted a short time to a series of examinations to determine whether any of these fry have survived. No whitefish were found. Investigations were again taken up in November and December, 1896. Various tests were made with appropriate kinds of apparatus in different parts of the lake, but no evidence was obtained that any of the whitefish remained. The physical features of the lake were carefully studied, soundings were made, a valuable series of temperature observations was recorded, and collections of the fishes, crustaceans, and other inhabitants of the lake were obtained.

Connected with Lake Washington, and distant only a few miles, are Lakes Union and Sammamish. Mr. Alexander conducted similar investigations in these waters, studying the physical conditions and making collections of the fishes and crustaceans.

During July and August, 1896, Messrs. Alexander and Cox carried on studies of the blueback or sockeye salmon (*Oncorhynchus nerka*) in certain streams flowing into Puget Sound from the east. One object of the investigation was to obtain information desired by the International Joint Fishery Commission as to whether any large numbers of blueback salmon entering Puget Sound ascend Washington rivers for the purposes of spawning. The movements of the bluebacks in the region of the San Juan Islands were studied, and the more important rivers were visited and examined, among them being the Skagit, Nooksack, and Stilliguamish. It was ascertained that the blueback enters only the Skagit River in noteworthy numbers, and that important spawning-beds occur in Baker Lake and Baker River, one of the principal tributaries of the Skagit.

TSILTCOOS, WHOAHINK, AND TAHKENITCH LAKES, OREGON.

These are small lakes situated near the coast a few miles south of the mouth of the Siuslaw River. A number of persons living in the vicinity had requested the Commission to stock Tsiltcoos Lake with black bass and Whoahink Lake with brook trout. Dr. Meek, who was engaged in experimental fish-cultural work on the Siuslaw River, was detailed to report on the advisability of complying with the requests. The biological and physical features of the lakes were studied and large collections were made of the native fishes and the various kinds

of fish-food found. It was learned that a considerable number of salmon run into one or more of these lakes; and that all of them, but particularly Whoahink, are well supplied with the native black-spotted trout, which attains a large size and possesses excellent game qualities. The planting of black bass in Tsiltcoos Lake would, in all probability, prove detrimental to the native trout and the salmon, while the eastern brook trout would probably never become so well established as to render these lakes more attractive to anglers than they now are.

UPPER KLAMATH LAKE, OREGON.

In 1889 the Fish Commission planted 400,000 fry of the common whitefish (*Coregonus clupeiformis*) in Upper Klamath Lake. Sufficient time having elapsed to enable the species to become established if the conditions were favorable, investigations were made to determine the result of the plant. Messrs. Meek and Alexander reached the lake October 31, and continued their observations until November 7. The parts of the lake which were most carefully examined were Pelican Bay and vicinity, and the extreme southern end, near Klamath Falls. The lake was found to be comparatively shallow, the greatest depth in the places where soundings were taken being 17 feet, while the usual depth did not exceed 6 or 7 feet. The bottom consists largely of a loose layer of decaying vegetation from the extensive tule marshes adjoining the lake. Fish-food, chiefly small crustaceans and insect larvæ, was found to be very plentiful. Trials were made with seines, gill nets, set lines, and other apparatus, but no whitefish were taken, nor did inquiry among the people on the shores of the lakes elicit any information showing that the fry have survived. The general physical characteristics of the lake hardly warrant the expectation that the common whitefish can be acclimatized.

The lake is, however, well supplied with one of the largest and best species of American trout. It attains a weight of 17 pounds and is easily captured by trolling, and is so abundant as to attract many anglers to the lake each season. The lake is also inhabited by four or five species of suckers, several of which are exceedingly numerous, of large size, and constitute an important part of the food supply of the Indians upon the Klamath Reservation.

CRATER LAKE, OREGON.

In response to the request of citizens of Klamath Falls, Ashland, and Medford, Oreg., and of the Mazamas, an association of mountain climbers with headquarters at Portland, Oreg., the Commission sent Messrs. Evermann and Cox to Crater Lake to determine whether it was advisable to plant trout in the lake, which now contains no fish whatever. Six days in August were devoted to an examination of the physical and biological features of the lake.

This lake is on the crest of the Cascade Mountains, about 100 miles east of Ashland. It is unique in character and ranks among the most

wonderful of the natural attractions of America. It is approximately circular in shape and about 5 miles in diameter. It lies in the top of Mount Mazama, and is completely encircled by a bold escarpment rising from 500 to 2,000 feet almost vertically from the water's edge. So steep are the walls that in only a few places is it possible to descend to the lake. Crater Lake is the deepest American lake, and one of the deepest in the world. The greatest ascertained depth is 2,000 feet, a large part of the bottom being practically a level floor of this depth. With a few limited exceptions there is practically no shore and scarcely any shallow water, the surrounding walls extending vertically beneath the water to a depth of several hundred feet. In Eagle Cove on the south side of the lake, in Cleatwood Cove on the north side, and about Wizard Island are found the only considerable areas of shallow water, the depth ranging from 2 to 100 feet; and, in the absence of streams flowing into the lake, the best conditions required for spawning-beds would probably be furnished at these places.

The water was ascertained to be sufficiently pure and of proper temperature for trout, and to contain a fairly abundant supply of fish-food, consisting chiefly of small crustaceans, insect larvæ, and mollusks. While the conditions do not seem favorable for the existence of an abundant fish life in this lake, it is probable that a limited number of trout would be able to maintain themselves in it, especially the species of black-spotted trout found in Lake Tahoe (*Salmo mykiss henshawi*).

COAST RIVERS OF CALIFORNIA.

In May, 1897, Dr. Charles H. Gilbert, with four assistants from Leland Stanford Junior University, was engaged to make an ichthyological canvass of the coastal streams of California, and at the close of the year the inquiry was still in progress. The object of the investigation was to study the fishes of the different streams with reference to their distribution, abundance, spawning habits and grounds, etc., particular attention being paid to the species of economic value.

FLORIDA.

In October and November, 1896, certain investigations were carried on in the coastal waters of Florida in response to a resolution of the United States Senate, dated February 15, 1895, requiring the Commissioner to make an inquiry as to the extent, methods, and present condition of the coast fisheries of the State, especially the sponge and oyster fisheries. Prof. B. W. Evermann and Dr. W. C. Kendall represented this division in the party sent by the Commissioner to make the necessary examinations. Special inquiries were made at Key West, Biscayne Bay, Tampa, Tarpon Springs, and other places, having for their object a study of the natural history of the various species of commercial sponges with reference to the causes of the decrease in their abundance and the possibilities of artificial propagation; also a deter-

mination of the abundance, size, spawning, food, etc., of the commercial salt-water fishes.

The sponge industry received much attention. It was ascertained that the methods employed are seriously affecting the permanency of the industry and that important modifications in the regulations governing this fishery are much needed. The inquiries led to the view that the lawful minimum size of sponges should be increased, the law forbidding the sale of undersized sponges should be enforced, arrangements should be brought about by which any given ground should be fished over only once in any period of two years, and provision should be made for the protection of those desiring to undertake the artificial propagation of sponges, a new field that gives promise of results of great economic importance.

The number of species of salt-water food-fishes in Florida is perhaps larger than in any other State. The fishes are especially numerous, as regards both individuals and species, among the Florida Keys. The species handled for food at Key West exceed 100, many of which are of much commercial importance. If to these are added those of no direct food value, the total number of fishes inhabiting the Key West region is found to be about 225. The investigations indicate that there has been no noteworthy diminution in the abundance of any of the food-fishes of this part of the State. The present methods followed in fishing are such as will conserve the fisheries to the fullest extent. While much information was obtained regarding the fishes, there is yet a great deal to be learned. The fishermen are, as a rule, poorly informed on the habits and spawning of even the common species, and their opinions can not be relied on. The most satisfactory way to gain a knowledge of the life-histories of these fishes is to station at Key West a trained observer, who will continue his observations during one or two entire seasons.

Large and important collections of fishes were made at the different places visited. These are now being studied, and will, in conjunction with other collections from Florida, serve as the basis for a comprehensive report on the fishes of the State. The general information collected was utilized in a report submitted to the Senate by the Commissioner in January, 1897.

MISSISSIPPI.

At the request of prominent citizens of New Orleans, an examination of certain waters about the mouth of Pearl River, Mississippi, was made in April, 1897, for the purpose of determining if anything could be done to increase the abundance of game and food fishes in that region. The locality is an important resort for New Orleans anglers, who are desirous that additional species of game fishes be introduced if the waters should prove suitable. The examinations, which were conducted by Messrs. B. W. Evermann, H. R. Center, and F. M. Chamberlain, were

carried on chiefly in the vicinity of Baldwin Lodge, located on Campbell Bayou. The water in this locality consists of two mouths of Pearl River and a large number of lagoons, bayous, and lakes. At the time of the visit these waters were almost fresh, being slightly brackish only in the portions nearest the Gulf of Mexico. During the dry season, however, it is likely that brackish water extends several miles above Baldwin Lodge. The lagoons and lakes are shallow, and the water in summer doubtless becomes quite warm. In April the temperature at the surface was found to vary from 68° to 76°, and at the bottom, in 10 feet of water, was 65°.

The large-mouthed black bass (*Micropterus salmoides*) is the principal fresh-water game fish in this region, though the goggle-eye (*Chænobryttus gulosus*) and several other species of sunfishes and catfishes are also abundant. During the dry season various salt-water fishes, such as sheepshead, redfish, drum, etc., appear in large numbers. The fishes which can be introduced into these waters to the best advantage are the crappie and the calico bass. It is very probable that both of these would thrive very well in the lagoons, lakes, and channels farthest from the Gulf.

SOUTHEASTERN TEXAS.

In the latter part of April a few days were spent by Messrs. Evermann and Chamberlain on the Sabine and Neches rivers, in southeastern Texas, for the purpose of determining whether these streams are suitable for stocking with shad. Inquiries were conducted at Orange, Beaumont, Lufkin, and Logansport. Considerable collections of fishes were obtained at these places, and inquiries were made of various people acquainted with the rivers, but no evidence was obtained indicating that the shad planted here several years ago have ever been seen since. The character of these streams does not indicate that they would prove suitable for shad. The water would probably be so muddy during the spawning season as to prove fatal to a large percentage of the eggs and fry.

LOUISIANA.

It having been represented to the Commission that the catch of catfish in the Atchafalaya River, Louisiana, has been rapidly decreasing during the last two or three years, a brief investigation was made during the latter part of April, 1897, to determine the cause of the decrease and the remedy therefor. The inquiries were carried on by Messrs. B. W. Evermann, F. M. Chamberlain, and H. R. Center.

The catfish industry of the Atchafalaya River centers chiefly at Morgan City, and is a very important one, the three firms doing business there shipping more than a million pounds of dressed fish annually.

During ordinary stages of water the fishing is prosecuted chiefly in the regular waterways or channels, and set lines of various lengths are used; but when the country becomes flooded in spring, the fishing is done in the woods. Instead of trot lines, a single short line is used,

one end of which is tied to a limb and the other allowed to hang 12 to 18 inches under water. The hooks are baited with "shad" (*Hiodon*, *Dorosoma*, *Signalosa*, etc.) or crawfish. The fisherman visits his lines twice a day if possible, takes the fish off the hooks and puts them in live-boxes, where he keeps them until the collecting tug from the company to which he sells comes along. The fish are then transferred to the live-cars of the tug and towed to Morgan City. The Morgan City tugs ascend the Atchafalaya River and its connecting lakes and bayous for 75 to 100 miles north of Morgan City. When the fish are brought to Morgan City, they are dressed, barreled in ice, and shipped to various points in Texas, Indian Territory, Kansas, Colorado, and elsewhere west and northwest. The principal species handled are the blue cat (*Ictalurus furcatus*) and the goujon or yellow cat (*Leptops olivaris*). A small percentage of the catch consists of the spotted or channel cat (*Ictalurus punctatus*) and the eel cat (*Ictalurus anguilla*).

The blue cat and the goujon reach a very large size. Formerly individuals of each weighing 75 to 110 pounds were not infrequent, but now one weighing more than 50 pounds is not often seen. The flesh of these fish is of excellent flavor and finds a ready sale wherever its good qualities are known.

The statistical inquiry very soon developed the fact that there has been a very great decrease in the catch during the last few years, and a careful inspection of the fish in the live-boxes of the fishermen and again in the companies' houses at Morgan City suggested the causes for the decrease. Overfishing and fishing during the spawning season are doubtless the principal causes.

A law fixing a minimum size of the fish which it is lawful to sell, and a close season during the height of the spawning period, would doubtless do much toward the rebuilding of the industry.

During the inquiries valuable collections of the different species of catfishes and other fishes of the region were made.

LAKE SUPERIOR.

In April, 1897, Mr. A. J. Woolman was detailed to make some inquiries in Lake Superior during the subsequent spring and summer months, relative to the food of the principal fishes found in the lake, including the common whitefish, the lake herring, other species of whitefishes, the lake trout, the siscowet, the wall-eyed pike, and the sturgeon. Besides enumerating the food-objects of each species, the inquiries were intended to bring out the variations in the character of the food dependent on age, size, season, spawning condition, etc.; the distribution, abundance, and habits of the food-organisms were also topics to be studied. A knowledge of the food of the predaceous species involves a study of the food of the fishes on which they subsist, and the investigation is therefore thrown back on a study of the minute life of the lake, the most important forms probably being the entomostraca.

The consideration of the food of very young fishes received special attention because of its bearing on fish-cultural work. It is important to determine whether the places in which whitefish and other fry are planted are provided with suitable food-organisms; and if not, the inquiries were intended to show the most favorable localities for the liberation of young fish. By the close of the fiscal year the work was progressing satisfactorily and gave evidence of important practical results.

STUDIES OF YOUNG FISH.

During the year some important studies of the movements, habits, food, growth, etc., of young shad and Pacific salmon were begun, and resulted in a considerable addition to existing knowledge. These will be extended so as to embrace most of the fishes cultivated by the Commission.

In association with the work of propagating shad on the steamer *Fish Hawk* in St. Johns River, Florida, in January and February, 1897, Dr. W. C. Kendall was detailed to conduct systematic observations relative to young shad in that stream. Later he accompanied the vessel to Albemarle Sound, North Carolina, and continued his inquiries in that region. On the completion of the shad-hatching there in March, the investigations were transferred to Potomac River, where arrangements were made for an active study of the young fish during the following months, at a number of points on fresh, brackish, and salt water.

In February, 1897, Mr. A. B. Alexander, fishery expert of the *Albatross*, was detailed to make studies of the movements and habits of young quinnat salmon. The Commission had under consideration the advisability of liberating artificially hatched salmon fry at points near salt water, instead of in the upper courses of the streams where they are naturally hatched, in order that they may have a better chance of escaping from their numerous enemies in the rivers and reaching the ocean. The tributaries of Tomales Bay, California, were selected for the experiments and observations. About 700,000 recently hatched fish were transferred to Olema, on a tributary of the bay, and were subsequently distributed in suitable lots to Bear Valley Creek, Paper Mill Creek, Dutch Bill Creek, and Olema Creek. Mr. Alexander began his observations on February 25 and continued till April 1, when he was relieved by Mr. N. B. Scofield, of Leland Stanford Junior University, who was employed until May 20. The inquiries consisted in noting the behavior of the young fish after planting; their movements to and from the salt water; their growth, food, and enemies; the influence of temperature and rains on their movements; and the length of their sojourn in the creeks.

The Tomales Bay region is made up of low lines of hills running north and south, barren on their western slopes, but heavily wooded on their eastern side. The bay itself, which is quite shallow, 2 or 3 miles wide and 30 miles long, occupies the space between two ridges.

Towards its upper end, it gradually grows very shallow and at low tide leaves a large mud flat; at high tide the water backs up in Paper Mill Creek for about 3 miles. Paper Mill Creek and Olema Creek are favorite angling resorts. The two streams are much alike, but the former is larger. Its banks from tide water to the source are heavily wooded, keeping the water cool. The upper half has considerable fall and descends over rocky cascades, but there are no places that fish can not get over. There are many broad and quiet pools and places where the current runs through narrow channels between the rocks; there are also broad riffles where the water runs over gravelly beds. The stream is regarded as an ideal spawning-ground for the steelhead.

None of the creeks tributary to the bay becomes dry in summer; all are quickly swollen by rains, and quickly subside again.

The reports of Messrs. Alexander and Scofield show that up to the time of the discontinuance of the inquiries most of the young salmon planted were still in the streams. The observations showed that some of them at least had run into salt water and that they probably go out at intervals in small schools. The movements of the fish in the streams are regulated primarily by the food supply, which in its turn may be affected by temperature or rains. When the food supply grows short, the young fish instinctively move downstream. In the fresh water they show no tendency to congregate in schools. Their numbers in any given locality are determined by how many the place will accommodate and give each an equal chance to secure its food. They prefer to scatter and shift for themselves. Young salmon in tide water, especially those in brackish water, seem to move in schools.

The inquiries indicated that the salmon are not preyed on by any of the fish in these streams, and that the number caught by snakes and birds must be very small. In the systematic seining done to obtain specimens for comparison, all of the salmon taken were strong and robust, and apparently no place could have been better suited to their development. The few fish taken in salt water were healthy-looking and had been eating young smelt; there are large quantities of young smelt in the bay, which would probably form suitable food for the salmon, and are of a size adapted to their needs.

Before the planting of the young salmon, there were no fish of this species in these streams. This fact, combined with the circumstance that they have done so well, makes it an exceptionally fine opportunity to determine how long such fish will remain in the streams. A person stationed at Olema can easily observe the salmon in the streams named from their source to salt water. To get the best results, observations should be carried on at least a year. By engaging the services of some of the fishermen, and attaching a minnow-seine to the center of their nets, young salmon can be collected in the bay at intervals and many of their habits in salt water learned.

INVESTIGATIONS OF THE ALBATROSS.

COASTS OF CALIFORNIA AND WASHINGTON.

The recent marked development of the fisheries of southern California, more especially those carried on with lines for bottom fish like the rock-cods, made it desirable that the location, extent, and resources of the principal fishing-banks should be determined, and the *Albatross* was assigned to the work. About eight years ago the vessel spent a few months on a preliminary examination of the fishing-grounds off the southern coast of the State, but has done practically nothing of a like nature since that time. The grounds then surveyed were principally off Santa Barbara, Ventura, and San Diego counties. The territory selected for the present inquiry comprised grounds off Los Angeles and Orange counties, particularly the vicinity of Santa Catalina Island. The investigation, which was carried on during part of the month of April, was curtailed by the necessity of preparing the vessel for the inauguration of inquiries in Alaska about June 1. A renewal of this work is contemplated. The examination of the waters consisted of the usual hydrographic work and the setting of various appliances to show the abundance and nature of the animal life. Trials for fish were made with trawl lines, hand lines, deep-water gill nets, beam trawls, seines, and dip nets in combination with electric light.

On the way to San Francisco after the conclusion of the foregoing work the vessel spent a short time in setting deep-sea gill nets and beam trawls off Monterey Bay and in the vicinity of the Farallone Islands, with a view to ascertain the presence of salmon or other anadromous fishes. Similar experimental trials for salmon were made off Cape Flattery and in the Straits of Fuca as the vessel was on the voyage to Alaska.

A detailed account of the foregoing work will be found in Lieut. Commander Moser's report of the operations of the *Albatross*.

SOUTHEASTERN ALASKA.

In the spring of 1897 arrangements were made to have the *Albatross* visit southeastern Alaska for the purpose of conducting fishery investigations. The vessel started north from San Francisco on May 8, arrived in southeast Alaska on June 6, and immediately began inquiries.

The principal subjects determined on for investigation were the salmon industry and the halibut fishery. The magnitude of the salmon fishery in Alaska and the absence of accurate information concerning the various streams made it very desirable that the Commission should begin a systematic survey of the waters frequented by the salmon. This fishery is prosecuted along 3,000 miles of the Alaska coast. Inasmuch as the regulation of the fisheries of the Territory is vested in the general government, an important object of the investigation is to ascertain the conditions prevailing in the different sections, in order that suitable protective laws may be provided, since no general law will meet all the conditions or be applicable to all regions.

It is thought that two or three years will be required to complete this work, which was in active progress at the close of the year. The inquiries will extend to each stream in or near which fishing is done or in which salmon are found, and will relate to the physical characters of the stream; the species of salmon entering it, the time and duration of their run, their relative abundance; the spawning time, habits, and grounds of each species; natural and artificial obstructions to the passage of fish upstream; the methods of fishing in their relation to the maintenance of the supply; the general fish-fauna in each stream and its relations to salmon, and the extent of the fishing, canning, and salting business.

INQUIRIES AND EXPERIMENTS RELATIVE TO OYSTERS.

Among the questions of vital interest to oyster-growers in the United States are the following: (1) Under the prevailing economic conditions, is it possible to profitably fatten oysters in artificial ponds or claires? (2) Is it commercially practicable to breed oysters in ponds so as to furnish a supply of seed in regions where it can not be raised with regularity by the ordinary means now employed? These subjects the Commission had under consideration during the fiscal year, but it was not possible to take up both, owing to the limited force available for such inquiries. The question of the feasibility of breeding oysters in inclosed or semi-inclosed ponds was deferred for the present, and the matter of fattening oysters was taken up because of its more widespread and immediate importance.

Observation and inquiry have shown that in a number of localities planters have encountered yearly increasing difficulty in bringing their oysters to such a condition as to yield the best financial returns. This difficulty is especially manifested in regions in which there has been a heavy increase in the area of the planted beds, and is apparently due to the inadequacy of the water to support the luxuriant micro-vegetation which is necessary to supply oysters with food. The problem for the oyster-grower, therefore, is to increase the oyster-food-producing powers of the water. It is evident that this can not be undertaken to advantage in the open waters of bays and bayous in which the oysters are grown, and the question resolves itself into the feasibility of some method of pond culture. Recognizing this, experiments were begun in May, 1897, in Lynnhaven River, Virginia, under the charge of Dr. H. F. Moore. A cove having an area of over an acre was inclosed by a substantial dam, so as to exclude the tides, and three small ponds were constructed for the conduct of check experiments. Tests are being made, by varying the temperature, density, and the chemical composition of the water, to determine the most favorable conditions for the development of the microscopic organisms upon which the oysters feed. At the close of the fiscal year the actual experiments had been in operation but a short time and the results can not yet be stated.

During the year a paper entitled "Oysters and methods of oyster-culture" was prepared by Dr. Moore. It aims to bring together, for the information of oyster-growers, the more important facts relating to the life-history of the oyster, and to furnish to those lacking experience the information necessary to enable them to carry on successful oyster-culture.

There have been the usual complaints of the destruction of oysters in Long Island Sound by starfish, but this enemy is now less feared and more successfully combated than in former years. The tangle seems to be the most effective appliance used in its capture.

In April Mr. Fred Mather sent to this office specimens of a small crustacean which is said to feed upon the starfish. It is an isopod of the family *Cirolanidæ*, hitherto undescribed, and is the subject of a paper to be hereafter published.

In Long Island Sound, in various parts of New Jersey, and in some other localities there has been more or less trouble with "green gills." Late in the month of June a few affected oysters were observed in Lynnhaven River, and during the summer all of the beds were more or less affected. It is notable that oysters placed in the experimental claire were wholly untinged by the green coloration. After all that has been written on this subject it should be unnecessary to point out the vegetable origin and harmlessness of the "green gills," but there is still much reluctance on the part of consumers to purchase green oysters, great loss being thereby entailed upon the growers.

During May, 1897, it was reported in the press that the oyster set in the vicinity of New Haven was dying of a mysterious malady, but no complaints were received at this office. It is probable that this trouble was local and not serious, as the seed-growers in other parts of Long Island Sound appear to have had a very successful season.

The oyster season of 1896–97 is generally reported to have been unsatisfactory to the dredgers of Chesapeake Bay, owing in part to the depletion of the natural beds, and also, it is stated, on account of the competition of planted oysters, which each year are occupying a more important place in the markets. The conflict between the natural-bed and the planting interests of Delaware Bay has resulted in legal and legislative warfare in New Jersey, a contest which has been waged with more or less energy for several years. The net results of such disputes elsewhere has generally been to liberalize the laws relating to planting, in consequence of which that branch of the industry is exciting much interest. An evidence of this is seen in the increased sales of seed oysters in Connecticut during the spring of 1897 and in the purchase of seed in the Chesapeake region by the oystermen of New Jersey and Delaware.

During the spring of 1897 arrangements were made to have Prof. F. L. Washburn, of the University of Oregon, make a study of the bays of the west coast to determine those possessing conditions favorable to the introduction of the eastern oyster. At the end of the fiscal year

this investigation was in progress. In November, 1896, 25 barrels of eastern oysters were planted in Humboldt Bay, California, and an equal quantity in Yaquina Bay, Oregon. Both lots were planted under the immediate supervision of Mr. C. H. Townsend. Specimens of those planted at Yaquina Bay were received at this office during the summer and exhibit an encouraging growth, and those at Humboldt Bay are also reported to be doing well. It is still too soon to say whether self-perpetuating beds can be established at these places. No spat has yet been found in either place, but Professor Washburn reports copious spawning during the past summer.

INVESTIGATION OF CONTIGUOUS WATERS OF UNITED STATES AND CANADA.

Under the provisions of an agreement, dated December 6, 1892, between the Governments of Great Britain and the United States, having for its object the investigation of the fisheries in the waters adjacent to the American-Canadian boundary, Mr. Richard Rathbun, of the United States Fish Commission, and Dr. William Wakeham, of the Canadian Department of Marine and Fisheries, conducted extensive inquiries during the years 1893, 1894, 1895, and 1896, with the aid of assistants from the respective departments. On December 31, 1896, the commissioners submitted their report, which was transmitted by the President to Congress on February 24, 1897, and printed as House Document No. 315, Fifty-fourth Congress, second session.

The report deals fully with the conditions prevailing in each of the international waters involved in the agreement; considers the physical and ichthyological features; discusses the relations of the fisheries, of obstructions, and of pollutions to the fish supply; and makes numerous recommendations concerning the preservation of the fisheries. The mackerel fishery, to which much attention was given by the commissioners during the past four seasons, was not considered in the report.

In view of the magnitude of the fisheries covered by the investigations, and of the importance to the fishing interests of the conclusions reached by the commissioners, their general recommendations, as well as those for the different waters, are here given in full:

On account of the diversified characteristics of the waters investigated, the variety of their products, and the magnitude of the industries to which the latter give rise, we have found it impossible to consider fully all of the questions which the subject presents, and have therefore been unable in many cases to reach more than general conclusions, leaving the matter of details to be settled by further and more complete inquiries. Our observations, moreover, have clearly demonstrated the inexpediency of attempting to regulate any of the fisheries herein discussed by a rigid code of enactments, owing to their constantly changing character and conditions, and we would therefore urge, in the event of joint action by the two Governments, that a permanent joint commission, to be composed of competent experts, be provided for, which shall be charged with the direct supervision of these fisheries, and shall be empowered to conduct the necessary investigations and to institute such modifications in the regulations as the circumstances may call for from time to time.

That a uniform system of regulations common to the entire extent of each body of water along the boundary line is required to insure the protection of its resources, is fully shown by the conditions which we have found to exist in nearly all of them, whether bordered on the side of the United States by a single State or by several States. The failure to secure adequate results in that direction has naturally been due to the diversity of legislation, but it has resulted in large part from the general lack of accurate information regarding the habits of the several fishes to serve as a basis for intelligent action. While we have been able to establish some important facts respecting the natural history of the commoner market species, much more remains to be accomplished in that regard, and the subject should be given due prominence in the future.

All questions, outside of navigation, with which we have had to deal have been considered solely from the standpoint of the preservation of the several fisheries, and we have endeavored in each instance to provide for the most liberal amount of fishing which, in our judgment, is warranted by the circumstances. In so doing we have been led to suggest greater license in some regions than is granted by existing laws, but wherever a State on the one side or the Dominion Government on the other would impose greater strictures than are here recommended we see no objection thereto.

We are convinced that no system of regulations can be properly administered except by the registration or licensing of the fishermen, as a basis for restricting the character and amount of apparatus employed in each locality, while, on the other hand, we feel confident that the fishermen themselves would be greatly benefited by such a measure, through the protection of individual rights thereby assured them.

Much of the irritation occasioned from time to time, especially in the region of the Great Lakes, through the fishermen of one country extending their operations into the territory of the other, has undoubtedly resulted from the imperfect knowledge which prevails respecting the relations of the intervening water areas. In fact, the belief is widespread that wherever the lakes exceed 6 miles in width each country has jurisdiction only to a distance of 3 miles from its shores, leaving a neutral area or high sea between, to which the fishermen from both sides are privileged to resort in common.

On the official maps of the Great Lakes the boundary line is not shown, nor can its position be accurately marked in most places until new surveys shall be made conjointly by the two Governments. It would be greatly to the advantage of the fishing interests in that region, and much annoyance would be prevented in the future by having the boundary line redefined and appropriately located on a series of charts made available for distribution among the fishermen.

ST. JOHN RIVER SYSTEM.

In order to restore and protect the fishery resources of international interest in the St. John River system, the following measures seem to be demanded:

(1) That all dams throughout the system be provided with suitable fishways, except those used exclusively for log driving and containing gates, and that the latter shall be kept open at all times when the driving of logs is not actually in progress, and just previous thereto for the collecting of water.

(2) That the construction of all new dams be subject to governmental authority and conform to such requirements in each case as the circumstances may warrant.

(3) That the practice of throwing sawmill waste of any kind into the water be everywhere prohibited; and that all existing accumulations of such waste in streams where it may be detrimental to the movements or spawning requirements of useful fishes be removed. As the sawmills situated in the city of St. John have been able for many years to dispose of their rubbish without recourse to the adjacent river, it is not considered that this provision would work undue hardship in other places.

(4) That it be prohibited to throw or to allow to pass into the water any garbage, lime, waste from gas works, or other deleterious substances from manufacturing or other establishments.

(5) That commercial fishing be limited to tidal waters, and be so restricted therein as to insure an ample run of salmon and other anadromous fishes to their respective spawning-grounds.

(6) That uniform regulations be adopted for the protection of the salmon, trout, and other useful fishes throughout the fresh waters of the system.

(7) In case the measures above suggested are carried out, it is recommended that joint action be taken to increase the supply of salmon by artificial propagation.

(8) It is recommended that all natural obstructions which impede the passage of salmon to important waters adapted to their spawning, such as the fall near the mouth of the Aroostook River, be examined with reference to improving the conditions for the distribution of that species.

ST. CROIX RIVER SYSTEM.

(1) That the disposal, through the medium of the water, of all kinds of sawmill refuse be prohibited throughout the entire river system. Sawdust is the only kind of such refuse now understood to be disposed of in this manner, and its retention on land can undoubtedly be provided for at comparatively slight expense, as has been done in other places.

(2) That all extraneous material encumbering the channel of the river in tidal water between the Calais-St. Stephen Bridge and The Ledge, and resulting from the deposition of sawmill refuse, be removed. This measure is requested in the interest especially of navigation, but there is no doubt that the fisheries would also be benefited thereby. We do not consider, however, that such a step would be justifiable while the practice of allowing said refuse to escape into the river still continues. It would also be of great advantage to the fisheries if the beds of sawmill refuse occurring between Union Dam and Fourth Dam, above tidal waters, could be removed to the extent of providing at least a wider and more direct channel for the passage of salmon.

(3) That the sewage from the St. Croix Cotton Mill be disposed of in such manner as to prevent any harmful influence upon the salmon in that vicinity during their ascent of the river.

(4) That the tanneries be prohibited from using the streams adjacent to them for the disposal of tan bark, tan liquor, fleshings, hair, or other refuse which may be deleterious to fishes. All liquids from the washings of the hides containing any harmful ingredients should be purified before being allowed to enter the stream.

(5) That all fishways and passageways through the several dams be placed in good repair and be modified where necessary to insure their greater efficiency, and that subsequently they be maintained in proper condition and their approaches kept clear of drift materials. The construction of all new dams should be subject to Government authority, and should conform to such requirements in each case as the circumstance may warrant.

(6) That in the case of all log-driving dams provision be made to keep one or more of the gates open at all times when their use is not actually required in connection with the driving of logs.

(7) That in those streams to which the salmon resort for spawning purposes all sources of pollution be restrained and all obstructions and existing impurities be removed as far as possible.

(8) That net fishing be prohibited throughout the fresh waters of the system.

(9) That the capture of salmon in the neighborhood of their spawning-grounds and in the approaches to fishways, or by any means except hook and line, be prohibited.

(10) That appropriate and uniform regulations be established with respect to all classes of fishing in the fresh waters of the system, the same having reference to methods and extent of fishing, close seasons, etc.

(11) That in the event of the removal of all obstructions and polluting agencies and the establishment and enforcement of suitable regulations, the increase of the supply of both salmon and landlocked salmon by artificial means be attempted through the cooperation of the two governments.

PASSAMAQUODDY BAY AND VICINITY.

International fishery interests in Passamaquoddy Bay and its neighborhood are concerned chiefly with the preservation of the herring, and as no decrease of that species has been proved, beyond the disappearance of the winter school, which can not be attributed to overfishing, it is not considered necessary to suggest any changes in the methods employed, and the only recommendations made are as follows:

(1) As the present regulation providing for a close season on the principal spawning-grounds off Grand Manan has undoubtedly been a wise one, and may have, to some extent, aided in maintaining the supply of herring, it is recommended that it be continued and that a similar close season be adopted for a part of the herring spawning-grounds off Machias.

(2) It is recommended that a regulation be adopted prohibiting the use of herring for the manufacture of oil or fertilizer.

(3) It is recommended that the minimum size of lobster which may be taken be fixed at 10½ inches, and that all lobsters caught, by whatsoever means, under that size be returned alive to the water.

(4) It should be made unlawful to take berried lobsters at any time.

(5) With a view of protecting the smelt, a close season, extending from March 15 to July 1, is recommended, during which close season it should be unlawful to take smelt in any manner except with hook and line.

LAKE MEMPHREMAGOG.

The interests of this lake can undoubtedly best be served by fostering the game fishes, and, in our opinion, this should be done to the extent of prohibiting all net fishing. The lake has become an angling resort of much importance, and as long as its attractions in that respect are properly maintained, the local welfare will be benefited more materially through the influx of visitors than by the continuance of a commercial fishery dependent on so small a basis of supply as that furnished by these waters.

The use of spears, which are employed on the spawning-grounds, is also to be regarded as detrimental and should be stopped.

It is further recommended that the black bass and lake trout be protected by close seasons, extending from November 1 to June 15 in the case of the former species, and from September 1 to January 1 in the case of the latter.

LAKE CHAMPLAIN.

(1) That no net fishing other than by seines be permitted in waters adjacent to the boundary line or elsewhere in the lake where international interests would be affected thereby.

(2) That the use of seines be permitted from February 1 to March 31, inclusive, for the capture of wall-eyed pike and other associated species, but under such limitations as to localities and number of nets employed as shall amply provide against the decrease of the species named. Should further inquiry establish the fact that this fishery is proving harmful to the wall-eyed pike by materially reducing the supply, its abolishment is recommended.

(3) That the use of seines be permitted during the month of October for the capture of whitefish and other associated species under suitable restrictions as to localities and number of nets employed.

(4) That the length of any seine shall not exceed 40 rods; and that the mesh of the seines shall not measure less than 2½ inches in the bunt and 3 inches in the wings.

(5) That the capture of black bass be entirely prohibited from November 1 of each year to June 15 following; that angling methods only be allowed for this species and the catch by each angler be limited to 15 fish daily; and that all bass taken in nets, and all bass measuring less than 10 inches long taken by anglers be immediately returned alive to the water.

(6) That the capture of wall-eyed pike by any means be prohibited from April 1 to May 31, inclusive, of each year.

(7) That joint regulations be also adopted with respect to any game or other fishes not specifically mentioned which may require protection.

RIVER ST. LAWRENCE BETWEEN THE STATE OF NEW YORK AND THE PROVINCE OF ONTARIO.

As an arrangement approved of by the sporting community has already been entered into for the greater part of the waters under discussion between Canada and the State of New York and the necessary legislation provided for, we consider it unnecessary to suggest any other regulations than those already agreed to. We are, however, of the opinion that a small amount of commercial fishing, made with fyke nets, fished during the winter months in creeks or marshy places for such species as bullheads, perch, suckers, sunfish, etc., could do no harm. If such nets were allowed they should not be set before November 1, and they should be removed from the water by March 31. Fished during such a season, in suitable localities, there could be no risk of their taking bass, wall-eyed pike, or maskinongé. A set-line fishery might also be allowed for such fish as sturgeon, eels, ling, and channel cat, as the removal of some of these fishes would certainly be of benefit to sporting interests.

Under the arrangement made between Canada and the State of New York it was enacted:

(1) That no commercial fishing be permitted in the waters of the St. Lawrence between a line drawn from Cape Vincent, in the State of New York, to the city of Kingston, in the Province of Ontario, and a second line from the town of Prescott, in Ontario, to the city of Ogdensburg, in New York.

(2) That within the waters above included the close season for bass, maskinongé, wall-eyed pike, and grass pike be from the 1st day of January to the 9th day of June, inclusive, in each year.

(3) That the limit of the number of bass to be taken by each rod per diem be fixed at twelve, and that the number of rods to each boat be limited to two.

(4) That all undersized and immature fish be returned alive to the water, and that no bass under 10 inches in length be taken.

While we do not consider that the close season as enacted above by any means fully covers the spawning season of the bass, which in the region of the Thousand Islands extends from the 15th of May to the 1st of July, at least, yet when taken in conjunction with a size limit, a limit to the number taken by each rod per diem, and a further limit of the number of rods per boat, it may be allowed that the protection is ample for the present.

We would recommend a continuance of the above arrangement and would further suggest that it be extended so as to include the rest of the St. Lawrence from the lower limit above mentioned, between the cities of Ogdensburg and Prescott, to the point where the river ceases to be the boundary between the two countries, at the crossing of the line of 45° north latitude.

LAKE ONTARIO.

In view of the extent to which the supply of both whitefish and lake trout has become exhausted in Lake Ontario, any regulations looking to the protection and increase of those species, in order to be effective, should be decidedly stringent.

With respect to the fisheries for them and for the other important fishes of the lake we recommend as follows:

(1) That a close season be adopted for both the whitefish and lake trout from the 15th day of October to the 31st day of December, between which dates they shall not be fished for or taken in any manner.

(2) That in the Bay of Quinte the close season for whitefish extend from the 1st day of October to the 31st day of December, and that the use of herring gill nets in that bay be prohibited during November.

(3) That the minimum size of mesh in the gill nets fished for whitefish and trout be fixed at 5 inches, in the herring gill nets at 2¾ inches, and in the sturgeon gill nets at 11 inches.

(4) That the quantity of gill nets used in connection with each fishery be restricted within proper limitations.

(5) That the use of baited set lines for sturgeon be permitted, but that the capture of that species by means of naked hooks or grapplings be prohibited.

(6) That all sturgeon measuring less than 4 feet long, taken by any means, be returned alive to the water.

(7) That a close season be adopted for the black bass from May 1 to June 15; that all black bass measuring less than 10 inches long, by whatever means taken, be returned alive to the water; that the number of bass taken by each rod per diem be limited to 20, and that the number of rods to each boat be limited to 2.

(8) That it be permitted to fish fyke nets and trap nets in the inshore waters of the lake for the capture of the coarser fishes between the 1st of October and the 30th of April, within proper limitations as to number and under such restrictions as shall prevent their being set on the spawning-grounds of whitefish, trout, or herring, or in such manner as to interfere with the spawning movements of those species.

(9) That the mesh in the bag of all trap nets and fyke nets measure not less than 2½ inches in extension when in use.

(10) That the use of seines on or about the spawning-grounds of any of the important fishes during their spawning season be prohibited.

(11) That the joint efforts to increase the supply of whitefish and lake trout by artificial means be continued, and that the scope of that work be increased to the fullest extent possible. It is recommended that the planting of the fry be not restricted to one part of the lake, but be extended to as many of the important spawning areas as possible.

(12) That the throwing into the water of fish offal, including dead fish taken from the nets, of city garbage, and of all other substances deleterious to fish life be prohibited. That steps be taken to prevent injury by the waste from sawmills, gas works, oil refineries, etc., especially in tributary streams containing spawning-grounds of important fishes.

LAKE ERIE.

Pound nets.—It is imperative that the extent of the pound-net fishery, especially in the western part of the lake, be very materially reduced, and that the positions and distances apart of these nets be so regulated as to make ample provision for the free circulation of the several important fishes. Although further observations will be necessary before the limitations of so comprehensive a measure can be properly adjusted or its details perfected, we venture to offer the following suggestions respecting it:

That the total number of pound nets in the lake be limited to 1,000. The reduction in the number is intended to apply mainly to the United States waters from Vermilion westward.

That the number of such nets set in a string be restricted to 6 on the United States shore and to 3 on the Canadian shore.

That the length of the pound-net leaders be restricted to 50 rods.

That in all strings the individual pound nets be separated by gaps between each crib and the next succeeding leader, which gaps shall be at least 50 feet wide and shall extend to the bottom.

That all pound nets or pound-net strings be separated laterally by interspaces of at least 1 mile.

That no pound nets or strings of pound nets be allowed to begin in a less depth than 10 feet or to extend out into a greater depth than 40 feet.

That in the vicinity of the islands at the western end of the lake the length of pound-net strings be further regulated in accordance with local conditions, but in no case should these nets obstruct more than one-third the width of any channel or passageway.

That the use of pound nets be prohibited on any reef or ground on which whitefish or herring are known to spawn, or within a reasonable distance therefrom.

That the use of pound nets be prohibited in any locality where young whitefish may be taken in undue quantity.

That the mesh in all pound nets measure in extension at least 2½ inches in the crib, after shrinkage.

That all pound-net stakes be removed from the water within thirty days from the close of the fall fishing season.

Gill nets.—The mesh in the gill nets used for the capture of herring, wall-eyed pike, blue pike, and saugers should measure at least 3⅛ inches in extension, and the employment of any gill net having a smaller mesh should be prohibited.

A very large reduction is called for in the extent of fishing with the small-meshed gill nets, especially for the herring and wall-eyed pike. In case this can not satisfactorily be accomplished by reducing the amount of netting employed, practically the same result may be reached by instituting a close season, which should preferably occur at the time of year when the greater waste of fish takes place.

We recommend that the use of the small-meshed gill nets be entirely prohibited west of a line connecting Point Pelée with Vermilion Light between July 1 and January 1.

In any locality where the small-meshed gill nets are liable to take an undue quantity of undersized whitefish their use should be prohibited, at least during the period when such undersized fish are there present.

The mesh in the gill nets used for the capture of whitefish should measure at least 4½ inches in extension, and it is considered that a 5-inch mesh would be preferable.

The quantity of whitefish gill netting now employed appears to be excessive, in view of the continued depletion of the whitefish, and it should be restricted unless the protection of the species can be better provided for by a close season.

The mesh in the gill nets used for the capture of sturgeon should measure at least 11 inches in extension.

It seems to us that the gill-net fishery for sturgeon at the eastern end of the lake is being conducted on too large a scale, and that a reduction should be made in the number of nets employed; but a special investigation will be required to determine the proper means of regulating this fishery. The hook-and-line fishery for the sturgeon also needs to be taken into consideration in the same connection.

The use of any gill net within one-fourth of a mile of any fixed net, such as a pound net or trap net, should be prohibited.

Fyke nets and trap nets.—The mesh of these nets should conform to the same regulations provided for the pound nets. Their number should be restricted in accordance with the capacity or requirements of each region in which they are fished. A great reduction in the number of the fyke nets is demanded in several places.

Seines.—The dimensions of seines and the size of mesh therein should conform in each instance to the conditions under which they are employed. The mesh should in all cases be sufficiently large to permit the escape of undersized fish, and the number of seines, as well as the manner of their use, should be properly restricted in all places.

It should be prohibited to fish seines on or about the spawning-grounds of the black bass, the pike-perches, or other important fishes during their spawning season or while the eggs and young fish continue to remain upon the grounds, and in all other places where the employment of this method would be unduly harmful.

Naked hooks for sturgeon.—It is recommended that the method of taking sturgeon by means of naked hooks or grapnels be prohibited.

Spears.—The use of spears for taking fish of any kind should be prohibited.

Whitefish.—This species is the one most urgently demanding protection, as well as efforts to rehabilitate the supply. A large reduction in the amount of apparatus used for its capture, accompanied by extensive fish-cultural operations, may be expected to aid materially in replenishing the stock; but we venture to suggest that, in our opinion, even greater benefits might be gained by the discontinuance of all fishing for the species during all or a part of its spawning season, as elsewhere explained.

Sturgeon.—All sturgeon measuring less than 4 feet long, taken by any means, should be returned alive to the water.

Black bass.—All fishing for black bass, including its capture by any means, should be prohibited from at least May 1 to June 15; and all bass which may be taken in the nets during that period should be returned alive to the water. No black bass measuring less than 10 inches, taken by any method, should be retained or sold.

Pollutions.—The throwing into the water of fish offal, including dead fish taken from the nets, of city garbage, and of all other substances deleterious to fish life should be prohibited. Steps should also be taken to prevent injury by the waste from gas works, oil wells, oil refineries, etc., especially in tributary streams containing spawning-grounds of important fishes. It is recommended that in connection with all harbor improvements and other work of that character due precautions be taken in disposing of the materials obtained by dredging, etc., to prevent injury to any fishing-grounds.

Propagation.—A continuance of the joint efforts to increase the supply of whitefish by means of artificial propagation is strongly recommended, and it is urged that the scope of this work be increased to the fullest extent possible.

DETROIT RIVER, LAKE AND RIVER ST. CLAIR.

(1) That the use of all nets, excepting seines employed in obtaining whitefish for the hatcheries and seines with not less than 4-inch mesh for catching sturgeon, be prohibited in the waters of the Detroit and St. Clair rivers.

(2) That all fishing with seines, traps, or other forms of nets be prohibited in Lake St. Clair north of a line drawn from the mouth of the Clinton River in Michigan to the mouth of the Thames River in Ontario.

(3) That the minimum size of mesh in the cribs of pound nets, trap nets, and fyke nets be not less than 2¼ inches in extension.

(4) That no nets whatever be permitted to be used between the 31st day of October and the 1st day of December, excepting for the purposes of the hatcheries.

(5) That a close season be adopted for the black bass from May 1 to June 15; that all black bass measuring less than 10 inches long, by whatever means taken, be returned alive to the water; that the number of bass taken by each rod per diem be limited to 20, and that the number of rods to each boat be limited to 2.

(6) That all sturgeon less than 4 feet long be returned alive to the water.

(7) That all fishing with grapnels or naked hooks be prohibited, but that all other hook-and-line fisheries be permitted, except for black bass between May 1 and June 15.

(8) That the throwing into the water of fish offal, including dead fish taken from the nets, of city garbage, and of all other substances deleterious to fish life be prohibited. That steps be taken to prevent injury by the waste from sawmills, gas works, oil refineries, etc.

LAKE HURON.

Pound nets.—A reduction in the number of pound nets in some places, especially in the northern part of the lake, and probably also in Saginaw Bay, is called for.

The recommendations made under pound nets in Lake Erie with respect to the length of leaders, the separation of individual nets in the string by gaps, and their distance apart are considered to be applicable also to Lake Huron. It is recommended that in Saginaw Bay not more than 6 pound nets be allowed in a string, and elsewhere in the lake not more than 3.

North of a line drawn from North Point, Michigan, to Clark Point, Ontario, the mesh in the cribs of all pound nets should measure not less than 4 inches in extension after shrinkage, and south of said line not less than 2½ inches. This would provide for the use of only a large mesh in that part of the lake where the whitefish is the most important species and where the young are being captured in undue quantities, and would permit the taking of herring and other small species in those localities where they are now mainly fished for. In the latter case the proposed mesh is also larger than the one now employed, and would perhaps serve to liberate a certain proportion of the undersized wall-eyed pike, which are at present a conspicuous feature of the catch.

The use of pound nets during November should be prohibited north of the line above defined, in order to provide a close season for whitefish.

All pound-net stakes should be removed from the water within thirty days after the close of the fishing season.

Gill nets.—The mesh in all gill nets should measure at least 5 inches in extension, except that nets of 2¾-inch mesh might be allowed to be fished on the Canadian shore between Sable River and Cape Hurd, from October 15 to November 1, for the capture of herring, which, at that season, do not appear to be associated with young whitefish in that locality.

During November it would be expedient to prohibit fishing by any gill net having a smaller mesh than 6 inches, which would serve in large measure to protect the spawning whitefish. The use of any gill net within one-fourth mile of any fixed net should be prohibited. The mesh in gill nets used for the capture of sturgeon should measure at least 11 inches in extension.

Fyke nets.—The mesh in the bag of fyke nets should measure at least 2½ inches in extension. The number of these nets should be restricted in accordance with the capacity or requirements of each region in which they are employed.

Seines.—The dimensions of seines and the size of mesh therein should conform in each instance to the conditions under which they are employed. The mesh should in all cases be sufficiently large to permit the escape of undersized fish, and the number of seines, as well as the manner of their use, should be properly restricted in all places. It should be prohibited to fish seines on or about the spawning-grounds of any of the important fishes, or in any place where their employment would be unduly harmful.

Naked hooks for sturgeon.—The method of taking sturgeon by means of naked hooks or grapnels should be prohibited.

Spears.—The use of spears for taking fish of any kind should be prohibited.

Sturgeon.—All sturgeon measuring less than 4 feet long, by whatever means taken, should be returned alive to the water.

Pollutions.—The throwing into the water of fish offal (including dead fish taken from the nets), of city garbage, and of all other substances deleterious to fish life should be prohibited. Steps should also be taken to prevent injury by the waste from sawmills and from manufacturing establishments of all kinds, both along the shores and in all tributaries containing spawning-grounds of important fishes. It is recommended that in connection with all harbor improvements and other work of that character, due precaution be taken in disposing of the material obtained by dredging, etc., to prevent injury to any fishing-grounds.

Propagation.—A continuance of the joint efforts to increase the supply of whitefish and lake trout through the agency of artificial propagation is recommended.

LAKE SUPERIOR.

The remedial measures suggested for Lake Superior are as follows:

(1) In all localities where there is evidence of overfishing by the pound nets the number of the latter should be suitably restricted. These nets should be separated by an interval of at least 1 mile, and they should not be allowed to extend more than one-third the distance across any channel or passageway.

(2) Where young whitefish abound and may be captured by the pound nets in appreciable quantities, the use of such nets should be prohibited either entirely or during such periods as the young of that species may be so present.

(3) The mesh in the cribs of all pound nets should measure at least 4 inches in extension when in use.

(4) It would seem that the extent of gill-net fishing for whitefish and trout had reached, if not passed, a safe limitation, and that some restriction should be placed upon the quantity of gill nets to be fished hereafter. Further observations, however, are required to establish a satisfactory basis for action in this matter.

(5) The mesh in gill nets employed for the capture of the common whitefish and the lake trout should measure not less than 4½ inches, and we consider that a 5-inch mesh would be preferable.

(6) The herring gill nets and those used for the smaller varieties of whitefish require a smaller mesh than the above, but the conditions under which such nets may be employed should be explicitly defined.

(7) No restrictions appear to be called for at present in respect to the herring gill nets, except that their use should be prohibited wherever young whitefish would be taken in them.

(8) The number of seines employed at present is relatively small, and it should not be allowed to increase beyond a safe limitation.

(9) The mesh in whitefish seines should measure not less than 3½ inches in the bunt and 4½ inches in the wings.

(10) The use of all kinds of seines should be prohibited wherever the capture of young whitefish is involved, either entirely or during the seasons when the young are present.

(11) It is considered that it would be beneficial to institute a close season covering the spawning period of the whitefish, during which no fishing for the species should be permitted.

(12) All sturgeon measuring less than 4 feet long which may be taken by any means should be returned alive to the water.

(13) It may be found advisable to establish local regulations for the protection of the wall-eyed pike in places where they occur, but no information that would be serviceable in that respect has been collected.

(14) The throwing into the water of fish offal and of all other deleterious substances in places where it would be harmful to fish life should be prohibited.

(15) Joint efforts for the increase of the supply of both the whitefish and the lake trout by means of artificial propagation are recommended.

LAKE OF THE WOODS, RAINY LAKE, AND RAINY RIVER.

International interests on Lake of the Woods are concerned chiefly with the preservation of the sturgeon. Although the pound-net catch of scale fish is comparatively large and important, especially at certain seasons, should the capture of sturgeon become unprofitable at any time, that method of fishing would probably be mostly, if not entirely abandoned, and little else be done thereafter in waters closely adjacent to the boundary line. As both the scale fish and sturgeon, however, are taken together and under the same conditions, their preservation should and can be arranged for on a common basis.

The most effectual measure of relief, and one which we strongly urge be carried out, is a restriction on the extent of fishing, which undoubtedly already far exceeds a safe limitation. It is impossible to determine positively the maximum number of pound nets which could be fished without danger of depleting the supply, as the latter is an uncertain and fluctuating quantity, and the matter will therefore have to be settled arbitrarily; but we are convinced that within the small area to which this kind of fishing is confined the total number of pound nets in use should not exceed 150, to be divided between the two countries in proportion to the extent of shore line belonging to each. Even this number we regard as too large to insure the ultimate preservation of the sturgeon, but we have been constrained not to reduce it still further in view of the fact that the industry has already been firmly established on so large a basis.

Besides the limitation upon the number of pound nets to be employed, we would recommend that not over two such nets be allowed in any one string; that the leaders to the same be not over 50 rods long, each; that the inner end of any pound net or pound-net string be set in not less than 10 feet of water, and that the outer end of the same extend not over 1 mile from the shore; and that no pounds be fished within 1 mile of the mouth of any stream which the sturgeon are known to enter. The object of such provisions is to insure as much freedom of movement for the sturgeon as possible, both during and subsequent to the spawning run.

We also consider it advisable that no gill-net or trawl-line fishing be permitted in the pound-net region, or south of a line extending due east from American Point at the mouth of Northwest Angle Inlet to the Peninsula, except the use of gill nets by the Indians for supplying their own needs.

While a close time covering the spawning season of the sturgeon could not fail to be beneficial, in order to be effective it would require to begin at such a date and to be continued for so long a time as practically to interfere with the entire spring and early summer fishery, the most profitable of the year. A close season is, however, suggested for the wall-eyed pike and whitefish, by restricting the pound-net season to the period beginning May 15 and terminating October 31, which is essentially in accordance with the present custom.

Protection should be afforded the young sturgeon by requiring the return to the water alive, of all individuals taken in the nets which measure less than 4 feet long. At present they are retained when as small as about 3½ feet, the ordinary maximum size being 5½ to 6 feet. No caviare is said to be obtained from sturgeon under 4 feet long, and none of those containing caviare landed during our visit were less than 4½ feet.

The capture of small whitefish, wall-eyed pike, lake trout, etc., should be restricted by regulating the size of mesh, which should measure not less than 4½ inches in pound nets and 5 inches in gill nets.

No fish offal, garbage, sawmill waste, or other polluting agencies should be thrown or allowed to pass into the waters of the lake.

Fishing for sturgeon in Rainy River, except for domestic use, should be prohibited. Further inquiries require to be made in Rainy Lake and the more eastern waters of the system before deciding upon the measures necessary to protect their fishery resources.

WATERS CONTIGUOUS TO THE BOUNDARY LINE BETWEEN BRITISH COLUMBIA AND THE STATE OF WASHINGTON.

(1) The following recommendations are intended to apply only to those waters adjacent to the boundary line between British Columbia and the State of Washington which are traversed by the main body of the sockeye salmon, and to which our inquiries were chiefly restricted. This area may be roughly defined as comprising the Strait of Juan de Fuca and those parts of the Gulf of Georgia and Puget Sound (Washington Sound) lying between the parallels of 48° 10′ and 49° 20′ north latitude, together with their adjacent bays and tributary streams. We consider, however, that it would be advantageous to extend the scope of any joint regulations which

may be agreed upon to all parts of this inclosed sea, and the information necessary to accomplish that purpose satisfactorily could readily be obtained.

(2) In the salt waters comprised within the State of Washington we see no reason for prohibiting at present any of the kinds of apparatus now employed there, namely, trap nets, purse seines, drag seines, reef nets, and gill nets, the bulk of the sockeye catch being made in the form of net first mentioned.

(3) We are in accord with the Canadian regulation which restricts commercial fishing on the Fraser River and off its mouths to the use of drift gill nets, and recommend that the rivers in Washington be subject to the same regulation.

(4) Being uncertain as to the capacity of the contiguous waters in question in respect to fishing operations, we are not prepared to suggest a direct limitation upon the quantity of apparatus to be employed, but consider that the present requirements of the case will be met by the restrictive measures which follow.

(5) The mesh in trap nets to measure in extension not less than 3 inches in the crib and 6 inches in the leader when actually in use.

Trap-net leaders not to exceed 2,000 feet in length.

Not more than two traps to be placed in one continuous line, and when so arranged to be separated by a gap of at least 100 feet between the inner crib and the beginning of the outer leader. All traps or strings of two traps to be separated by lateral passageways of at least 2,500 feet. The inner end of all trap-net leaders to begin in a depth of not less than 1 fathom at low tide, and the space intervening between it and the shore to remain entirely unobstructed.

All trap-net stakes to be removed from the water, in the interest of navigation, within thirty days from the close of the fishing season.

(6) Drift gill nets not to exceed 150 fathoms each in length.

The drift gill nets employed for taking quinnat salmon to have not less than 7¾-inch mesh extension measure, and to be used only from April 1 to September 15.

The drift gill nets employed for taking the sockeye and other smaller species of salmon to have not less than 5¾-inch mesh extension measure, and to be used only from July 1 to October 1.

All drift nets when in use to be kept at least 250 yards apart, and to obstruct not more than one-third of the width of the river.

(7) We are not prepared to suggest any changes in the dimensions or in the manner of employing drag seines, purse seines, and reef nets, nor do we consider any such changes essential while the extent of fishing by these methods remains as small as at present.

(8) It is recommended that in all rivers commercial fishing with nets be restricted to the tidal part of the river.

(9) We consider it very important that the movement of the salmon toward their spawning-grounds be facilitated by weekly close times of thirty-six hours' duration, which we suggest extend from 6 a. m. on Saturday to 6 p. m. on Sunday of each week during the continuance of the fishing season.

(10) We also recommend an annual close season, extending from October 1 to April 1 of each year, during which all net fishing shall be prohibited.

(11) We recommend that the Indians be allowed to fish at all times by their customary methods, except the use of drift nets and spears on the rivers during the close seasons, during which periods, moreover, they should be permitted to take salmon only for the purpose of supplying themselves with food, and not for sale or barter.

(12) As no evidence of a decrease in the abundance of any of the salmon species has been obtained, we do not feel justified in recommending joint action at present in the matter of their artificial propagation. While we feel confident that the natural supply can best be maintained by early compliance with suitable protective measures, we found it generally admitted that the efforts made by the Canadian Government to increase the stock of sockeye salmon on the Fraser River by fish-cultural methods has been beneficial, the annual run of the fish being made more constant and the off seasons being improved. In view of the growing demand for

the shipment of quinnat salmon in a fresh condition, which may sooner or later come to exceed the supply, we venture to suggest the possibly greater advantages to be gained by the artificial hatching of that species.

(13) We are convinced that the remedial measures which have heretofore been adopted, although not enforced, for disposing of the fish offal from the canneries on the Fraser River are inadequate to accomplish the results intended, and are also to a large extent impracticable. The practice of throwing this waste material into the river is to be deprecated on general principles; but, except in respect to a few localities, no specific evidence has been presented to indicate that it may be detrimental either to the health of the community or to the welfare of the salmon, and there is no proof that the latter have suffered from this cause. It seems to us that as much, if not greater, harm would result from dumping the offal in the open waters off the entrance to the river as from its disposition in the customary manner in the vicinity of the canneries, providing the necessary precautions are taken. So far as we have been able to ascertain, when thrown into the current of the river in a fresh condition it is practically always dissipated, and produces a nuisance only when placed in quiet, shallow water, or in eddies, which tend to retain it along the shores or to carry it into the adjacent sloughs. Factories established for converting it into oil and fertilizer have failed of success, nor is there any apparent prospect of its extensive utilization in the immediate future.

While suggesting renewed inquiries for reaching a more satisfactory solution of this question, we are constrained to recommend that for the present the current practice be allowed to continue, under such restrictions as may be called for to prevent the accumulation of the offal in any situations where its effect can be shown to be prejudicial. The fishery officer of the district should be empowered to designate all places where the throwing in of this waste should not be permitted.

No complaints respecting the offal in the vicinity of the canneries in the State of Washington have been received from any source, nor do any regulations regarding the manner of its disposition in that region seem to be called for at present.

(14) Waste from sawmills and other substances deleterious to the salmon should not be allowed to pass into any streams which they frequent.

FUR-SEAL INVESTIGATIONS.

The Fish Commission steamer *Albatross* was detailed by the President for duty in connection with the investigation of the fur-seal question in Bering Sea. The inquiries, which were, by act of Congress, placed under the direction of the Secretary of the Treasury, were addressed to the condition of the seal herds on the Pribilof, Commander, and Kuril islands, and were conducted by a scientific commission appointed by the President, consisting of Dr. D. S. Jordan, in charge; Mr. Leonhard Stejneger and Mr. F. A. Lucas, of the U. S. National Museum; Lieut. Commander Jeff. F. Moser, U. S. N., commanding steamer *Albatross*; Mr. C. H. Townsend, naturalist of the *Albatross*; Col. Joseph Murray, special agent of the Treasury Department, and Mr. G. A. Clark, secretary. A similar commission was appointed by the British Government, the members being Prof. D'Arcy W. Thompson of University College, Dundee, Scotland; Mr. James M. Macoun, of the Geological Survey of Canada; Mr. G. E. H. Barrett-Hamilton, and Mr. A. Marett, photographer.

As stated in the last report, the *Albatross* left Seattle on June 24, 1896, having on board all the United States representatives and all the British representatives except Mr. Barrett-Hamilton. The party was

landed at the Pribilof Islands on July 8 and spent the ten days following in observations on the condition of the rookeries. On July 18 the *Albatross* proceeded westward with Dr. Stejneger for the purpose of making similar investigations respecting the seal herds on the Commander and Kuril islands; the rookeries of the Commander Islands being inspected from July 30 to August 9, those of the Kuril Islands from August 22 to August 26, and the herd on Robben Island from August 28 to September 2. The *Albatross* then proceeded to Hakodate, Japan, to refit and to enable Dr. Stejneger to make further inquiries regarding the seals of the Asiatic herd. The vessel then sailed for San Francisco, touching at the Hawaiian Islands.

The commissioners remaining on the Pribilof Islands were engaged in studying the conditions of seal life, in mapping and photographing the rookeries, and in making inquiries as to the methods of the sealing fleet in the adjacent waters. The last-named work was assigned to Messrs. Townsend and Lucas, who cruised among the pelagic sealing vessels on the U. S. revenue cutter *Rush*, examining their catch, noting the sexes of the seals killed, and making dissections intended to throw light on the feeding and breeding habits of the seals. Other investigations relating to pelagic sealing were made later in the season by Messrs. Lucas, Macoun, and Barrett-Hamilton. On August 16 Dr. Jordan and Professor Thompson sailed in the British vessel *Satellite* to make a further examination of the rookeries on the Commander Islands, then returned to the Pribilofs September 1, bringing with them Mr. Barrett-Hamilton. Mr. Townsend returned to San Francisco on August 23 for the purpose of collecting statistics relative to pelagic sealing.

Messrs. Jordan, Thompson, and Lucas started home from the Pribilofs on September 8, the other commissioners remaining on the islands until October 22, with the object of ascertaining the effect of pelagic sealing on the young seals born during the summer.

The result of the season's investigations of the fur-seal fisheries have been published in a preliminary report.* A further decrease in the number of breeding seals on the rookeries of the Pribilof and Commander islands was disclosed, additional evidence on the destructiveness of pelagic sealing was procured, and the resulting starvation of young seals was observed at the close of the season by representatives of both governments.

During the time that the *Albatross* remained at the Pribilofs Captain Moser was engaged in making a survey of the different rookeries, with a view to test the correctness of the maps that had been prepared by earlier investigators. During the cruise from the Commander Islands to Japan the *Albatross* took many soundings in the little-known waters about the Kuril Islands and in Okhotsk Sea and secured at some of the more remote localities a number of hitherto unknown fishes.

* Observations on the fur-seals of the Pribilof Islands, Treasury Document 1913.

THE LABORATORY AT WASHINGTON.

A large amount of miscellaneous investigation and experimentation is carried on at the Washington laboratory. In its relation to the fish-cultural branch of the service the work consists in the examination of specimens of diseased fishes or fishes infested with parasites forwarded from the various stations and in microscopic studies of the food of artificially-hatched fishes. Many specimens of fishes from all parts of the country are sent to the Commission for identification by private individuals, associations, and institutions. The duty of studying and labeling natural-history collections and of preparing sets of same for distribution also falls to the laboratory assistants.

Collections of fishes and other animals made by the vessels and field parties of the Commission are sent to the laboratory of this division to be studied, labeled, and distributed. The collections in a given year are usually larger than can be critically studied and reported on in detail during the same time. During the present year reports on the following collections have been either completed or well advanced: (1) A large series of fishes and crustaceans from the basin of the Columbia River and elsewhere on the Pacific Coast; (2) fishes obtained in the Klamath Lakes basin in 1894; (3) fishes of Vermont collected in 1894; (4) large series of salt-water fishes from Indian River, Biscayne Bay, Key West, Tarpon Springs, and other points in Florida; (5) fishes of the Missouri River basin; (6) very extensive assortment of fishes of the Great Lakes obtained in 1893, 1894, and 1895; (7) fishes from the interior of Florida collected in the winter of 1896–97; (8) miscellaneous fishes secured at points in Alabama, Mississippi, Louisiana, and Texas in 1897; (9) fishes from the interior of New York.

In accordance with the custom long prevailing, collections of fishes and other natural-history specimens were sent to the United States National Museum. The material consisted of (1) a collection of marine invertebrates obtained in the course of oyster investigations in Long Island Sound in 1890 and 1892; (2) a quantity of stomach contents and ovaries of fur-seals secured by the *Albatross* in Bering Sea during several recent years; (3) collections of mollusks from the Pacific Ocean taken by the *Albatross* during the years 1887 to 1896; (4) miscellaneous collections of fresh-water and salt-water mollusks obtained by various field parties during the years 1888 to 1896; (5) collections of mollusks obtained by the *Fish Hawk* in Long Island Sound and on the coast of South Carolina; (6) collections of reptiles and batrachians, containing about 500 specimens, obtained in various parts of the United States by field expeditions; (7) types of 41 new species of fishes collected by the *Albatross* in Bering Sea and the North Pacific Ocean in 1889, 1890, and 1891, and by field parties in Upper Klamath Lake, Oregon, in 1894 and 1896.

The collections of cephalopods, that had been accumulating in the Commission for a long time and included several thousand specimens

from the Atlantic and Pacific oceans, were prepared and shipped to Prof. William E. Hoyle, of Owen's College, Manchester, England. Professor Hoyle is a recognized authority on this group of mollusks, and kindly agreed to study and report on the Commission's collections.

Tow-net collections of small crustaceans from lakes in Idaho, Washington, and Oregon, obtained by assistants of the Commission in the course of ichthyological explorations, were, by request, transmitted for study to Prof. S. A. Forbes, director of the State Laboratory of Natural History, Urbana, Ill., who had previously given the Commission several valuable reports on this class of animals.

A lot of sea-weeds collected by the *Albatross* in Alaska was sent to Prof. W. A. Setchell, of the department of botany in the University of California, for examination and report.

A complete working series of American fishes is a great desideratum in the laboratory, and active measures have been taken to fill out the reserve collection and arrange it in a manner convenient for ready reference. While the small size of the laboratory precludes the possibility of having a large series of specimens on hand, there is ample room for typical examples of all the fresh-water species and the smaller salt-water ones.

A special collection of considerable importance has been begun, consisting of carefully identified immature fishes of various sizes and ages, more especially those which are propagated by the Commission or are related to those artificially cultivated.

THE WOODS HOLE LABORATORY.

The laboratory of the Commission at Woods Hole was operated in the usual manner during this year. The privilege of using the tables, equipment, and facilities was extended to a number of persons from various well-known educational institutions, who were given sleeping accommodations in the residence building. The laboratory was ready for occupancy July 1 and remained open till about October 1, Mr. Alexander Jones, the acting superintendent of the station, being in general charge.

The investigators who were granted the privileges of the laboratory, the institutions they represented, and the subjects of their studies were as follows: Mr. Ulric Dahlgren, Princeton University, nervous system of flounder; Mr. Alfred A. Doolittle, Princeton University, embryology of echinoderms and collecting; Mr. Leonard H. Robbins, Princeton University, anatomy of dogfish; Mr. F. C. Waite, Harvard University, development of green glands in decapoda; Mr. George Lefevre, Johns Hopkins University, budding of ascidians; Dr. Reid Hunt, Johns Hopkins University, stimulation of cardiac nerves of fishes; Prof. C. C. Nutting, State University of Iowa, description and classification of hydroids; Dr. William Patten, Dartmouth College, phylogeny of horseshoe crab; Dr. J. H. Gerould, Dartmouth College, nervous system of

echinoderms; Mr. W. A. Redenbaugh, Dartmouth College, nervous system of horseshoe crab; Mr. H. M. Chase, Dartmouth College, anatomy of elasmobranchs; Mr. Ellis Kerr, Northwestern University, urinogenital system of amphibia; Mr. H. B. Cragin, Northwestern University, development of olfactory nerve and histogenesis of nasal epithelium in *Amblystoma;* Mr. W. H. Dudley, anatomy and development of the lateral-line sense organs in killifish; Dr. H. V. Neal.

NOTES ON FISHES, FISH-FOOD, AND FISH DISEASES.

Reappearance of tilefish.—The history of the discovery of the tilefish (*Lopholatilus chamæleonticeps*) in 1879, followed by its almost complete extermination from natural causes in 1882, forms one of the most interesting chapters in connection with the food-fishes of the Atlantic coast. In 1892 the *Grampus*, as a result of a special search, succeeded in taking 8 specimens between Marthas Vineyard and the capes of Delaware, the first that had been met with since the great mortality which befell the species ten years previously. In 1897 the tilefish was accidentally taken in such numbers as to suggest a considerable body of fish and to warrant the hope that the early expectations of its taking a place among the food products of the country may eventually be realized. The 78-ton schooner *Mabel Kenniston*, of Gloucester, Mass., was overtaken by a gale on Georges Bank on February 8, 1897, and was blown 120 miles to the westward. After the gale was over haddock trawls were set in 65 fathoms of water, and when the lines were hauled 30 tilefish were caught, weighing from 6 to 15 pounds apiece. Dogfish were very abundant and troublesome, otherwise the captain thought he would have taken fully 100 tilefish. They were landed at Gloucester February 16, and were all eaten locally and pronounced "better than salmon." The weather was very thick, and the vessel's position when fishing could not be definitely determined, but it was 104 miles southwest of No Man's Land, in latitude about 39° 40′ and longitude about 72° 10′.

The bluefin whitefish in Lake Superior.—Up to a few years ago the bluefin or blackfin whitefish (*Argyrosomus nigripinnis*) was known only from Lake Michigan and some small lakes in Wisconsin and Minnesota. It has recently, however, come into prominence in Lake Superior, where, in some sections, it is now extremely abundant. Vague reports of the occasional capture of a "blackfin" in Lake Superior have reached the Commission from time to time, but it was not until 1897 that specimens of this species came into the possession of the office; these were three in number, and were sent by Mr. S. P. Wires, the superintendent of the Government hatching station at Duluth, Minn.

The coming into prominence of the bluefin in Lake Superior is analogous to that of the longjaw (*Argyrosomus prognathus*) in Lake Ontario. Both were brought to the notice of the fishermen after a very marked decrease in abundance of the common whitefish (*Coregonus clupeiformis*), whose place they seem, to a considerable extent, to have occupied.

The following interesting notes on the bluefin in this lake have been communicated by Mr. W. D. Tomlin, secretary of the Duluth Fisheries Association:

The coming of the bluefin into Lake Superior waters contiguous to the port of Duluth has been apparently recent. Twelve years ago (1885), when the fishermen here first combined to protect themselves, the bluefin or blackfin was very little known. The fishermen covered hundreds of miles with their fishing operations, leaving their homes very early in the spring and staying until the ice formed on the nets. Many of the present fishermen used to go out about 50 miles and get some fine catches of whitefish in their nets; and as soon as the fall fishing had ended the lake herring—always known as a prolific fish and easily found—was an object for consideration for some weeks until the winter set in. Occasionally one or two bluefins would be taken in a lift of nets. They had no sale, were not recognized as a herring, and could not be passed as a whitefish; so the fishermen used to take them from the nets and clean them at once and let the cook supply them as a pan fish. When thus taken fresh from the icy water and cooked as described they were fine eating, but if left over until the next day they were strong and insipid. When the whitefish began to go farther out into the lake the fishermen followed them, and very few bluefins were taken or even thought of.

As recently as 1894 or 1895 some fishermen, who have homes about 20 miles out from Duluth, on the Minnesota shore, began to set nets entirely for lake trout, because it did not pay them to run 150 miles for whitefish. Then in the fishing once in awhile the larger bluefins would be caught in the trout nets, and since that time the increase has been enormous, and during the past few years they have attained remarkable abundance. During last summer they were a positive drug on the market, and it was almost impossible to sell them, except to those ignorant of the true whitefish. As soon as the lake opens they can be caught by the ton. Booth & Co. state they will not agree to take any of them from the fishermen. They had nearly 20 tons of them in the refrigerator during last summer and could not dispose of them.

At the first appearance of the bluefins they frequented the grounds on which herring had always been caught, but later the schools have extended outward until they are caught on grounds formerly the feeding-grounds of the whitefish. The fishermen are now liable to find them anywhere within 30 miles of Duluth, principally along the Wisconsin shore. As a result of their migration from Lake Michigan they seem to have increased in weight. Some will be found at the 2-pound mark; and, as a result of the rich food supplies that can be obtained at this end of Lake Superior, it will be a matter of no surprise if these fish follow the course of the whitefish and the lake trout and take on bulk and weight. It is stated that Wisconsin will not place any restriction on the fishing for these fish, and Minnesota will possibly follow the same course.

It was at one time surmised that the bluefin or blackfin was a species of whitefish that had been introduced with the multitude of fry that had been turned into the lake by the Fish Commission. Considerable inquiry was made by the fishermen concerning the coming of these fish, and the rumor gained currency that bluefin eggs had been sent up with other eggs and had been hatched out and planted; but Mr. F. N. Clark, superintendent of the Michigan stations of the U. S. Fish Commission, assured me that no bluefins had been planted by the Commission in Lake Superior.

Food of artificially hatched fish.—In order to determine the natural food resources for young black bass of the fish ponds on the river front in Washington in which the propagation of bass has been carried on for a number of years, microscopic examinations of the water and of the stomach contents of recently hatched fry were made in May, 1897. The water was found to be extremely rich in entomostraca, rotifers, and other

animals suitable for bass food, and also in small vegetable and animal organisms on which the fish food subsists. The more abundant forms included species of *Cyclops*, *Daphnia*, *Alona*, *Scapholeberis*, *Amœba*, *Hydra*, *Bothrimonus*, several genera of infusoria, nematodes, *Volvox*, *Spirogyra*, *Micrasterias*, *Euglena*, and some other algæ. The stomach contents of the young bass from the same ponds showed that cladocera were being principally consumed. One small-mouth bass 4 days old contained 10 specimens of *Cyclops*, *Daphnia*, and other cladocera; one 2 days old had 8 specimens of the same animals; three large-mouth bass a few days old had been subsisting on *Daphnia*.

The possible use of finely powdered cereals as food for young whitefish has from time to time been suggested. At Put-in Bay, Ohio, station in 1897 Superintendent Stranahan fed wheat shorts to about 2,000,000 whitefish fry contained in tanks. They at first appeared to thrive, but by May 7 had all died, and specimens were forwarded to Washington for examination. In nearly every case the alimentary tract was well filled with granules of wheat starch, and it was apparent that the fry readily took the food. The nutritive value to fish, however, of such a substance is doubtful, and an examination of the condition of the granules in the hind gut, as compared with those in the anterior part of the alimentary canal, showed no evidence that they had undergone digestion to the slightest degree. The assimilative powers of the very short intestinal canal of the whitefish fry are not sufficiently active to utilize raw vegetable material of this nature. It is possible, however, that by cooking the shorts and diluting them with other food they may prove of service in rearing young whitefish.

Study of rainbow trout and steelhead trout in aquaria.—In the month of April, 1897, the aquaria at Washington contained a large number of artificially hatched rainbow trout (*Salmo irideus*) and steelhead trout (*Salmo gairdneri*). The fish were 4 inches in length and 12 months old, the rainbow trout having been hatched from eggs of domesticated fish at the Wytheville (Va.) station, and the steelheads from eggs of wild fish obtained at Fort Gaston (Cal.) station. Comparing the fish as they appeared in the aquaria, the rainbow trout were relatively shorter and deeper, darker in coloration, with more numerous spots, especially on the caudal fin; the under parts were darker, the middle of the side more rosy; the pectoral, ventral, and anal fins were darker, the white edges being made prominent by contrast. The rainbow trout have the spots on the back larger and more numerous. In the steelhead the spots on the top of head are very much smaller and more numerous. Comparative measurements showed no differences except that the rainbow is somewhat deeper than the steelhead (depth $4\frac{1}{5}$ in rainbow, $4\frac{1}{2}$ in steelhead). The scales in the lateral line are rather larger in the rainbow and the origins of the dorsal and anal fins are more anterior.

Fish parasites and diseases.—About May 15, 1897, a very destructive disease appeared among fresh-water fishes in the aquaria at Washington. The onset of the attack was very rapid, and in a short time spread

to a large number of fishes, young quinnat salmon and young Swiss lake trout being the species chiefly affected. The disease in its appearances and symptoms differed from any previously manifesting itself in the local aquaria, and on examination was found to be due to a protozoan parasite (*Ichthyophthirius multifiliis* Fouquet). This is the same animal that produced great mortality among fishes in the Fish Commission aquaria at the World's Columbian Exposition in 1893, and was there studied by Dr. Stiles, of the Department of Agriculture, whose report on the subject is printed in the Bulletin of the Commission for that year. It is noteworthy that at Chicago the disease first appeared in a lot of catfish (*Ameiurus albidus*) from the Potomac River.

The parasite thickly covers the entire surface of the body and also enters the mouth and gill-cavities and the intestines. The skin becomes coated with a thick mucus, the gills are matted together with slime, and the gill-coverings bulge. The infested fish abstain from eating and remain at or near the surface of the water. The respiratory movements are rapid and gasping. Death is gradual and seems due to a combination of starvation and asphyxiation.

From 60 to 70 per cent of the salmon and nearly all of the trout succumbed to the disease, which was arrested in the course of a month by thoroughly cleaning the aquaria and filling them with a strong salt solution. About the first of May some of the young salmon were sent from Washington to the aquaria at the Nashville Exposition. In a few weeks the disease appeared on them, but they were killed before the trouble had spread to other fishes. Brook trout in the same aquarium were not attacked.

In the spring of 1897 a diving beetle (*Laccophilus maculosus*) appeared in numbers in the fish ponds in Washington and proved destructive to young bass. Dr. H. F. Moore made some observations on its habits and ravages, and found it to be a very dangerous enemy of young fish, which it attacks savagely. Beetles in the larval stage were also discovered in the bass ponds. Suggestions were made as to expedients for preventing subsequent inroads on the young bass.