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REPORT  
OF THE  
UNITED STATES  
COMMISSIONER OF FISHERIES

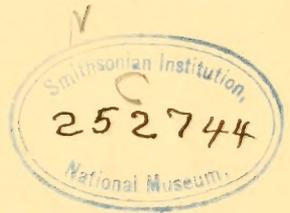
FOR THE FISCAL YEAR 1919

WITH

APPENDIXES

HUGH M. SMITH

Commissioner





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- DISTRIBUTION OF FISH AND FISH EGGS DURING THE FISCAL YEAR 1919. Appendix I, 76 pp. (Document No. 878. Issued September 9, 1920.)
- ARTIFICIAL PROPAGATION OF THE SALMONS OF THE PACIFIC COAST. Revised and enlarged by Henry O'Malley. Appendix II, 32 pp., 9 pls., 11 figs. (Document No. 879. Issued June 8, 1920.)
- ARTIFICIAL PROPAGATION OF STURGEON. REVIEW OF STURGEON CULTURE IN THE UNITED STATES, by Glen C. Leach, and ARTIFICIAL PROPAGATION OF STURGEON IN RUSSIA, by Nicolas A. Borodin. Appendix III, 7 pp. (Document No. 880. Issued February 19, 1920.)
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- FRESH-WATER TURTLES: A SOURCE OF MEAT SUPPLY. By H. Walton Clark and John B. Southall. Appendix VII, 20 pp., 8 pls. (Document No. 889. Issued July 30, 1920.)
- THE OYSTER AND THE OYSTER INDUSTRY OF THE ATLANTIC AND GULF COASTS. By E. P. Churchill, Jr. Appendix VIII, 51 pp., 29 pls., 5 figs. (Document No. 890. Issued October 12, 1920.)
- ALASKA FISHERIES AND FUR INDUSTRIES IN 1919. By Ward T. Bower. Appendix IX, 160 pp., 5 pls., 1 map. (Document No. 891. Issued December 11, 1920.)
- FISHERY INDUSTRIES OF THE UNITED STATES. REPORT OF THE DIVISION OF STATISTICS AND METHODS OF THE FISHERIES FOR 1919. By Lewis Radcliffe. Appendix X, 191 pp., 1 pl., 2 figs. (Document No. 892. Issued December 10, 1920.)

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**REPORT OF THE  
UNITED STATES COMMISSIONER OF FISHERIES  
FOR THE FISCAL YEAR ENDED  
JUNE 30, 1919**



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**REPORT**  
OF THE  
**COMMISSIONER OF FISHERIES.**

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DEPARTMENT OF COMMERCE,  
BUREAU OF FISHERIES,  
*Washington, October 10, 1919.*

**STR:** In presenting this report in which is given a résumé of the varied activities of the Bureau of Fisheries for the fiscal year ending June 30, 1919, I take the liberty to express appreciation of your sustained interest in and ever-ready, helpful criticism of the Bureau's work and to acknowledge your potent assistance which has made it possible for the Bureau to assume larger functions of public usefulness than it ever had before and has prepared the way for still greater service and achievement. To state that you have made permanent impress on this Bureau's career is but to repeat what is generally held by the responsible employees in office and field.

This occasion is taken to reaffirm the critical condition that has been created by the long continuance of inadequate compensation in all grades of the service. The prospective recommendations of the Joint Congressional Commission on the Reclassification of Salaries are confidently expected to meet and counteract the disorganizing situation now confronting the office force in Washington; but the labors of the commission will be futile, so far as this Bureau is concerned, if provision is not speedily made by Congress for the rectification of salaries in the field.

**RELATIONS WITH THE FISHERY INDUSTRIES.**

**SUMMARY OF ACTIVITIES.**

Inasmuch as outside of Alaska the Bureau exercises no jurisdiction over the fisheries, its relations therewith are necessarily confined to advisory, investigational, educational, and informative work to meet the special requirements of the country at large, the individual States, and various branches of the fishery industries.

The need for food production and food conservation during the war and post-war periods has afforded unprecedented opportunities for increasing the consumption of fish and incidentally for developing uses for by-products of the fisheries. Appreciative of these opportunities, and being desirous of contributing its full share of effort during the great national emergency, the Bureau has made use of all available means to secure the fullest practicable utilization of the country's aquatic resources. To this end it has cooperated effectively

with Federal and State food administration representatives and other governmental agencies, with producers, with the trade, with civic organizations, and with other elements of the population. By lectures and practical demonstrations it has shown directly to some fifteen thousand housewives the value of fish as food and the best and most economical methods of preparing it for the table, and in this way it has been enabled to show the merits of many of the little-used or neglected fishes which are fully the equal of more valued species, thereby increasing the fisheries and the markets for such forms at a time when they were needed most. It has augmented materially the saving and use of waste products of the fisheries, as, for example, the conversion of fish waste and waste fish into oil and fish scrap for fertilizer or fish meal as an animal feed, and the making of leather from the skins of aquatic animals. New or foreign methods of preservation have been introduced and wasteful practices have been discouraged. Investigations of the basic principles governing the methods of preservation of fishery products, for which there is a long-felt want, have been initiated and are yielding important results. A fishery-products laboratory in which such investigations can be continued under accurately controlled conditions has been built and equipped, and a temporary experimental field laboratory has been placed in operation.

The Bureau has also given greater attention to the collection of fishery statistics, which afford the only available, reliable basis for determining the condition and trend of the commercial fisheries of the country, serve as a guide for the enactment of necessary protective legislation, and indicate the need for and results of fish-cultural operations. The monthly returns of the quantities and values of the fish landed at Boston and Gloucester, Mass.; Portland, Me.; and Seattle, Wash., by American and Canadian vessels have been submitted by local agents and published as monthly and annual bulletins for the use of the trade. A statistical canvass of the fisheries of the Great Lakes, together with Lake of the Woods, Rainy Lake, and Lakes Kabetogama and La Croix, was made during the year, and a special bulletin on the subject was issued. In addition, there have been initiated and are nearing completion a comprehensive canvass of the fisheries of the South Atlantic and Gulf States for the calendar year 1918, and canvasses of the shad and river-herring fisheries of the Potomac River and of the shad fishery of the Hudson River for the calendar year 1919.

Plans are being developed for taking statistical canvasses with sufficient frequency to include all of the major geographical divisions of the fisheries once in a five-year period. To complete this work satisfactorily and take up such special canvasses as are required from time to time will require a somewhat larger force of statistical agents and clerks.

#### INCREASING PRODUCTION AND CONSUMPTION OF FISHERY PRODUCTS.

The Bureau has encouraged west-coast whaling companies to save and market whale meat for food and has rendered effective assistance in bringing the merits of whale meat to the attention of consumers. In 1918, 30,000 cases of the meat were canned and 195 tons were frozen for market, the latter being utterly inadequate to supply the demand. Equipment has now been provided for an output of 50,000 cases of

canned meat and 1,000 tons of frozen meat in 1919. Samples of the canned meat examined by the Bureau were found to be of good quality and to constitute a cheap and wholesome food. It is reported that in 1918 the principal whaling company on the Pacific coast, with stations in Washington, British Columbia, and Alaska, took 999 whales, of which about 200 were of the sei species (*Balænoptera borealis*) whose meat is light-colored and particularly good for canning. Attention has been given to the renewal off the coast of Maine of a fishery for whales, the flesh of which is to be marketed for food, and various persons connected with the fisheries are considering the practicability of such an undertaking. Interest has been aroused in Texas in the use of the meat of porpoises, which are reported to occur in numbers on the coast of that State. It has been ascertained that the oily taste which may be more or less objectionable to some persons can be overcome by removing the connective tissue which lies between the blubber and the meat. Some difficulty was experienced in inducing fishermen to provide the markets with supplies sufficient to satisfy the demand. An economic circular containing 32 recipes for preparing the meat of whales and porpoises for the table has been issued.

Being convinced that the production of fish in the States bordering on the Gulf of Mexico could be materially increased if larger markets to care for the surplus catch were provided, the Bureau cooperated with representatives of the Department of Agriculture and the Food Administration in securing the introduction of Gulf fish into Nashville, Louisville, Indianapolis, and neighboring points, and introduced approximately half a million pounds of fish from points in Florida into these cities. To effect relief for unsatisfactory shipping conditions, similar service was inaugurated between Chincoteague, Va., and the markets of Philadelphia and New York, and a number of shipments were made under supervision of Government agents.

Nearly 14,000 cases of canned river-herring products (fish, roe, and buckroe), sea herring and gadoid buckroe, valued at over \$54,000, were introduced to the markets of Atlanta, Birmingham, Montgomery, Knoxville, Nashville, and Chattanooga, largely as a result of exploitation work conducted by agents of the Bureau.

On the fishing banks in the Gulf of Mexico groupers are more abundant than snappers. The demand for snappers has been in excess of the supply, while that for groupers has normally been insufficient to care for more than half of the catch, with the result that quantities of these wholesome, white-meated fishes have been wasted, and valuable time has been lost by the fishermen in searching for the highly prized snappers. During the war, owing to the reduction in the size of the fleet, most of the groupers taken could be marketed. Recently, with an increase in the number of vessels operating, the catch has again exceeded the demand. The Bureau has, therefore, carried on extensive exploitation measures in inland cities of the South in an effort to stimulate sufficient demand to care for the entire catch. Restaurants and cafés, in particular, have been encouraged to use these fishes. A placard recommending groupers and an economic circular containing 29 recipes for preparing them for the table have been issued for the use of the trade.

The lack of a market for the catch of black drum, the destructiveness of this fish to oysters, and the excellent quality of the canned

product have led the Bureau to undertake a special movement to popularize the fish, and an assistant was detailed to visit fishing centers on the Gulf coast for detailed information regarding abundance, seasons, etc. Of points on the Florida coast, Cedar Keys appears best suited for the establishment of a fishery, the fish being reported as plentiful throughout the year. An even larger supply appears to be available at Point Isabel, Tex., where about 70 per cent of all fish taken is reported to be black drum. At this place the fish are caught throughout the year with pocket nets; that is, drag seines provided with pockets. The information gathered will be brought to the attention of those interested in establishing a fishery or a cannery for this fish.

Efforts have been put forth to stimulate the production and consumption of many other products, including alewives or river herrings, carp, crevalles, eulachon, red drum, robalo, rockfishes, sea catfish, rays, sharks (fresh, salted, and smoked), the roe and buck-roe of fishes, sea mussels (canned), squid, etc.

#### DEMONSTRATIONS IN FISH COOKERY.

No recent activity of the Bureau in the field of practical fishery work has met with such universal favor among producers, dealers, and consumers as its lectures and demonstrations in the methods of preparing and cooking fish.

Demonstrations were first given in Seattle, Wash., in May, 1918, with the object of showing housewives the best and most economical methods of preparing and cooking fish and of acquainting them with the merits of many of the common fish and fishery products with which they had little or no acquaintance. This work was extended to 15 other cities and towns in the States of Washington, Oregon, and California, and was highly commended in every center. In February, 1919, when the supplies of fish in the cold storages of the country were about double the normal holdings and there was imminent the possibility that large quantities of this good food might have to be destroyed for lack of markets, the demonstrators were detailed to the Middle West, to give a series of demonstrations in St. Louis, Chicago, St. Paul, Minneapolis, Cincinnati, and Cleveland. At these meetings housewives were encouraged to use frozen fish and were given instructions in buying and preparing them for the table. Stewards' associations, home demonstration workers, food-conservation officials, community-service organizations, and others were interested and benefited by the instructions given. The value of the work was well vouched for by the trade in its reports of increased demand for frozen fish, and many housewives commented on their previous failure to use such fish, believing them to be of poor quality, if not actually unfit for food. In May a successful series of demonstrations was held in Boston and Cambridge, Mass., after which the work was brought to a close for lack of funds.

To enable State and local agents of the States Relations Service of the Department of Agriculture to carry the benefits of this work to the housewives of their respective communities, demonstrations were given in St. Augustine, Titusville, Miami, West Palm Beach, and Key West, Fla.; at the Agricultural and Mechanical College of

Mississippi; in Savannah and Valdosta, Ga.: and before a gathering of State agents in Washington, D. C.

In all, some 125 demonstrations were given, the average attendance being about 100 persons. In this work the Bureau was particularly fortunate in obtaining the services of a highly trained and skillful demonstrator, ably assisted by two persons, one of whom was a man with wide acquaintance with the fisheries. From every city in which demonstrations have taken place expressions of appreciation of their usefulness and importance have been received, and many women have acknowledged that they had been using little or no fish, largely because of some groundless prejudice, and have testified to the value of this work to them.

This entire program was made possible at a most opportune time by the use of money allotted by the President from the fund for the national security and defence. The total cost of the work was less than \$12,000. It is with very great regret that announcement must be made of the failure of Congress to grant any money or authority for continuing this highly beneficent service.

#### FISH-COOKERY EXPERIMENTS.

As an essential factor in the Bureau's campaign for inducing the wider use of aquatic products as food, more particularly those that have been wholly or partly neglected, an experimental kitchen has been equipped, and workers expert in domestic science have been employed to determine the best methods for preparing new or little-known fishery products for the table. The information assembled has in some cases been forwarded directly to the trade, in others it has been arranged for publication in the Bureau's economic circulars to further the use of particular products. In addition, a cookbook on aquatic foods has been prepared for publication.

#### INCREASING THE USE OF WASTE PRODUCTS OF FISHERIES.

There is, on one hand, an increasing demand for new and enlarged sources of supply of protein feeds for hogs, cattle, and poultry, and of oils suitable for paints, varnishes, hydrogenation, and many other uses. Considerable quantities of fish waste and waste fish, on the other hand, which should be used to supply these deficiencies remain unutilized for lack of small, inexpensive plants suitable for caring for this waste, and because of lack of knowledge on the part of possible producers of apparatus and methods required and other difficulties by no means insurmountable.

The Bureau needs, and has made request for, the creation by Congress of a new position so as to permit the employment of a properly trained technologist to devote his entire time to these problems. Such work would annually result in the saving of fishery products possessing a value many times the cost of investigations. In the absence of proper provision for this work, the Bureau is attempting to render such service as its limited facilities will permit.

Encouragement has been given to manufacturers of fish scrap to convert all suitable material into fish meal as feed for domestic animals. Attention has been directed to the perfection of details of manufacture, and, as a result of these efforts, manufacturers in

the Chesapeake Bay region are prepared to produce and market from 2,000 to 5,000 tons of this feed in the 1919 season, provided a sufficient number of users of such feed can be acquainted with its merits and interested to purchase it. In the development of markets and in acquainting farmers with the value of such feeds, the Bureau of Animal Industry of the Department of Agriculture is lending effective cooperation. It is also conducting hog-feeding experiments with meal made from fish and fishery products, as, for example, menhaden meal, grayfish meal, and shrimp bran, to determine their quality as compared with other feeds. Such tests as have been completed indicate that fish meal is fully the equal of tankage.

On the west coast, including Alaska, the increasing demand for fish meal is reflected in the rapid increase in production. According to the Pacific Fisherman, the production in 1916 amounted to 2,640 tons of meal and 776 tons of fertilizer, in 1917 to 5,297 tons of meal and 1,390 tons of fertilizer, and in 1918 to 7,773 tons of meal and 802 tons of fertilizer, all of which was inadequate to satisfy the demand. In 1918 the reported yield of the menhaden industry of the Atlantic seaboard was 16,017 tons of dried scrap, much of which it is believed could better have been made into fish meal, and 33,187 tons of acidulated scrap.

During the war fish oils commanded unusually high prices, followed by a decided drop after the signing of the armistice. As a result of the increasing demand for these oils, prices have since approached their former high level. The falling off of the flax crop, the lack of supply, and the abnormally high prices of linseed oil have compelled the paint industry to seek new sources of drying oils required in paints and varnishes. It is believed that in the future menhaden oil and possibly other fish oils will be more extensively used in making certain types of paints and varnishes. Investigations to determine the fitness of various fish oils for such purposes have been arranged for. It is estimated that the production of fish oils in the United States, including Alaska, in 1918 amounted to approximately 6,000,000 gallons, of which 3,943,100 gallons were menhaden oil, a considerable increase over 1917 for both items.

In addition to the foregoing work, the Bureau has given attention to the possibilities of increasing the use of shrimp waste, to the methods of handling fish waste and waste fish employed in California, and to assembling samples of meal and oil for chemical examination, and has furnished a large number of interested correspondents with literature on the subject, including extracts from various publications not readily obtainable, and has placed them in touch with manufacturers of machinery employed in the industry and with markets for the products.

#### DEVELOPMENT OF AQUATIC SOURCES OF LEATHER.

The development of the aquatic leather industry, to which the Bureau has been giving considerable attention, has progressed satisfactorily. Nets of the special type developed by the Bureau for the capture of sharks and other powerful fishes are now being employed in taking these forms in commercial quantities. One leather company has established fishing plants at Morehead City, N. C., and Fort, Myers, Fla., to provide regular supplies of shark hides for tan-

ning purposes, and has a tannery for converting these into leather. Another company has acquired a site at Edmunds, Wash., where it plans to tan and finish into leather all kinds of aquatic hides, such as sharks, whales, hair seals, etc. Other companies are experimenting with these products and will later engage in the industry.

Difficulty was at first experienced in removing the shagreen from shark skins in a satisfactory manner. Suitable methods have now been devised for doing this before the sharks are skinned and from the cured skins as well, and the removal of the shagreen has also been accomplished at the close of the tanning process.

Following the Bureau's suggestions, all parts of the shark are now being utilized. Besides using the skins for tanning into leather, the valuable liver oil is extracted and marketed, the remainder of the fish is converted into fertilizer or fish meal, and experiments are in progress to develop suitable methods of preserving the flesh for food purposes. The Washington Institute of Industrial Research is cooperating with the Bureau to determine the fitness of shark, grayfish, and skate-liver oil as a drying oil for making paint and varnish. It is claimed that these products have sufficient value to support the fishery, thus permitting excellent leather to be made from the hides at low cost.

According to the Bureau of Standards, which has been cooperating with the Bureau of Fisheries in this work, fish leather such as that made from shark skin has a more spongy and fibrous texture than mammal leather. When pulled open at right angles to the surface, it often exhibits a laminated structure similar in appearance to that of a loosely-matted felt. Material is being assembled to enable that bureau to determine more definitely the qualities of fish leather, such as durability, pliability, porosity, water absorption, wearing qualities, and to make further tests as to tensile strength. Tests made at the Bureau of Standards of such samples as have been submitted indicate that fish leather usually possesses less strength than mammal leather, such as calfskin or cowhide, but that it is soft and pliable and has ample strength for many uses. As the industry grows it is expected that special uses will be found, dependent upon the inherent differences of hides from different fishes. One such use to which attention is being given is the employment of pieces of grayfish skin in place of the usual clip or fastener on garters, the small denticles catching in the webbing of the stocking.

Leathers of excellent appearance and quality are now being made from porpoise hides, and it is believed that hereafter the skins of these animals will be utilized, not wasted.

As the hides of the sharks give the greatest promise because of size, abundance, and quality, the Bureau is continuing to devote special attention to the development of the shark fishery and to determining definitely the properties of the various products and the uses to which they are best adapted. It has been the practice of fishermen to operate most intensively for those fishes for which the demand is greatest and to permit such predatory forms as the sharks, possessing little or no value, to multiply and to increase their depredations upon the more highly prized forms. This is an added reason for the development of a fishery for sharks and of uses for the products.

## PRINCIPLES GOVERNING PRESERVATION OF FISH BY SALTING.

During the lack of proper laboratory facilities the Bureau, with the cooperation of the National Research Council, was enabled to carry on at Johns Hopkins University Medical School, Baltimore, Md., an investigation of the problems of preserving fish with salt, and Dr. E. V. McCollum kindly volunteered to supervise the work at that institution. Experiments were conducted later at fishing centers in Virginia, North Carolina, and Florida.

The primary object of the investigation was to devise an improvement in the present methods of salting fish and to find an acceptable way of salting fish at summer temperatures, particularly in the Southern States, where difficulty in the warm months is encountered.

Incidentally, the work has added materially to our knowledge of the basic principles governing the salting process. The fish used in the experimental work were squeteague and river herring. The rate of penetration of salt into fish and the decomposition of the protein, as indicated by the amount of amino-acid nitrogen formed, were used as criteria of the efficiency of salting methods.

Sulphates and also salts of calcium and magnesium, as impurities in common salt, were found to retard the penetration of salt into fish muscle, but to produce a firmer, whiter flesh than pure sodium chloride. By reason of retarded penetration, salt containing these impurities permits fish to spoil at a lower temperature than salt not containing such impurities. Of these deleterious substances, the calcium salts are the only ones present in commercial salt in a large enough quantity to have a marked effect on the quality of the fish.

The removal of all blood and viscera, including roe and milt, appears to be an important factor in the salting of fish in warm climates. Experiments made indicate that the blood spoils at a temperature at least 25° F. lower than the spoilage temperature of the flesh of fish.

An investigation of the chemical changes taking place in the fat and protein of fish during storage is in progress, and a report of the completed work is being prepared for publication.

## DEVELOPMENT OF A PROCESS FOR RECOVERY OF WASTE BRINE.

It has been the usual practice among fish curers to discard the used brine employed in brine-salting fish, and also to some extent in the dry-salt process, and to make new brine for new lots of fish. Much salt has been wasted, the recovery of which was impracticable for a number of reasons. For example, the brine is loaded with a large amount of organic matter, blood, mucus, soluble proteins, methylamines, bacteria, etc., whose removal would be expensive; and, since salt was comparatively cheap and used in large quantities, any recovery process must of necessity produce results at low cost.

Recent investigations of the Bureau have shown that a better quality of fish may be produced by using higher grades of salt and have indicated the possibility that salting could be successfully accomplished in warmer climates. Without some recovery process the cost of refined salts may be prohibitive.

For these reasons the Bureau undertook to develop a process of purifying fish brine without expensive evaporation. Advantage was taken of the absorption by exceedingly fine precipitated particles of a tasteless and inert substance of the suspended and dissolved

organic matter, which is subject to decay. It has been demonstrated that the precipitate does remove most of the organic matter, and a plant has been installed in a fish-packing establishment at Gloucester, Mass., for trial. If this recovered brine can be rendered suitable for use again, the old brine used in preserving the fish brought to this plant will, when recovered, supply most of the salt needed for future use. At the present time, when the price of salt is about \$16 per ton, as compared with \$3 three years ago, this is an item of importance. The recovery process provides for the filtering off and drying of the precipitate, a product rich in protein which may be converted into fertilizer or fish meal. It is expected that this process, in conjunction with improved methods of salting requiring high-grade salt, to which reference has been made, will mark an advance in salting methods. The development of a practicable recovery process should enable the fish trade to use high-quality domestic salts in place of crude foreign grades.

As this work is still in the experimental stage, the results, including complete description of details of apparatus, will not be disclosed until the practicability of the method has been satisfactorily demonstrated.

#### URGENT NEED FOR EXHAUSTIVE INVESTIGATIONS OF PRESERVING METHODS.

In no branch of the fisheries is there greater need for exhaustive study than in the methods of preservation of fishery products. The methods in common practice are largely empirical, and in many cases the basic principles governing the operation are not definitely known. There is waste of time, labor, fuel, and materials, and the fisheries remain undeveloped from the lack of knowledge of suitable methods. To solve problems which in many cases are of vital importance to the welfare of communities, well-equipped fishery-products laboratories and a well-trained corps of skilled technologists are required. With adequate provision for these it would be possible to conduct many important investigations under accurately controlled conditions and render inestimable service in developing the fishery industries. To appreciate the handicap under which the fisheries labor, one has but to recall how amply agriculture is supplied with both Federal and State experiment stations, with skilled investigators and agriculturists trained in colleges and universities provided for the purpose, and how greatly it has benefited thereby, while the fisheries have utterly lacked any such advantages, and their development has in consequence been retarded. During the past year provision has been made for one such laboratory for the Bureau, and one university has established a college of fisheries in which the methods and problems of the fisheries will receive careful study and a corps of students will be trained for the industry.

#### FISHERY PRODUCTS LABORATORIES.

Through an allotment of \$125,000 from the fund for the national security and defense, approved and authorized by the President on July 2, 1918, the Bureau has been enabled to build a fishery-products

laboratory in Washington, D. C., to provide equipment, and to initiate investigations of importance to the industry.

The building is 45 by 80 feet, with two floors and an attic, and is of hollow-tile and concrete construction. On the first floor there are a large mechanical laboratory, low-temperature rooms for storage and refrigeration, chemical laboratory, incubation room, stock room, and a built-in smokehouse. On the second floor there are a laboratory, a fishery-products exhibit and demonstration room, an experimental kitchen, and offices.

The mechanical laboratory contains equipment for the canning, freezing in brine, drying, and smoking of fishery products, hydraulic press, filter press, grinder, steam boiler, vacuum and compressed air pumps, and various other appliances. For canning purposes there are a complete plant for sealing the cans by a double seamer, a retort with controlling and recording instruments, complete apparatus for sealing and processing glass containers by vacuum process, and another apparatus for processing tin containers, also by a vacuum process. In the experimental drier the heat, humidity of the air, and volume of air driven over the product can be controlled and registered and the weight of the material can be recorded, so that the exact conditions governing the drying of various fishery products may be worked out. An experimental plant for freezing fish in brine has been imported from Denmark and has been shown to persons interested in refrigeration. This plant, which was the first of its kind to be brought to and used in this country, enables the Bureau to demonstrate to the trade a new method and to afford the scientific staff of the laboratory a means of investigating the various types of brine freezing and comparing them with the customary freezing in air. The built-in smokehouse is of hollow-tile and cement construction, lined with white, glazed wall tile, provided with a flue, iron door, ventilators, shaving pans heated with gas, long-distance recording thermometer, and dampers for control of heat and ventilation.

The refrigeration plant is equipped with a 5-ton carbon-dioxide machine, and three rooms of different temperature are provided. The chemical laboratory is supplied with soapstone furniture, improved cabinets for classifying and holding chemical stock, viscosimeter, refractometer, polarimeter, colorimeter, specific-gravity balances, supereentrifuge, apparatus for determination of amino groups, apparatus for gas analysis, and other equipment needful for chemical study of materials and processes. That the factors which influence the character of the product may be known, measured, and controlled, provision has been made for recording hygrometers and thermometers, thermostats, pitot tubes, and pressure and vacuum gauges.

In the absence of a laboratory of this kind for a guide, much study and effort had to be expended in working out plans and details of equipment. The building was completed during the year, and several important investigations therein have already been instituted.

This laboratory has been planned and equipped for the study of the general problems of the industry, to enable its investigators to try out new methods and suggestions for improvement of common practices, and to overcome difficulties encountered in the field. It is intended for a workshop in which the properties of fishes and fishery products may be subjected to careful and thorough investigation and uses developed therefor, a place in which to perform the

manifold examinations and analyses demanded of this Bureau in the interests of the fisheries.

There is need for other similar laboratories in or near an important fishing center in each of the main geographical divisions of the country, for the study of the special problems of those divisions, for the conduct of investigations which can only be conducted at the seat of the industry, and for aiding in the perfection of apparatus and methods used in the capture, preservation, and preparation for market of the fishes of the region. The work of each of such laboratories should be under the direction of the Washington laboratory and coordinated with it and with the laboratories in other centers.

On the coast of California there is now special need for work in this field. Although noteworthy progress has been made in the development of its fisheries, for example, those for tuna and sardines, there are still large, undeveloped fishery resources in the barracuda, mackerel, rockfishes, etc. Desirous of lending assistance to the fishery industries of this region, provision has been made for a temporary laboratory for the study of some of the more pressing problems.

After some six weeks study of the advantages of the various fishing centers of southern California, suitable temporary quarters in San Pedro were obtained for the establishment of a small experimental plant. The equipment of this plant was completed within three months, and during May and June, 1919, investigations in the canning of mackerel, barracuda, rockfishes, smelt, pilchards, and tuna were initiated. According to a schedule which has been worked out, each species is subjected to 16 preliminary methods of packing, all of which may be run at one time. At the conclusion of the canning the packs are subjected to uniform storage conditions. At the end of six weeks these preliminary packs are examined as to firmness, appearance, taste, quality, etc., and analyzed to determine whether there has been a chemical change. Adopting the methods of the most promising of the preliminary packs, finished packs—that is, packs to which condiments or special packing oils have been added or in which the fish is subjected to some special treatment—are next put up. These final packs range from the simplest and most inexpensive to the most complicated and exclusive form of treatment. In order to determine the keeping qualities of the various methods with reasonable certainty, it is planned to examine samples at the end of 3, 6, and 12 months. If the product is in good condition and excellent in quality at the end of a year, it is felt that the process may be given to the trade. Careful records are kept of all operations and of the weight and amount of ingredients used. If the market price of ingredients is known, it will be possible at any time to determine the cost per case. Perhaps the most promising of the packs made during the year were those of the mackerel packed in olive oil, tuna style, and kippered and canned in cottonseed, corn, or olive oil. This species, generally known on the east coast as chub mackerel, is reported to be very abundant, but owing to the limited demand comparatively small quantities are now brought in by the California fishermen.

#### NEW ENGLAND VESSEL FISHERIES.

The vessel fisheries at Boston and Gloucester, Mass., and Portland, Me., the three principal New England fishing ports, were more than ordinarily prosperous during the calendar year 1918, notwithstanding

the presence of enemy submarines along the coast and on the fishing grounds for some time during the summer and the consequent loss of a number of fishing vessels. This condition was due largely to the increased demand for fishery products and the prevailing high prices during the war period.

The fishing fleet discharging at these ports in 1918 comprised 521 sail, steam, and gasoline screw vessels. They landed at Boston 2,830 trips with 109,476,041 pounds of fish, valued at \$6,587,754; at Gloucester 3,414 trips with 74,175,499 pounds, valued at \$3,062,605; and at Portland 2,506 trips with 21,849,613 pounds, valued at \$881,189; a total of 8,750 trips and of 205,501,153 pounds of fresh and salted fish, having a value to the fishermen of \$10,531,548. This total includes 60 trips landed at these ports by 21 Canadian fishing vessels, amounting to 5,602,749 pounds of fresh fish, valued at \$218,625. These fish were landed in accordance with an arrangement with the Canadian Government, as an emergency war measure, granting reciprocal privileges to fishing vessels of both countries, one feature of which was that Canadian fishing vessels were permitted to land their fares at American ports directly from the fishing grounds. Canadian fishing vessels began to utilize this privilege in April and continued during the remainder of the year. The larger part of these fish, or 4,668,620 pounds, valued at \$164,946, were landed at Portland.

There was a decrease of 534 trips in the total number for the three ports as compared with the previous year, but an increase of 30,070,567 pounds, or 17.14 per cent, in the quantity, and of \$2,170,216, or 25.95 per cent, in the value of the fish landed. The catch of cod increased 27.19 per cent in quantity and 52.57 per cent in value; haddock, 24.49 per cent in quantity and 27.12 per cent in value; and pollock, 83.07 per cent in quantity and 66.08 per cent in value. The catch of halibut increased less than 1 per cent in quantity, but had 37.88 per cent greater value. There was considerable falling off in both the quantity and value of hake, cusk, mackerel, swordfish, and tilefish.

The fishery products landed at these ports by fishing vessels each year are taken principally from fishing grounds lying off the coast of the United States. In the calendar year 1918, 68.10 per cent of the quantity and 70.86 per cent of the value of the catch landed by American and Canadian fishing vessels were taken from these grounds; 4.36 per cent of the quantity and 4.70 per cent of the value were from grounds off the coast of Newfoundland; and 27.52 per cent of the quantity and 24.43 per cent of the value, from fishing grounds off the Canadian Provinces. Newfoundland herring constituted 3.10 per cent of the quantity and 3.15 per cent of the value of the products landed during the year. The herring were taken on the treaty coast of Newfoundland, and the cod and other species from fishing banks on the high seas. All fish caught by American fishing vessels off the Canadian Provinces were from offshore grounds.

*Cod.*—Cod ranked first in importance in both quantity and value, the catch, fresh and salted, amounting to 71,824,427 pounds, valued at \$3,617,205.

*Haddock.*—The catch of haddock ranked second to that of cod, amounting to 66,671,541 pounds, valued at \$3,199,276.

*Hake.*—The yield of hake has fallen off in the past few years. In 1918 the catch was 5,280,829 pounds, valued at \$273,085. In 1916 over 13,000,000 pounds were taken, and in 1910 the quantity landed at Boston and Gloucester alone was nearly 20,000,000 pounds.

*Pollock.*—The pollock catch was much larger than usual, the quantity landed being 26,560,620 pounds, valued at \$962,085.

*Cusk.*—The output of cusk was small as compared with recent years, amounting to only 2,658,260 pounds, valued at \$103,031. The catch of this species has usually been about three million to upward of six million pounds.

*Halibut.*—The catch of halibut was 1,781,004 pounds, valued at \$302,280, which was 14,940 pounds more than in the previous year, with \$83,048 greater value.

*Mackerel.*—The total yield of fresh mackerel taken by the American fleet in 1918 was 69,314 barrels, compared with 111,932 barrels the previous year, a decrease of 42,618 barrels. The catch of salted mackerel was 13,030 barrels, as compared with 32,162 barrels the previous year, a decrease of 19,132 barrels. The aggregate quantity of mackerel landed at Boston, Gloucester, and Portland by the fishing fleet during the year was 10,158,467 pounds, valued at \$1,188,924, of which 7,582,414 pounds, valued at \$853,639, were fresh, and 2,576,053 pounds, valued at \$335,285, were salted. This quantity includes 29,152 pounds of fresh mackerel, valued at \$2,423, from the Cape Shore, landed by Canadian vessels.

In 1919 both the purse seiners and gill netters in the mackerel fishery had a comparatively good season. The mackerel landed by the southern fleet were mostly large and medium fish, and sold from 8 to 18 cents per pound, according to market conditions. The total catch of mackerel up to July 1 was 38,787 barrels fresh and 6,452 barrels salted, compared with 29,259 barrels fresh and 8,079 barrels salted the previous year.

#### PACIFIC SALMON FISHERIES.

Outside of Alaska the Bureau's connection with the salmon (and other) fisheries of the Pacific seaboard consists of very extensive cultural operations addressed to the salmons in all the coastal States, biological and other investigations of the salmons and salmon waters, and interest in the welfare of the vast industry dependent on the salmon supply.

The conduct of salmon culture is, by law, contingent on the enforcement by the States of measures for the adequate protection of the salmons, so that the money and effort devoted to the work of artificial propagation may not be wholly or partly vitiated. The question has arisen as to whether certain practices of the salmon fishermen are needlessly wasteful and destructive. If the answer is affirmative, remedial action by the States is clearly demanded if the Bureau is to continue the operation of its hatcheries.

A feature of the salmon fisheries which has attracted much attention in recent years and has been widely discussed is the taking of salmon by lines and nets at sea, on the feeding grounds of the schools, under conditions that necessarily involve the destruction of large numbers of immature fish on which the future of the industry depends. This practice which for years has been followed in Monterey Bay, Calif., has more recently been taken up and very actively engaged in off the Columbia River, off the Strait of Juan de Fuca, and to a less extent in other sections.

The Bureau conducted an inquiry into this matter by a biological assistant who is devoting his entire time to Pacific salmon problems, and in August, 1918, made known the results of the inquiry. The following data are extracted from the published report:

In Monterey Bay chinook salmon are taken exclusively by troll, and a large percentage are immature. Accurate figures are not yet available, but well over 50 per cent of the fish seen at Monterey are distinctly immature. This is shown by the age as determined by the scales, by the size of the fish, and by the size of the eggs in the ovaries.

Off the mouth of the Columbia River within the past four years trolling and purse-seining have increased rapidly. Four years ago there were no purse seines and but few troll boats operating in this section, probably not more than 20 or 30. In 1918 there were several dozen purse seiners and probably 2,000 trollers fishing just outside the mouth of the river. An examination of some of the fish brought in by this gear disclosed many immature specimens among them, although these constituted a rather small proportion of the catch at the time the examinations were made, August 12 and 13. However, at one of the canneries at Astoria there was about a ton of small fish which had been taken by troll, called locally "grayling," and a cursory examination showed that they were practically all immature. It should be noted that all reports available, derived from various sources, agree that the proportion of small and presumably immature, fish is much greater earlier in the season, particularly during May and June.

Outside the Strait of Juan de Fuca purse-seining has been carried on for a number of years. Silver salmon constitute a large proportion of the catch. The center of the industry is at Neah Bay. A report by Dr. Charles H. Gilbert ("The Salmon of Swiftsure Bank," 1913) contains a description of the fish taken here and shows that the majority are more or less immature.

Practically all of the fish taken thus by troll and purse seine in the open ocean are feeding and their stomachs are full of food. Within a few hours after they are taken from the water auto-digestion sets in and the fish soon become soft. The ribs loosen and the bellies frequently become so soft that they break through. Such fish are spoken of as being "belly-burned." At Monterey this is not a serious matter, so far as our observation goes, as the fish are delivered soon after being caught. In the Columbia River and Puget Sound regions, however, the fish are frequently in poor condition before they are delivered. The small fish seen in Astoria were in very poor condition and appeared hardly fit for human food. They were soft and badly "belly-burned" and the odor arising from them was most unpleasant.

The economic waste resulting from this fishing may be summarized as follows:

1. *Waste resulting from the taking of fish before they have attained full size.*—A large number of these fish lack one, two, three, and even four years of being mature, and in this time would increase to from twice to 20 times the weight when taken. This loss may be to some extent offset by the fact that fish are taken which before reaching maturity would fall prey to enemies other than man. There must be, however, comparatively few fish of the size taken

by trollers and purse seiners which would thus be captured by predacious animals. The results of the marking experiment with Yes Bay sockeyes on the Columbia River indicate that between 5 and 10 per cent returns may be expected from 4-inch fish planted in fresh water approximately 150 miles from sea. It seems very unlikely, therefore, that any considerable loss takes place after the fish have migrated, become accustomed to life in the ocean, and reached a size of from 1½ to 10 pounds. Undoubtedly a very high percentage of such fish would survive until fully mature. The taking of these fish before they reach full size is nothing less than sacrificing large future returns for much smaller immediate returns, and, as already shown, the quality of these smaller immediate returns is low.

2. *Waste resulting from the spoiling of fish.*—The poor condition in which many fish taken in the open ocean reach the packing houses has previously been commented on. At the best, this must result in a poorer quality of food and at the worst the salmon becomes so foul that even the most unscrupulous packer will discard them—a total loss. In cleaning the small fish, those below 5 pounds in weight, the butchers usually cut the body just back of the pectoral fins instead of removing merely the head, as is customary in cleaning the larger fish. Although there are no accurate figures bearing on this, the practice must increase the waste due to cleaning from about 25 to 40 per cent.

3. *Waste resulting from the injury of fish hooked but not landed.*—This is undoubtedly much larger than is generally supposed. No data are available, and they would be difficult to obtain. Not infrequently, however, the fishermen report that they have lost as many as they landed. A conservative estimate would perhaps be 2 fish lost for each 10 landed. Fish which have been hooked are frequently taken by gill nets and traps within the Columbia River. Occasionally the hook and spoon is found embedded in the jaws, but more often the jaws are split and badly torn. Many of the fish hooked and lost undoubtedly die, but what percentage is unknown.

The Bureau duly brought this subject to the attention of the fishery officials of the States of California, Oregon, and Washington, and assured them of its desire to assist them in any feasible manner in meeting this menace to the salmon industry. Up to the writing of this report the Bureau has received no request for assistance and is not advised of any remedial measures that have been adopted by the States concerned.

#### VESSEL FISHERIES OF SEATTLE.

The fishing fleet of Seattle, Wash., landed 834 trips during the year 1918, consisting of 17,091,695 pounds of fresh fish, having a value to the fishermen of \$1,887,653, from the fishing grounds along the coasts of Oregon, Washington, and Alaska. The largest quantities were taken from Gray's Harbor Grounds, Flattery Banks, west coast of Vancouver Island, Hecate Strait, and Portlock Bank. The products included halibut, 10,244,200 pounds, valued at \$1,528,846; cod, 85,300 pounds, valued at \$2,202; sablefish, 4,354,950 pounds, valued at \$271,167; "lingcod," 1,784,600 pounds, valued at \$62,292; rock-fishes, 620,770 pounds, valued at \$22,899; and sturgeon, 1,875 pounds, valued at \$247. Compared with the previous year, there was an

increase of 214 trips by fishing vessels, and of 2.64 per cent in the quantity and 8.56 per cent in the value of the products. The catch of halibut was not so large as in the previous year, but there was a notable increase in the production of sablefish, "lingcod," and rockfishes.

The fishery products taken in Puget Sound and landed by collecting vessels during the year amounted to 10,605,323 pounds, valued at \$912,598. This quantity included 8,929,745 pounds of salmon, valued at \$811,028, and the remainder consisted of steelhead, herring, smelt, flounders, sole, crabs, and various other species. Compared with the previous year, there was a decrease in the products landed by collecting vessels of 17.28 per cent in quantity and 7.68 per cent in value.

#### FISHERIES OF GREAT LAKES, LAKE OF THE WOODS, AND RAINY LAKE.

A canvass of the fisheries of the Great Lakes and certain contiguous waters for the calendar year 1917 was completed by the Bureau during the past fiscal year. The fisheries of the Great Lakes were ascertained to have employed 9,221 persons, the investment was \$10,555,669, and the products amounted to 103,759,223 pounds, valued at \$6,297,969. The principal species taken, including fresh, salted, and smoked fish, were carp, 7,163,347 pounds, valued at \$334,888; ciscoes, 53,429,325 pounds, valued at \$2,609,917; "blue pike," 2,102,803 pounds, valued at \$140,025; "wall eyed," 2,496,691 pounds, valued at \$298,271; sauger, 3,929,172 pounds, valued at \$240,035; sheephead or drum, 2,901,994 pounds, valued at \$70,936; suckers, 5,361,138 pounds, valued at \$204,825; lake trout, 13,325,389 pounds, valued at \$1,285,085; whitefish, 6,190,748 pounds, valued at \$723,167; and yellow perch, 4,206,011 pounds, valued at \$245,223. With the ciscoes are included lake herring, chub, longjaw, bluefin or blackfin, and tullibee.

Compared with the returns for 1908, published by the Bureau of the Census, there was an increase of 8.06 per cent in the number of persons engaged and of 119.27 per cent in the investment, but a decrease of 2.69 per cent in the quantity with an increase of 67.14 per cent in the value of the products. Compared with the statistics for 1903, collected and published by the Bureau, there was a decrease of 1.20 per cent in the number of persons engaged, an increase of 41.22 per cent in the investment, and an increase of 20.37 per cent in the quantity and 129.39 per cent in the value of the products.

In the fisheries of Lake of the Woods and Rainy Lake, including Lakes Kabetogama and La Croix, 195 persons were engaged; the investment was \$177,210; and the products amounted to 2,167,169 pounds, valued at \$118,508. The principal species taken were ciscoes, whitefish, pike, pike perch ("wall-eyed pike"), and suckers.

### BIOLOGICAL INQUIRY.

#### STUDY OF FISHES.

*Salmon investigations.*—There are so many significant questions concerning the habits, migrations, and propagation of the salmon in Pacific States and Alaska that the Bureau has long felt it desirable to attack their solution in a more adequate manner. With the begin-

ning of the last fiscal year a special assistant was engaged for continuous study of the habits of salmon entering streams of the Pacific States. The investigations previously undertaken in Alaska have also been continued. While the investigations in Alaska have been productive of some results which it has been possible to apply with profit in the fish-cultural operations and in the fishery regulations in that section, they must be continued for a further period before results of such definite character are secured as to warrant the publication of a report. The Bureau has now in hand a report presenting the data previously accumulated as bearing upon the migrations and growth of young salmon in the Sacramento and Columbia Rivers.

In the course of the year special biological inquiries were directed to the salmon taken in trolling and purse-seining operations off the coasts of Washington, Oregon, and California. The practical application of the ascertained facts to the regulation of the fishery is elsewhere referred to.

One of the results of the hearings of the American-Canadian Fisheries Conference in Seattle and Vancouver was an arrangement to conduct a joint investigation of the rate of migration of sockeye salmon from salt water into the Fraser River. Early in July, 1918, marking experiments on a large scale were undertaken by representatives of the Bureau of Fisheries and the Canadian Government in cooperation. Although the run of this species was very light that year, more than 4,000 fish were tagged and liberated, and a considerable number of these were subsequently recovered. Results of notable interest and practical importance were obtained and are covered in a report which is in course of publication.

Special interest also attaches to the results gained during this fiscal year from experiments in marking young sockeye salmon planted in the Columbia River in the spring of 1916. At that time about 50,000 yearling sockeyes hatched from eggs received from the Yes Bay (Alaska) hatchery and reared in ponds of the State hatchery at Bonneville, Oreg., were marked and liberated in the Columbia River. Salmon of this species have been found to return in the fourth and fifth years. Many of the marked fish returned during the summer of 1918, the fish being then in the fourth year of life. The marked fish recovered in the Columbia River (being of Alaskan stock) were found to be distinctly different in size and general appearance from the Columbia River bluebacks, representing the identical species, but resembling in every way the fish from the Yes Bay region, where the eggs were taken. Salmon of the Yes Bay type average about 6 pounds, whereas the Columbia River bluebacks this year averaged about 3 pounds. The large size of these fish is particularly significant as indicating that for at least one generation heredity rather than environment determines the size of the fish. This opens prospects for improvement in the quality of the run of fish through carefully conducted cultural operations.

*Pilchards on the northwest coast.*—During January, February, and March, 1919, a preliminary inquiry was conducted into the occurrence of pilchards on the northwest coast suitable for canning as sardines, especial attention being given to the following localities in Oregon and Washington: Coos Bay and Coquille River, Umpqua River, Yaquina Bay, Alsea Bay, Siletz River, Tillamook Bay, Netarts Bay, Columbia River, Willapa Harbor, and Grays Harbor.

It was learned that somewhat irregular runs of pilchards occur generally along the coast from April to October, especially in the regions of Coos Bay and Umpqua River. While it is believed that the fish are eminently suitable for canning as sardines or otherwise, the Bureau has not felt that the general trade conditions existing in the canning industries justified its giving immediate encouragement to new ventures in the canning of fish on the northwest coast or elsewhere. It is expected that further inquiries and observations may be made at an appropriate season.

*The paddlefish.*—One of the important fishes of the Mississippi Basin which is diminishing in numbers and seems threatened with extinction is the paddlefish, which is valued to some extent for its flesh but principally for the roe, which is useful for preparation as a relatively high grade of caviar. Up to the present time it has never been possible to secure definite information regarding the breeding habits of this fish. Realizing that a special effort must be directed at this problem before it may become too late, the Bureau, in cooperation with the conservation department of Louisiana, undertook a special study of the breeding habits and propagation of the paddlefish during the latter half of the fiscal year under report. Definite results were not secured, but it is believed that a groundwork was laid which may contribute toward solution of the problem with further attempts. Meantime it is interesting to record that experiments initiated at the fisheries biological station at Fairport, Iowa, in 1914, have shown that the paddlefish will live and grow for periods of years while inclosed in an artificial body of water such as the storage reservoir of the station.

*Spawning of squeteague.*—An investigation into the spawning habits and condition of the squeteague in Delaware Bay was conducted in May and June, 1919. It was found that spawning began a little before the middle of May and continued until the middle of June or later. Many fish were examined, townet hauls for the floating eggs were made, and temperatures and salinities were determined.

This body of spawning fish supports an extensive gill-net fishery, which is pursued in small skiffs, the New Jersey law limiting each boat to the use of 50 fathoms of gill net. Experiments were made in the artificial fertilization of eggs from the fish thus taken; this proved to be entirely feasible, and the eggs so fertilized were returned to the water directly on the grounds.

It is evident that it would be productive of good results if the commercial fishermen should become educated to the desirability and advantage of saving the ripe eggs from fish taken for market during this season, fertilizing the eggs and returning them to the water.

#### FISH IN RELATION TO MOSQUITO CONTROL.

In a previous report mention is made of the practical services rendered by this Bureau in cooperation with the Bureau of Public Health Service in protecting the health of soldiers in Army cantonments. A report of investigation and operations conducted in the vicinity of Camp Hancock has been published conjointly by the two bureaus.

In an effort to determine as precisely as possible the conditions of effective control of mosquitoes by fish, the Bureau has continued

its cooperation with the Bureau of Entomology at Mound, La., where experiments are conducted looking to the improvement of health as regards malaria in rural communities and to the protection of farm labor in the South.

Experiments of like nature are being prosecuted in northern waters where, though mosquito-borne diseases are less prevalent, nevertheless the economic losses attributable to the prevalence of mosquitoes are of great significance.

#### EXPERIMENTAL FISH CULTURE.

Previous reports have dwelt upon the importance of fish-cultural experiment work and the progress in this field which has been made in connection with fisheries biological station at Fairport, Iowa. The experiments and investigations have continued to show favorable progress, and at the close of the fiscal year the Bureau had taken steps to apply some of the results hitherto gained at Fairport for the improvement of pond fish-cultural operations at several of its regular stations. The field of experimental work in fish culture is so broad, so complex, and so little surveyed, that it is a matter of regret that the means are wanting for the effective prosecution of studies of this character under the very diverse conditions encountered in different parts of the country and with reference to a greater number of species of fish.

#### SHELLFISH INVESTIGATIONS.

*Oysters.*—The problems of oyster culture continue to be of such critical importance that the Bureau has been impelled to devote to their solution as great a measure of its resources as could legitimately be applied to one object. While the investigations have not been localized more than was essential for the accomplishment of useful results, the primary seat of activities has been in the vicinity of Milford, Conn., where a temporary field laboratory is maintained for studies of the oyster.

Examination of the waters of this region revealed the fact that a large number, perhaps more than half, of the leased grounds have ceased to be worked because of the small yield of oysters thereon, which is due, in turn, to the general failure of set. The strike of set during the past two years has, in fact, been practically negligible. Consequently, the investigation has been directed primarily toward ascertaining the cause of the failure of the set.

Following suggestions arising from earlier investigations, it was endeavored in 1918 to work out suitable methods for following up the movements of the oyster larvæ with the view of ascertaining just where to place cultch immediately before the time for spatting or setting to occur. The centrifugal machine used during the season of 1917 for separating larvæ from the water was largely superseded this year by a series of screens or sieves of copper-wire cloth of successive stages of fineness from 40 to 200 meshes to the inch. Passing samples of water through the sieves seems to yield as satisfactory results as the centrifuge in separating the oyster larvæ from other objects of different sizes, besides possessing the advantage of roughly classifying the larvæ according to size and age.

The first free-swimming larvæ were found July 16, 1918; the period of greatest abundance was from August 9 to 26, and none was observed after August 30. As the larvæ were found to be free-swimming for a period of about 20 days, it is evident that the bulk of the spawning occurred about August 1. Set was found during the last week in August on most of the beds in water not over 4 or 5 fathoms deep, but practically all of this set died except that which attached in the very early part of the season.

A tentative conclusion drawn from this investigation is that it is of prime importance to secure an early setting, such as results from the spawning of oysters in the shallow and warmer waters of harbors and mouths of rivers. Since it is just such beds that are generally most affected by pollution in the form of sewage and trade wastes, which may be fatal to the life of the free-swimming larvæ, it is evident that the matter of the possible effect of pollution on the occurrence of oyster set demands serious consideration. With the cooperation of the water laboratory of the Bureau of Chemistry studies have, therefore, been undertaken with regard to the nature and the effect of the pollutants introduced in the shallow waters.

Further investigations relating to the natural propagation of oysters have been conducted in Great South Bay, Long Island, and Narragansett Bay, R. I.

A very serious condition has manifested itself in oyster beds of a large section of the York River in Virginia, where for several years the oysters have been rendered virtually valueless for market. Examinations of the oysters, begun in November, 1918, revealed the fact that they were affected with a green coloration associated with watery and lean meats. This condition is quite distinct from that known as "green gill" and does not appear to be in all respects of the character of greening which in other localities has been attributed to the storage of copper. No cause has yet been found for the condition observed, which is, perhaps, a very indirect result of disturbance of environmental conditions. The investigation is still in progress, and the Bureau expects to continue it by regular periodic observations for such period of time as may be necessary to arrive at definite conclusions. Since chemical problems are involved, the Bureau has enlisted the cooperation of the water laboratory of the Bureau of Chemistry in the further prosecution of the study.

A poor condition of oysters presented itself, likewise, in Apalachicola Bay during the early winter. After careful investigations were conducted by the Bureau, the condition was attributed to a deficiency of rain in preceding months. At a later time, and after a period of increased rainfall, it was learned that the oysters had fattened and resumed a normal condition.

Late in the fiscal year the Bureau was enabled to undertake at slight expense, by cooperation with the New Jersey State Agricultural Experimental Station, a study of the feeding, growth, and propagation of oysters in the vicinity of Barnegat Bay.

The service of the Bureau to the oyster industry has been rendered more effective by the cooperation extended by several State departments, notably in Connecticut, Maryland, New Jersey, New York, and Rhode Island.

*Sea mussels.*—The sea mussel is one of the largely unutilized resources of the North Atlantic coast. While it has not been difficult

to create a demand for sea mussels properly prepared, and while some packers have been interested to preserve mussels for market, difficulties have been encountered in obtaining at the right time an adequate supply of mussels in condition for use. During the fiscal year 1918, the Bureau conducted a reconnoissance of the mussel beds of the southern coast of New England and along the shores of Long Island Sound. In the fiscal year 1919 a similar investigation was made on the coast of Maine, with valuable aid from the commission of sea and shore fisheries of Maine. A summary of the results as reported by the investigator may be given:

1. A survey of the mussel beds lying near low-tide level was made between Portland and Eastport. The most important beds were centered in six regions: Casco Bay, Medomak River, St. George River, Deer Isle, Frenchmans Bay, and Jonesport.

2. Within these limits more than 1,200 acres of natural mussel beds were located which were estimated to yield 1,279,000 bushels. Not more than 10 per cent of this area supported a growth of first-class, marketable shellfish. The rest of it was covered with a small, undersized stock of poor quality that would never amount to anything unless transplanted to deeper water and more advantageous situations.

3. The best beds lie at or below low-tide mark and yield from 2,500 to 5,000 bushels per acre.

4. Artificial cultivation, by transplanting young or seed mussels from beds situated between tide marks to areas in deep water, where conditions are favorable for growth and fattening, would result in an enormous production of marketable shellfish.

5. There is no oyster industry on the Maine coast with which a mussel industry might conflict.

6. The water of the bays and estuaries on the Maine coast is unusually pure and free from pollution, which makes them most desirable areas for the production of marketable mussels.

7. There is a small demand for Maine mussels in Chicago which is being supplied from the beds in Frenchmans Bay.

8. Several of the leading packing houses located on the North Atlantic coast are interested in the canning of mussels and are taking steps to put the product on the market. They should be encouraged in this effort by help in solving the problems that arise in the handling and preserving of the shellfish and by advertising any products of real merit that are produced.

9. It is believed that the development of a mussel fishery is a practical thing and that it will add considerably to the wealth and food supply of the Nation.

*Fresh-water mussels.*—The investigations and experiments bearing upon the propagation of fresh-water mussels, conducted in connection with the fisheries biological station at Fairport, have continued to yield valuable results. One of the most significant experiments was conducted in the Mississippi River at Lake Pepin during the summer of 1918, when fish, after infection with the glochidia of fresh-water mussels, were kept in an inclosure 12 feet square, erected in shallow water in the lake. This small pen was provided with a board bottom over which a thin layer of sand was laid, and after it was placed in water of suitable depth in the lake it was stocked with

172 fish of various species bearing an artificial infection of glochidia of the Lake Pepin mucket (*Lampsilis luteola*). Seventy-nine of the fish were retained in good condition beyond the period of 14 days regarded as necessary for the completion of the stage of parasitism. In all, 11,199 living young Lake Pepin muckets were taken from the pen on September 23 (besides 502 individuals removed on previous dates). This represented an average yield of a little over 80 living mussels per square foot in addition to a few of other species resulting from natural infection. This experiment is of much significance as bearing upon the success of the artificial propagation of the Lake Pepin mucket.

*Miscellaneous studies of shellfish.*—While it has not been feasible to continue actively the investigations of the blue crab which have been so successfully prosecuted in the fiscal years immediately preceding, the Bureau has completed reports dealing with the blue-crab fishery of the Chesapeake Bay and with the life history of the blue crab. These reports, which were in process of publication at the close of the fiscal year, will undoubtedly be of material value to State authorities concerned with the protection of the crab and the preservation of the fishery in undiminished force. It has been gratifying to learn that a greatly increased catch of blue crabs in these waters has ensued, in consequence, as it is believed, of wise protective measures based in great part upon the results of the Bureau's investigations.

At the Key West, Fla., biological station, inquiries into the habits and growth of the spiny lobster have been continued, and upon the basis of useful information furnished to the State authorities of Florida, more effective protective measures have been enacted into law.

Through the cordial cooperation of the United States National Museum, the Scripps Institution for Research at La Jolla, Calif., and the California Fish and Game Commission the Bureau was enabled, at scant cost, to conduct investigations into the life history of the spiny lobster of the southern coast of California. Results of substantial interest were obtained.

The Bureau also continued, during a portion of the fiscal year, its examination into the shellfish resources of the northwest coast.

#### ADING PRODUCTION AND PREVENTING WASTE.

In view of the shortage of food supply which has confronted the country, the Bureau deemed no service more important than that which could be rendered to combat conditions responsible for losses of preserved fish or wastage due to a lack of coordination of supply and demand, in addition to preventing waste of surplus catches of fish and bringing new species of fish into the market. Some of these problems could best be attacked by methods of scientific inquiry, such as the investigation of the preparation of fish by methods of dehydration and the study of methods of preventing the deleterious reddening of salt codfish. In some instances the situation seemed to demand not investigation, but action, and in such cases the scientific personnel of the Bureau was ready and effective for the performance of any service that the situation seemed to require. Consequently, it is proper in connection with the report of scientific investigations to

mention the cooperative services rendered in the campaign for increased consumption of fish from the Gulf of Mexico involving efforts to facilitate capture, transportation, and sale of the fish; the giving of demonstrations and personal instruction in the proper cure of Alaska herring; the partial equipment of an experimental fishery-products laboratory in southern California; and the conduct of experiments in the preservation of fish by methods of canning, salting, and smoking.

While legislation for the protection of fish and shellfish is a function of the several States, it is one of the primary objects of the scientific activities of the Bureau of Fisheries to acquire and distribute such information as will be useful in the framing and enforcement of wise protective laws. Allusion has already been made to assistance afforded the authorities of several States with regard to the protection of the salmon, the blue crab, and the spiny lobster. Cooperation of like nature has been extended in relation to various other fishery resources, notably the fresh-water mussels.

It has been evident for a number of years that the future of the fresh-water mussel industries was largely dependent upon the adoption of proper measures of conservation. An important step in the direction of conservation was taken when, following a series of investigations by the Bureau of Fisheries, Congress authorized the conduct of the artificial propagation of mussels in connection with the establishment of the fisheries biological station at Fairport. The success of artificial propagation, however, is dependent upon the adoption and enforcement of appropriate protective measures, and for this phase of conservation the States alone are responsible. It is not only important that the several States concerned should enforce measures of protection, but, since the mussel resources are frequently found in interstate streams, it is an essential condition of the best results that there should be identical or concurrent legislation among the several States exercising jurisdiction over the different portions of a stream.

Much interest in the matter of concurrent legislation has been manifested not only by the manufacturers of pearl buttons and the mussel fishermen, but by responsible officials of several States as well. The Bureau of Fisheries has also endeavored to cooperate with all interested persons in the devising of protective measures which would be effective in the accomplishment of the desired results without creating greater disturbance of economic conditions than is inevitable. Having been informed that serious efforts were being made in several States of the Mississippi Basin to have protective legislation enacted by the legislatures then in session, the Bureau prepared a statement treating of the necessity for measures of conservation, and this statement was comprised in a paper entitled "Fresh-Water Mussels: A Valuable National Resource Without Sufficient Protection," issued in February and widely distributed in the States concerned.

It seems not inappropriate to direct attention to the fact that the scientific activities of the Bureau have suffered in consequence of the wide disparity between the salaries paid in the Bureau and those paid for work of similar character in other branches of the Government service, and more especially in outside institutions of learning or

research. In consequence of this condition, it is found impossible to keep the lower positions continuously filled, and the effective personnel is always less than the nominal personnel as authorized by the Congress. That a gratifying degree of progress in investigational work has been made during the fiscal year under report is due in great measure to the labors of loyal and self-sacrificing assistants who have devoted themselves permanently or temporarily to national service through the Bureau of Fisheries. It is only fair to them that this statement should be made.

#### BIOLOGICAL LABORATORIES.

Owing to exceptional conditions none of the Bureau's biological laboratories were in regular and full operation during the fiscal year 1919.

The laboratory at Beaufort, N. C., had been surrendered to the Navy Department for the period of the war, the Bureau having entirely withdrawn except as the experiments in terrapin culture were continued in such manner as to prevent the loss of valuable stock or the interruption of experiments which involved observations and records during periods of several years. At the close of the fiscal year negotiations between the Department of Commerce and the Navy Department were in progress looking to the return of the station to this Bureau.

The Woods Hole (Mass.) laboratory was largely occupied by the Navy Department, and the Bureau had either abandoned temporarily or transferred to other points the investigations normally conducted at this station.

The Fairport (Iowa) biological station was in fuller operation than any other, but since it had been impossible to replace immediately the main building destroyed by fire in December, 1917, the station was operated during the summer of 1918 with a reduced force. Nevertheless, through the loyal cooperation of the permanent personnel of the station and the cheerful submission by temporary investigators to service under conditions of discomfort and inadequate facilities, the progress of the work of the station suffered much less interruption than might have been expected. Some important phases of the work of this station have already been alluded to in connection with various special subjects.

In the early part of the fiscal year advertisements were made soliciting bids for the construction of a fireproof building at Fairport, as authorized by Congress with the appropriation of \$80,000 for its construction and equipment. Notwithstanding that the Bureau had made a special effort to reduce the cost of the building as much as possible without sacrificing the essentials of safety and efficiency, the lowest bid received was found to be beyond the available appropriation. Steps were taken immediately to revise the plans, partly by the elimination of some desirable facilities and partly by the most careful attention to such details of construction as might permit a reduction in costs without sacrifice of value. Bids were again solicited during the spring of 1919, but again none was received that came within the amount of the appropriation. It was, therefore, deemed unavoidable that a supplemental estimate be submitted to the Congress. This having been done, an additional appropriation of

\$10,000 was made available, and the work of construction is in progress.

At the Key West (Fla.) biological station further progress in construction has been made, and the station is rendering a useful, if as yet somewhat limited, service. The inadequacy of the appropriations granted for the construction and equipment of this laboratory, as well as for its personnel, are matters which will be presented to the Congress in connection with the estimates for the fiscal year 1921. The activities of the station at present have to do with the spiny lobster, with results as indicated on a preceding page, and with the habits, distribution, and propagation of marine fishes.

The Bureau maintains no biological laboratory on the west coast, although it enjoys at times the courtesies of other laboratories existing on that coast. It has also several assistants engaged actively in investigations localized in Pacific Coast States. Since a local headquarters has been found desirable in addition to the office maintained at Seattle, the Bureau has reopened an office in San Francisco. With one resident officer in charge, this office serves a very useful purpose, not only as a headquarters and base of supplies for investigators and other employees, but as an agency for the transaction of local business of the Bureau and for the dissemination of information to the public. Appreciation of the service of this office is attested by the increasing number of persons who call to consult the Bureau's publications, to secure its economic circulars and memoranda, or to solicit information on diverse subjects relating to fish and fisheries.

## PROPAGATION AND DISTRIBUTION OF FOOD FISHES.

### RÉSUMÉ OF THE OPERATIONS.

The artificial propagation and distribution of food fishes, together with the various collateral activities closely associated therewith, were attended by serious drawbacks in 1919. Difficulty in obtaining and retaining the services of qualified men at the compensation allowed by Congress; the increasing cost of labor, materials, and supplies; and increased charges for the movement of fish-distributing cars, amounting to more than 50 per cent since January 1, 1919, were among the circumstances that combined to retard operations and that compelled most careful planning, efficient execution, and sustained interest and zeal in order to maintain the magnitude and quality of the work without exceeding the funds available.

Nevertheless, the year's output of food and game fishes was larger than ever before. The total number of fishes and fish eggs distributed was about 5,876,985,000, an increase of 718,000,000 over 1917, and about 1,778,000,000 over 1918. Nearly 733,000,000 of fertilized eggs were sent out from the Federal hatcheries; most of these were from the commercial species of the Great Lakes and from Pacific salmons, and nearly all were consigned to State hatcheries, where incubation was completed, the young being planted in local waters. Upward of 440,000,000 eggs of marine fishes were obtained from commercial fishermen of New England, fertilized and planted on the spawning grounds, in addition to the large numbers handled at the hatcheries. Over 4,500,000 of young fish were distributed as

fry, mostly lake trout, whitefish, cisco, and pike perch on the Great Lakes; shad, salmon, yellow perch, and striped bass on the coastal rivers; carp and buffalofish in the interior waters; and cod, haddock, pollock, and flounder on the Atlantic seaboard. The output of fingerlings, yearlings, and adults was upward of 151,000,000, with catfish, carp, chinook salmon, sockeye salmon, brook trout, rainbow trout, and crappies predominating. Although the distribution of fish in the fingerling stage decreased about 10 per cent from 1918, this falling off was practically confined to one species and indicates no slackening of effort. On the contrary, facilities for fingerling production are being increased, particularly as regards the salmon of the Pacific coast.

Comparing the general distribution of 1919 and 1918, it may be noted that there was an increase in cisco, rainbow trout, Atlantic salmon, landlocked salmon, buffalofish, carp, shad, pike perch, yellow perch, crappies, pollock, and haddock, and there was a decrease in whitefish, chinook salmon, steelhead salmon, and lake trout.

SUMMARY BY SPECIES OF THE DISTRIBUTION OF FISH AND FISH EGGS DURING THE FISCAL YEAR 1919.

Species.	Eggs.	Fry.	Adults, yearlings, and finger- lings.	Total.
Catfish.....			12,639,830	12,639,830
Carp.....		23,699,000	19,754,060	43,453,060
Buffalofish.....		111,100,000	2,596,335	113,696,335
Shad.....		84,024,250		84,024,250
Alewife.....		25,000		25,000
Whitefish.....	111,650,000	198,715,000		310,365,000
Lake herring (cisco).....	146,700,000	86,180,000		232,880,000
Chinook salmon.....	11,802,500	1,016,600	34,400,150	47,219,250
Sockeye salmon.....	24,140,100	39,756,000	37,642,220	101,538,320
Silver salmon.....		7,464,020	2,345,730	9,809,750
Humpback salmon.....		5,426,500	369,960	5,796,460
Chum salmon.....		6,253,640	3,663,760	9,917,400
Atlantic salmon.....		2,390,000	700	2,390,700
Landlocked salmon.....	405,125	424,870	182,560	1,012,555
Steelhead salmon.....	805,000	128,125	1,493,290	2,426,415
Rainbow trout.....	2,939,820	38,500	3,409,190	6,387,510
Blackspotted trout.....	133,000	200,000	2,875,100	3,208,100
Loch Leven trout.....			73,000	73,000
Lake trout.....	3,068,000	28,495,475	765,180	32,328,655
Brook trout.....	107,000	4,158,050	7,638,615	11,903,665
Grayling.....		275,000		275,000
Smelt.....	3,000,000	6,437,000		9,437,000
Pike and pickerel.....			375,935	375,935
Freshwater drum.....			18,975	18,975
Crappies.....			15,837,865	15,837,865
Largemouth black bass.....		425,045	1,100,420	1,525,465
Smallmouth black bass.....		195,700	43,745	239,445
Rock bass.....			75,460	75,460
Warmouth bass.....			1,060	1,060
Sunfish.....		3,050	1,350,115	1,353,165
Pike perch.....	406,200,000	175,550,000	10,710	581,760,710
Yellow perch.....	22,660,000	179,289,500	2,353,800	204,303,300
White perch.....		2,035,000		2,035,000
White bass.....			8,865	8,865
Yellow bass.....			600	600
Striped bass.....		13,540,000		13,540,000
Mackerel.....		9,508,000		9,508,000
Cod.....	243,870,000	64,331,000		308,201,000
Pollock.....		703,972,000		703,972,000
Haddock.....	200,390,000	129,592,000		329,982,000
Winter flounder.....		2,654,192,000		2,654,192,000
Miscellaneous fishes.....		1,000,000	747,250	1,747,250
Lobster.....		7,500,000		7,500,000
Total.....	1,177,870,545	4,547,340,325	151,774,480	5,876,985,350

## HATCHERIES OPERATED.

There has been no addition to the list of regular hatcheries operated. A hatchery provided by the National Park Service of the Department of the Interior was constructed under the supervision of the Bureau in Glacier National Park and is being maintained as an auxiliary of the Bozeman (Mont.) station. Its special function is to maintain and increase the supplies of fish in the various waters of the park. The construction of the hatchery in Rhode Island has been further delayed by the inadequacy of the available appropriation, and Congress will have to provide a substantial addition to the original sum in order that the hatchery and other necessary structures may be completed. The shad hatchery in Maryland near the mouth of the Susquehanna River, whose operations were suspended by order of the Secretary because of failure of the State to conform with the requirements imposed by Congress, has remained closed, and its equipment has been largely transferred to other stations.

The hatchery work as carried on at the 70 main and auxiliary stations in 1919 was located in 33 States and Alaska. The following list, arranged in alphabetical order by States, shows the fish-cultural stations and auxiliaries in operation during 1919, with the fishes handled at each. Mere egg-collecting stations are not included.

## MAIN AND AUXILIARY FISH-CULTURAL STATIONS OPERATED DURING THE FISCAL YEAR 1919.

State and locality.	Species handled.
Alaska:	
Afognak.....	Sockeye and humpback salmons.
Yes Bay.....	Do.
Arkansas: Mammoth Spring.....	Largemouth and smallmouth black basses.
California:	
Baird.....	Chinook salmon.
Battle Creek.....	Do.
Mill Creek.....	Do.
Colorado: Leadville.....	Blackspotted, brook, lake, and rainbow trouts.
Georgia: Cold Springs.....	Bass, sunfish, catfish.
Idaho: Paris <sup>a</sup> .....	Whitefish.
Illinois:	
Meredosia.....	Rescued fishes.
Quincy.....	Do.
Iowa:	
Fairport.....	Do.
Manchester.....	Brook and rainbow trouts, bass, sunfish.
Bellevue.....	Rescued fishes.
North McGregor.....	Do.
Kentucky: Louisville.....	Brook and rainbow trouts, bass, sunfish.
Louisiana: Atchafalaya.....	Buffalofish.
Maine:	
Boothbay Harbor.....	Cod, haddock, flounder.
Craig Brook.....	Atlantic and landlock salmons, brook trout.
Green Lake.....	Landlocked and steelhead salmons, brook trout, smelt.
Grand Lake Stream.....	Landlocked salmon.
Maryland: Bryans Point.....	Shad, yellow perch.
Massachusetts:	
Berkshire.....	Brook and rainbow trouts, smallmouth black bass.
Gloucester.....	Cod, haddock, pollock, flounder.
Woods Hole.....	Cod, flounder.
Michigan:	
Northville.....	Brook and rainbow trouts, smallmouth black bass.
Alpena.....	Lake trout, whitefish.
Bay City.....	Pike Perch.
Charlevoix.....	Lake trout, steelhead salmon, whitefish, pike perch.
Detroit.....	Pike perch.
Minnesota:	
Duluth.....	Brook and lake trouts, whitefish, pike perch.
Homer.....	Black bass, rock bass, rescued fishes.
Mississippi:	
Tupelo.....	Black bass, crappie, sunfish, warmouth bass.
Friars Point.....	Rescued fishes.
Missouri: Neosho.....	Catfish, rainbow trout, black bass, crappie, sunfish.

<sup>a</sup> Auxiliary of the Springville (Utah) hatchery.

## MAIN AND AUXILIARY FISH-CULTURAL STATIONS OPERATED DURING THE FISCAL YEAR, 1919—Continued.

State and locality.	Species handled.
Montana:	
Bozeman.....	Blackspotted, brook, and rainbow trouts, grayling.
Glacier National Park.....	Blackspotted, brook, and rainbow trouts.
New Hampshire: Nassau.....	Brook and rainbow trouts, landlocked salmon, smallmouth black bass.
New York: Cape Vincent.....	Brook and lake trouts, whitefish, cisco, yellow perch.
North Carolina:	
Edenton.....	Shad, black bass, sunfish, yellow perch, white perch.
Weldon.....	Striped bass.
Ohio: Put in Bay.....	Carp, whitefish, pike perch, yellow perch.
Oregon:	
Clackamas.....	Chinook and steelhead salmon, blackspotted, brook, and rainbow trouts.
Applegate.....	Chinook, silver, and steelhead salmon.
Rogue River.....	Chinook, silver, and steelhead salmon, blackspotted and rainbow trouts.
Upper Clackamas.....	Chinook, silver, and steelhead salmon.
Willamette Falls.....	Shad.
St. Helens.....	Do.
South Carolina: Orangeburg.....	Catfish, black bass, sunfish.
South Dakota: Spearfish.....	Blackspotted, brook, lake, and Loch Leven trouts, steelhead salmon.
Tennessee: Erwin.....	Brook and rainbow trouts, black bass, sunfish.
Texas: San Marcos.....	Black bass, sunfish.
Utah: Springville.....	Blackspotted, brook, and rainbow trouts.
Vermont:	
St. Johnsbury.....	Brook, lake, and rainbow trouts, landlocked and steelhead salmon, smallmouth black bass.
Holden.....	Brook and lake trouts, landlocked and steelhead salmon.
Swanton.....	Pike perch, yellow perch.
Virginia: Wytheville.....	Brook and rainbow trouts, black bass, sunfish.
Washington:	
Baker Lake.....	Chinook and sockeye salmon.
Birdsview.....	Chinook, chum, humpback, silver, sockeye, and steelhead salmon, blackspotted trout.
Darrington.....	Chum and silver salmon.
Brinnon.....	Chum, silver, and steelhead salmon.
Sultan.....	Chinook, silver, and steelhead salmon.
Quinault.....	Chinook, silver, and sockeye salmon.
Duckabush.....	Chum, humpback, and silver salmon.
Quilcene.....	Chinook, chum, humpback, silver, and steelhead salmon.
Big White Salmon <sup>a</sup> .....	Chinook salmon.
Little White Salmon <sup>a</sup> .....	Chinook, chum, and sockeye salmon.
West Virginia: White Sulphur Springs.....	Brook and rainbow trouts, black bass, sunfish.
Wisconsin: La Crosse.....	Brook and rainbow trouts, rescued fishes.
Wyoming:	
Saratoga.....	Blackspotted, brook, and rainbow trouts, steelhead salmon.
Yellowstone National Park <sup>b</sup> .....	Blackspotted trout.

<sup>a</sup> Auxiliary of the Clackamas (Oreg.) hatchery.<sup>b</sup> Auxiliary of the Bozeman (Mont.) hatchery.

Five special railway cars employed in distributing the output of the hatcheries traveled 97,571 miles, and detached messengers in charge of special shipments of fish traveled 425,966 miles. Distributions were made, as usual, in every State and Alaska.

The United States Railroad Administration adopted a new tariff for the movement of fish cars, which went into effect January 1, 1919. The charge for a one-way movement of a car is 10 one-way adult fares, with a minimum charge of \$15. This is a material increase over the average rate formerly paid by the Bureau. The United States Railroad Administration also adopted new regulations governing the transportation of live fish in cans and fish eggs in crates in regular baggage service. Effective May 1 in southeastern territory, June 15 in eastern territory, and April 1 in western territory, the baggage tariff was changed to provide for handling not to exceed twenty 10-gallon cans of live fish or 20 crates of fish eggs, or 20 such containers combined.

During the year there were received 8,603 applications for fish for interior waters, most of the applications bearing the indorsement

of a Senator or Representative in Congress. It has been possible to take favorable action on practically all of these applications, the only exception being in the case of the smallmouth black bass, the demand for which is far in excess of the output of the few hatcheries at which this species can be successfully produced.

## RELATIONS WITH THE STATES IN FISH CULTURE.

Practical cooperation with the States has continued to prevail throughout the country. In several States egg-collecting stations have been operated jointly, the eggs taken being developed in the hatcheries most conveniently located or from which distribution of the resulting fry could be most advantageously accomplished.

Large numbers of eggs and limited numbers of young fish have been donated to the State fish commissions. This cooperation was extended to 29 States and covered upward of 670,000,000 eggs and over a million young fish, as shown in the following table. On the other hand, various States have made similar donations to the Bureau.

## ALLOTMENT OF FISH AND FISH EGGS TO STATE FISH COMMISSIONS DURING THE FISCAL YEAR 1919.

[All figures are for eggs unless otherwise indicated. Fingerlings are designated *a* and fry *b*.]

State and species.	Number.	State and species.	Number.
California: Chinook salmon.....	11, 802, 500	New Jersey—Continued.	
Connecticut:		Steelhead salmon.....	25, 000
Catfish.....	<i>a</i> 1, 100	Yellow perch.....	21, 500, 000
Crappie.....	<i>a</i> 3, 600	New York:	
Sunfish.....	<i>a</i> 1, 400	Lake trout.....	1, 800, 000
Yellow perch.....	<i>a</i> 1, 625	Whitefish.....	9, 000, 000
Idaho: Rainbow trout.....	50, 000	Lake herring.....	32, 500, 000
Illinois: Whitefish.....	5, 000, 000	Landlocked salmon.....	<i>b</i> 15, 000
Indiana: Pike perch.....	8, 050, 000	Steelhead salmon.....	200, 000
Iowa:		Strawberry bass.....	<i>a</i> 100
Rainbow trout.....	70, 000	Sunfish.....	<i>a</i> 100
Rock bass.....	<i>a</i> 13, 000	Pike perch.....	60, 000, 000
Pike perch.....	5, 000, 000	Ohio: Whitefish.....	10, 800, 000
Kentucky:		Oklahoma:	
Brook trout.....	<i>a</i> 150	Rainbow trout.....	<i>a</i> 7, 800
Rainbow trout.....	<i>a</i> 4, 250	Black bass, largemouth.....	<i>a</i> 3, 600
Yellow perch.....	<i>b</i> 100, 000	Black bass, smallmouth.....	<i>a</i> 400
Maine: Landlocked salmon.....	405, 127	Oregon:	
Maryland:		Blackspotted trout.....	121, 000
Rainbow trout.....	50, 000	Rainbow trout.....	765, 000
Rock bass.....	<i>a</i> 2, 900	Sockeye salmon.....	3, 440, 100
Sunfish.....	<i>a</i> 1, 415	Pennsylvania:	
Sucker.....	<i>b</i> 1, 000, 000	Whitefish.....	37, 070, 000
Massachusetts: Pike perch.....	5, 100, 000	Lake herring.....	88, 700, 000
Michigan:		Pike perch.....	15, 050, 000
Lake trout.....	1, 000, 000	Rhode Island:	
Whitefish.....	20, 000, 000	Black bass, smallmouth.....	<i>b</i> 7, 500
Pike perch.....	288, 800, 000	Pike perch.....	<i>b</i> 200, 000
Minnesota:		South Dakota:	
Lake trout.....	250, 000	Brook trout.....	<i>a</i> 45, 000
Rainbow trout.....	50, 000	Rainbow trout.....	<i>a</i> 50, 000
Steelhead salmon.....	125, 000	Tennessee: Rainbow trout.....	42, 700
Black bass.....	<i>a</i> 6, 500	Vermont:	
Missouri: Yellow perch.....	{ 160, 000	Steelhead salmon.....	50, 000
Montana:		Pike perch.....	16, 200, 000
Catfish.....	<i>a</i> 2, 400	Washington:	
Brook trout.....	<i>a</i> 3, 000	Rainbow trout.....	100, 000
Rainbow trout.....	1, 000, 000	Steelhead salmon.....	230, 000
Black bass.....	<i>a</i> 700	Wisconsin:	
Crappie.....	<i>a</i> 1, 300	Catfish.....	<i>a</i> 7, 200
Yellow perch.....	<i>a</i> 780	Whitefish.....	20, 000, 000
Nevada: Rainbow trout.....	25, 000	Black bass.....	<i>a</i> 5, 000
New Hampshire:		Wyoming:	
Rainbow trout.....	<i>a</i> 2, 224	Rainbow trout.....	100, 000
Pike perch.....	6, 000, 000	Steelhead salmon.....	50, 000
New Jersey:		Total.....	{ 670, 716, 427
Rainbow trout.....	35, 000	<i>a</i> 165, 544	
		<i>b</i> 1, 362, 500	

## PROPAGATION OF COMMERCIAL FISHES OF GREAT LAKES.

While there were many discouraging features connected with the propagation of the commercial fishes of the Great Lakes, the aggregate output of the hatcheries was nearly twice as large as in 1918. Unfavorable weather during the spawning season, together with the scarcity of skilled labor, tended to reduce the numbers of lake trout and whitefish produced, but the poor showing in that branch of the work was in part compensated for by the large increase in the output of cisco and pike perch, the production of which was six times greater than in the preceding year.

For the first time in its history, the Duluth hatchery was stocked with pike-perch eggs collected in State waters, this being made possible through an arrangement with the State authorities for co-operative work at Pike River. The Bureau's share of the operations was 40,000,000 eggs.

A temporary hatchery established at Bay City, Mich., on Saginaw Bay, was equipped with apparatus from other Michigan stations and supplied with water from the city mains for the purpose of utilizing the large number of pike-perch eggs which were reported to be obtainable from the commercial fishermen of that region. The fishermen cooperated to the fullest possible extent in supplying eggs, and the success of the collections far exceeded all expectations. Consignments of eggs from this station were as follows: Two hundred and eighty-eight million eight hundred thousand to the Detroit State hatchery; 60,000,000 to the New York Conservation Commission, and 29,250,000 to the auxiliary hatchery of the Bureau at Charlevoix. The 95,400,000 eggs which were retained at Bay City were lost owing, it is supposed, to chlorine used by the city authorities for clarifying and purifying the water. It is evident that favorable work in pike-perch propagation may be done at this point, and the establishment of a hatchery with a capacity of at least 1,000 jars is desirable. This plant could handle other fish besides pike perch, and there is particular need for artificial propagation addressed to local ciscoes or lake herrings.

In the Lake Michigan and Lake Huron fields covered by the auxiliaries of the Northville station, it was necessary, owing to lack of men, to reduce the number of egg-collecting points formerly operated, which condition, combined with abnormally warm weather and a small run of fish, resulted in the taking of only 33,269,000 lake-trout eggs, less than half the previous year's record. Whitefish eggs for the substation at Charlevoix to the number of 35,548,000 were secured from Lakes Michigan and Huron and were supplemented by shipments of 64,680,000 eggs from Lake Erie, all of poor quality. In the whitefish operations of the Put in Bay hatchery in Lake Erie, 420,650,000 eggs were collected, all but 50,000,000 being obtained from fish taken by commercial fishermen. A considerable proportion of these eggs were consigned to the various State fish commissions, and upward of 126,000,000 vigorous fry were liberated from the Put in Bay hatchery.

The Cape Vincent hatchery had an unusually successful season. For the first time since its establishment, no lake-trout eggs were shipped from other stations, full reliance being placed on home collections. Whitefish eggs to the number of 93,510,000 were secured

from fishermen of Lake Ontario, the great bulk of this take coming from the Canadian side of the lake under an arrangement with the fishery authorities of Canada. The hatchery was overstocked, and consignments of eggs were made to New York, Pennsylvania, and Canadian hatcheries. Fisheries at Fair Haven and Sodus Point yielded 218,000,000 eggs of the cisco, and fisheries in the eastern end of the lake produced additional eggs that brought the total to 239,950,000, of which 146,700,000 were transferred to hatcheries in New York, Pennsylvania, and Canada. The immediate output of the Cape Vincent station was 86,180,000 cisco fry, all planted in Lake Ontario.

In the usual operations on Lake Champlain addressed to the pike perch, 245,350,000 eggs were taken at the newly acquired site near the mouth of Swanton River, and after considerable numbers were shipped to applicants the remainder were incubated at Swanton, yielding 71,500,000 fry which were deposited locally.

An attempt is being made to establish a run of chinook salmon in the St. Lawrence River and Lake Ontario, and to this end chinook salmon eggs in limited number are being sent from the Pacific coast to the Cape Vincent hatchery. The first shipment, consisting of 820,000 eyed eggs from the Little White Salmon hatchery on the Columbia River arrived at Cape Vincent in November, 1918, and 798,400 fry were hatched therefrom. Some of the young reared in troughs took food readily and made splendid growth and had small mortality. The result of this shipment was the planting of 627,000 advanced fry and 150,000 fingerlings.

Mention should be made of the inauguration of whitefish hatching at Bear Lake, situated in Idaho and Utah. A field station, auxiliary to the Springville hatchery, was established at Paris, Idaho, in the autumn of 1918, and several million eggs were secured from fish taken by net fishermen. The experience gained will be valuable in planning for the continuance of this work, which is demanded in order to perpetuate and maintain the whitefish peculiar to this lake.

#### CULTIVATION OF POND AND RIVER FISHES.

The numerous stations throughout the country that are concerned with the maintenance of the supplies of fish in the rivers and minor waters of the interior have in general been successful in meeting the ever-increasing demands that have been made on them for trouts, basses, and other species.

The demand for brook trout far exceeds the productive capacity of the hatcheries when reliance is placed solely on the eggs obtainable from brood fish and from wild fish in waters available to the various hatcheries. It has, therefore, been necessary to supplement the local collections by considerable numbers of eggs purchased from commercial fish-culturists. During the year 1919 approximately 11,000,000 such eggs were distributed among 15 stations. The other brook-trout eggs that were handled in 1919 consisted of 900,000 collected from wild fish in Vermont, 4,350,000 from wild fish in Colorado, Utah, and Wyoming, and smaller numbers from domesticated fish, the total number from all sources being 16,463,200. The output of 11,903,665 included 7,638,615 distributed as fingerlings. All pending applications for brook trout have been filled by liberal

allotments, and carload shipments have in addition been made to various national forests, the deliveries being to officers of the Forest Service who superintended the planting of the fish.

The demand for rainbow trout is next to that for the brook trout. Considerable collections of eggs have, as usual, been made from domesticated fish held in ponds at the Wytheville, Erwin, White Sulphur Springs, Manchester, and Neosho stations, but the bulk of the eggs—namely, 7,357,100—has come from wild fish in Montana, Wyoming, and Utah. A new and very promising field for collecting eggs of wild rainbow trout has been located in Sage Creek, Wyo., about 70 miles from the Saratoga station. The Madison Valley field in Montana, operated from the Bozeman station, was unusually productive, and 3,935,000 eggs of exceptionally good quality were secured, an increase of nearly a million over the record season of 1918. The collection of grayling eggs in this same locality was the smallest for a number of years.

The landlocked salmon is in great demand in its native State of Maine and in various States to which it is not indigenous. The sources of egg supply in 1919 were Green Lake, Fish River Lakes, and Grand Lake Stream, the number of eggs obtained being 213,000, 914,000, and 345,000, respectively. The first duty of the Bureau as regards landlocked salmon is to maintain the fish in its home waters. As these waters are extensive and many of them are depleted, and as the number of fish available for distribution is limited, many applications from outside States have had to be refused.

The available supply of basses, crappies, sunfishes, etc., has been about the average of recent years. The Mammoth Spring station, the principal source of smallmouth black bass, suffered a serious reduction in output owing to the loss of brood fish by flood. The extension of facilities for black-bass culture is constantly in progress, but the demand can not be adequately met with the existing stations, and an increase in bass stations is needed, particularly in the southwestern section of the country.

In the second season's operations at the temporary field hatchery on the Atchafalaya River in Louisiana, the output of buffalofish was materially increased. From fish caught for market the Bureau's agents, in cooperation with the State department of conservation, were able to save 136,200,000 eggs, from which 110,940,000 fry were hatched. Extremely unfavorable weather interfered with the work and reduced the output.

#### CARP CULTURE.

Carp culture, discontinued many years ago, has been resumed, as yet on an experimental scale, on Lake Erie in response to a strong local demand from carp fishermen and carp dealers. The western end of the lake is the scene of extensive carp fishing, in connection with which there are maintained large inclosures in which carp are held alive pending shipment to market. The Bureau's operations consist in taking eggs from the fish caught in seines in the Portage River, Ohio, which would otherwise be lost, and hatching them at the Put-in Bay station, the fry being returned to the local waters in which the carp spawn naturally. During the fiscal year 1919 the young carp thus produced and liberated numbered 22,800,000.

Widespread interest in the carp among landowners is evidenced by the large number of applications submitted from all parts of the country for carp for stocking private ponds. In view of the unsuitability of the carp for many waters and the prejudice against it that exists partly because of the mistakes made in the original plantings, the Bureau refers all applications to the fishery authorities of the respective States and defers to their recommendation in acting on applications. Without the State's indorsement the requests for carp are denied.

#### PROPAGATION OF RIVER FISHES OF ATLANTIC SEABOARD.

Fairly successful results attended the work of the shad hatcheries on the Potomac River and Albemarle Sound, the fry planted numbering 68,558,550, as compared with 39,168,800 in 1918. Most of this output is to be credited to the Bryans Point hatchery, but the Edenton hatchery had a noteworthy increase over all recent years.

The striped-bass hatchery maintained on the Roanoke River as an auxiliary of the Edenton station experienced drawbacks owing to flood water. During the very short spawning season (Apr. 29 to May 11) 17,942,000 eggs were collected; the fry hatched therefrom, numbering 13,540,000, were deposited locally.

In the artificial propagation of the Atlantic salmon, designed primarily to perpetuate the run of that species in the Penobscot River, 870 adult fish were collected in spring and held in pens, and from the 700 survivors at the spawning time 2,613,400 eggs were obtained, the brood fish then being released. The eggs were hatched in 165 days at a mean temperature of 38° F., and the young, numbering 2,390,000, were deposited at suitable points in the Penobscot, Dennys, Pleasant, and Narragausus Rivers.

At the Bryans Point hatchery the usual excellent results were secured in the propagation of yellow perch. Adult fish that had been caught for market were obtained from fishermen and held in live cars until their eggs were deposited. The fry from this source, all planted in the Potomac and tributaries, numbered 153,679,500.

#### PACIFIC SALMON OPERATIONS.

Throughout the Pacific States and Alaska the Bureau's salmon-cultural operations in the season 1918-19 were hampered by war activities and by the high cost of materials and the high cost and scarcity of labor. No improvements or repairs at the stations other than those of a minor and pressing character were attempted, and those were done mostly by the regular station force. The untoward conditions were aggravated by the impossibility of maintaining a complete personnel in the statutory positions; at times in certain fields more than 50 per cent of the regular positions were unfilled. A further drawback was the influenza epidemic.

Satisfactory operations were conducted at the two Alaska stations, the collection of eggs of the sockeye salmon at the Afognak hatchery being the largest since the eruption of Mount Katmai in 1912, when all the sockeye salmon inhabiting lakes and streams in the ash belt were destroyed. The take of eggs in these waters has been gradually increasing since 1914, when 7,380,000 were obtained, rising to 54,681,-

000 in 1918, with indications of a still greater improvement during the 1919 season. At the Yes Bay hatchery 47,300,000 sockeye salmon eggs were secured, as against 34,950,000 in the previous season. An innovation in the holding and rearing of young salmon has been inaugurated at Yes Bay by the treatment of the hatchery creek. The water passing through the creek is controlled by a 6-foot gauge, and a 1,000-foot space at the upper end is divided into numerous feeding ponds by placing semicircular rock dams across the stream, while a wire trap has been placed at the lower end of the creek for the capture of Dolly Varden and cutthroat trout, natural enemies of the young salmon in this region. At the lower end of the lake an area of about 4 acres has been screened off and about 6,000,000 young salmon have been placed therein for rearing.

At the various hatcheries in Washington the salmon of all species liberated have aggregated 38,378,285, of which 21,103,025 were fingerlings, while 1,791,000 additional fingerlings were on hand at the end of the fiscal year. At Birdsvlew, the principal station in the vicinity of Puget Sound, the collections were less extensive than in the previous year, but at Baker Lake the season's outcome was, on the whole, an improvement over several previous years. In continuance of the efforts to establish a run of humpback salmon in the off years, consignment of eggs have been sent from the Alaska stations, and the resulting young have been planted in various tributaries of Puget Sound.

In the Columbia River and throughout the Oregon fields the work at all salmon stations was seriously handicapped by long-continued drought and by the activities of the commercial fishermen, which resulted in the escapement of only a limited number of fish to the spawning grounds. At the Little White Salmon station 10,693,000 chinook-salmon eggs were obtained, and from these 9,177,500 No. 2½ fingerlings were produced. At the Big White Salmon station the egg collections were relatively large, aggregating 10,665,000, the young from which were planted locally as No. 2½ fingerlings.

Salmon hatching in California, at Baird and subsidiary stations, was less expensive than in previous years, owing to low stages of the Sacramento River resulting from a drought. The success of the salmon work in this field is imperiled by the irrigation dam at Redding. No fish are able to pass over this dam excepting, possibly, a few of the early run, which may get over before the slide boards are put in place. No fishway is available, and people living in the vicinity are continually using spears and hooks in the capture of the spawning fish congregated below the dam. The State authorities have promised to install fish ladders, but even with that advantage the future operations are doomed if fishermen are allowed to continue their operations. At the Mill Creek station 17,284,500 chinook-salmon eggs were collected, of which 11,164,500 were shipped when eyed to the State hatchery at Sisson, and 2,304,000 were transferred to Baird. The remaining eggs produced 3,498,800 fingerlings of Nos. 1½ and 2 sizes, all of which were planted in the creek. At Battle Creek, formerly one of the most productive salmon stations on the Pacific coast, only 5,384,000 eggs were obtained. Of these, 638,000 were shipped to the Sisson hatchery, and from the remainder 4,509,000 fry were hatched and reared to the fingerling stage before liberation. No spawn-taking operations were conducted at the Baird hatchery, and there was no

noticeable run of salmon in the McCloud River. The work at this pioneer salmon hatchery was reduced to the care of the eggs shipped from its Mill Creek auxiliary. The output, consisting of 2,280,000 Nos. 1½ and 2 fingerlings, was planted in the McCloud River.

The season of 1918 was one of the most successful for shad production on the Pacific coast. Two field hatcheries operated at Willamette Falls and St. Helens, Oreg., as auxiliaries of the Clackamas station, collected 17,265,000 shad eggs from the fishermen's catch.

#### CULTIVATION OF MARINE SPECIES.

Marine-fish culture, conducted at the three New England stations—Boothbay Harbor, Me.; Gloucester, Mass.; and Woods Hole, Mass.—was as a whole successful.

Perhaps the most effective branch of this work is that addressed to the winter flounder (*Pseudopleuronectes*), a species that within a few years has assumed great commercial value in Massachusetts and is now rapidly growing in importance in Maine, giving employment to many persons and yielding good returns at a time when there is little else for the fishermen to do. At Boothbay Harbor egg collections from local waters, especially Linekins Bay, aggregated 1,326,408,000, from which 1,279,256,000 fry were hatched and planted, a very high percentage. At Gloucester, where the catch of gravid flounders was below the average for the past three years, 152,020,000 eggs were taken, and 138,990,000 fry were obtained therefrom, the percentage of hatch being about 91.5. The flounder work at Woods Hole was the most extensive in the history of the station. Most of the eggs, aggregating 1,433,613,000, were obtained from Waquoit Bay fish, but other points on Vineyard Sound and Buzzards Bay yielded considerable numbers, while at a field station established at Wickford, R. I., on Narragansett Bay, 323,238,000 eggs were secured and sent to Woods Hole for incubation. The output was 1,098,130,000 fry and 137,816,000 eyed eggs which latter had to be planted because of the crowded condition of the hatchery.

The hatching of eggs of the shore cod was on such a small scale as to be practically a failure at all stations. There was a fairly large collection of eggs for the Gloucester hatchery, but the low density of the water produced a heavy mortality among the eggs undergoing incubation and made undesirable the sending of other eggs which, to the number of several hundred million, were in consequence deposited on the spawning grounds.

A force of spawn takers working among the Gloucester haddock and pollock fishermen took large numbers of eggs from fish that had been caught for market. Upward of 1,110,470,000 pollock eggs were collected and 702,250,000 fry were hatched and planted. An experimental shipment of pollock eggs from Gloucester to Boothbay Harbor was intended to prepare the way for regular consignments on occasions when the Gloucester hatchery is overflowing. The pollock eggs, arranged on trays surrounded by snow and rockweed, and packed in a field shipping case, arrived in good condition after a 12-hour railway trip and hatched with normal loss. Haddock eggs to the number of 332,740,000 were obtained; 127,190,000 of these had to be planted owing to the low density of the hatchery water, the remainder producing 129,400,000 fry.

The possibility of saving enormous numbers of eggs of marine fishes by placing spawn takers on fishing vessels was experimentally tested in March and April, 1919. Three spawn takers were detailed to accompany fishing craft to Georges Bank with instructions to take eggs from any ripe cod and haddock that might be caught, fertilize, measure, and plant them overboard. As a result of seven trips, 73,200,000 haddock eggs and 58,950,000 cod eggs were thus treated. Two men made four trips on trawl-line vessels and took 32,600,000 haddock eggs and 26,280,000 cod eggs during 46 days. One man spent 30 days on three trips on an otter trawler, and during that time secured, fertilized, and planted 40,600,000 haddock eggs and 32,670,000 cod eggs. The value of work of this nature would seem to depend on the active cooperation of the fishing vessels. If the operations are to be of a magnitude that will make them worth while, a man or several men on each fishing vessel should be assigned the task of fertilizing the eggs of the ripe fish brought aboard the vessel.

#### LOBSTER HATCHING.

Lobster hatching has practically been abandoned. The Bureau was never able to conduct it on a scale sufficiently extensive to produce any noteworthy effects on the supply, in the face of incessant fishing and a very general disregard for provisions of law affecting egg-bearing and short lobsters.

From the remnant of 8,000,000 lobster eggs carried over from the previous year's operations at the Boothbay Harbor station, 7,500,000 larval lobsters were produced and liberated in local waters in July. At the request of the Maine authorities, 2,000 stripped lobsters which the State had purchased and still owned were held at the Bureau's pound at Pemaquid from the beginning of the fiscal year until September. When the lobsters were collected, it was discovered that a very heavy mortality had resulted, only 624 lobsters being found.

Lobster hatching in recent years was possible only under conditions that violated fundamental principles of business and biology. The Bureau was willing to continue the work year after year in the hope of bringing about a widespread observance of law by affording the fishermen a means of disposing of their berried lobsters and by constantly keeping before the fishermen the need for saving the lobster eggs and immature lobsters. This course, however, could not be indefinitely continued under prevailing conditions, and Congress has now placed such limitations on the expenditure of the fish-cultural appropriation as to make it doubtful whether the lobster hatching can be legally conducted in the existing situation.

The outlook for the lobster from the standpoint of the public is distinctly gloomy in most sections, but the fishermen, as a rule, are well satisfied so long as the present outrageous prices prevail. A recent episode, doubtless typical of numerous communities, serves to indicate how difficult is the task that confronts the State officials. The lobstermen of a certain locality were called together and informed of the desire of the State to secure their support in carrying out the provisions of law for the protection of egg-bearing and short lobsters. The meeting then voted on the proposition, and more than 80 per cent of the lobstermen in the community signified their intention to continue to ignore the law.

The small appropriation made by Congress in an act approved July 1, 1916, for a lobster-rearing plant proved entirely inadequate, even when the capacity of the proposed plant was materially reduced from time to time in an effort to bring it within the appropriation. Request for a supplemental appropriation was not approved by Congress. In these circumstances, the appropriation has been turned back into the Treasury in the expectation that the project may be revived later.

#### RESCUE OF STRANDED FOOD FISHES.

An outgrowth of the fish-cultural work that has assumed very great value and importance is the salvaging of food fishes from land-locked ponds, pools, and bayous in overflowed districts of the Mississippi valley. These fish, in the natural course of events, are destined to perish and be entirely wasted when the shallow ponds in which they have been left by the receding waters become dry or frozen. During the fiscal year 1919 headquarters for rescue work were established at eight points on the Mississippi extending from Minnesota and Wisconsin to Mississippi and Arkansas; and seining parties from the various fish-cultural stations and the biological station at Fairport covered a wide extent of territory and made collections in excess of those of any previous year. Especially effective work was done from Homer, La Crosse, Bellevue, and North McGregor. When the season closed about December 1, there had been salvaged over 55,000,000 young fishes, representing practically every important species inhabiting those waters, with buffalofish, carp, catfish, crappie, and yellow perch predominating, as shown in the following table:

#### FISHES RESCUED FROM OVERFLOWED WATERS OF THE MISSISSIPPI VALLEY DURING THE FIRST SIX MONTHS OF THE FISCAL YEAR 1919.

Black bass, largemouth.....	445, 954
Black bass, smallmouth.....	2, 190
Buffalofish.....	2, 590, 335
Carp.....	19, 748, 562
Catfish.....	12, 607, 446
Crappie.....	15, 805, 549
Drum.....	18, 977
Pike.....	375, 937
Pike perch.....	10, 710
Rock bass.....	810
Sunfish.....	1, 065, 652
White bass.....	8, 665
Yellow bass.....	600
Yellow perch.....	2, 354, 438
Miscellaneous.....	747, 250
Total.....	55, 783, 075

Practically all the fishes thus saved are replanted in the adjacent public waters, but a few are consigned to applicants in various States. In 1919, 55,173,000 fish, more than 98.9 per cent of the total collections, were restored to the Mississippi and tributaries.

Plans have been completed for conducting these operations on a larger scale than heretofore during the fiscal year 1920, and the indications are that the results in 1919 will be more than doubled. The extent of the work that may be accomplished depends mostly on the funds that are available. There are productive fields yet untouched, especially in the central section of the Mississippi valley, and the

saving of these valuable food resources by systematic annual rescue work is of vital importance to the maintenance of the fisheries of the region. The Bureau will expand its efforts to the full limit of financial possibility, and should be reinforced by all the States, some of which up to the present time have exhibited no interest and assumed no responsibility.

#### SOME NEEDS OF THE FISH-CULTURAL SERVICE.

Among the more urgent needs in the Bureau's fish-cultural work is an increase in the number of hatcheries. The new establishments are desired for States or regions not now provided with hatcheries or only inadequately served by existing hatcheries. In addition to the foregoing, there should be several salmon hatcheries provided for Alaska.

There should be congressional recognition of the invaluable service rendered by the Bureau in salvaging food fishes in the overflowed districts of the Mississippi Basin, and liberal financial provision should be made for its continuance and extension.

Throughout the fish-cultural service there is an underpaid personnel. If the standard of efficiency is to be maintained there must be provided at once a revised salary scale that will retain desirable men and induce others to enter the various grades. Noteworthy results in the artificial propagation of aquatic animals and in the stocking of our interior and coastal waters can not reasonably be expected from a staff that in many cases is changing more quickly than appointment papers can be prepared and delivered.

#### ARTIFICIAL PROPAGATION OF FRESH-WATER MUSSELS.

The active efforts taken by the Bureau to maintain by artificial means the supply of pearly fresh-water mussels, on which depend important fisheries and an extensive button-making industry, have presented the usual aspects. The work is conducted under the supervision of the fisheries biological laboratory at Fairport, Iowa, at various favorable points in the Mississippi Basin from Arkansas northward.

During the fiscal year 1919 about 136,907,365 young mussels, or glochidia, in a condition of parasitism on fishes, were liberated in public waters as compared with 209,132,825 liberated in the previous year. This decrease was due chiefly to unsatisfactory labor conditions, which made it difficult to keep efficient seining crews steadily employed, with a resulting reduction in the fish catch. The principal reduction was in the Lake Pepin field, the output of which was 35,423,125, as compared with 91,226,800 in 1918.

Four species of commercial mussels were propagated, the leading ones being the common mucket (*Lampsilis ligamentina*) and the Lake Pepin mucket (*Lampsilis luteola*), the others being the yellow sand-shell (*Lampsilis anodontoides*) and the pocketbook (*Lampsilis ventricosa*). The inoculated fish hosts were liberated in the Mississippi River off Fairport, Iowa; in Lake Keokuk, Iowa; at New Boston and Oquawka, Ill.; in the Mississippi River at Lake Pepin, Minn. and Wis.; in Lake Pokegama, Minn.; and in the Black River in the vicinity of Pochontas and Clover Bend, Ark.

The cost of production during the year was \$0.0689 per thousand, practically double that of the previous year. The increased cost was due to the greater cost of labor, equipment, and materials. Overhead charges and an allowance for depreciation amounting to \$0.0236 per thousand are included in this computed cost. In connection with this work, 51,600 adult and 653,600 fingerling fishes were reclaimed from landlocked waters in the overflowed lands and liberated in public waters. Of the fishes rescued, 150,949, or approximately 21 per cent, were infected with larval mussels before release.

Experimental plants of adult mussels from the Mississippi River and from Lake Pepin were made in the Roanoke and Shenandoah Rivers in Virginia.

The following table shows the details of the work of artificial propagation:

MUSSEL PROPAGATION 1919, SHOWING NUMBER OF EACH SPECIES PLANTED AND POINTS OF DEPOSIT.

Species.	Lake Pokegama, Minn.	Mississippi River at Lake Pepin, Minn. and Wis.	Mississippi River at Fairport, Iowa.	Mississippi River, at New Boston, Ill.
Yellow sand-shell.....				193,000
Mucket.....			15,634,000	10,200,540
Lake Pepin mucket.....	21,632,100	34,463,300		
Pocketbook.....		959,825		
Total.....	21,632,100	35,423,125	15,634,000	10,393,540

Species.	Mississippi River at Oquawka, Ill.	Mississippi River at Lake Keokuk, Iowa and Ill.	Black River, Ark.	Total.
Yellow sand-shell.....	36,000			229,000
Mucket.....	20,661,000		14,525,500	61,021,040
Lake Pepin mucket.....	7,845,000	10,757,100		74,697,500
Pocketbook.....				959,825
Total.....	28,542,000	10,757,100	14,525,500	136,907,365

## ALASKA FISHERIES SERVICE.

### GENERAL CHARACTER OF THE SERVICE.

The duties devolving on the Bureau in connection with the general fisheries of Alaska include the enforcement of law and regulations with regard to the salmon fisheries, the collection of statistics and the dissemination of statistical and other information, the inspection of private salmon hatcheries, the investigation of the aquatic resources, the improvement of the physical condition of salmon streams, the holding of public hearings on proposed regulations for the protection of the salmon supply, and the submittal to the Secretary of Commerce of recommendations embodying modifications of existing regulations.

During the calendar years 1917 and 1918 the Bureau, in cooperation with the Washington-Alaska military cable and telegraph system of the War Department, informally maintained for the benefit of the fishermen of Alaska an intelligence service which covered the towns of Ketchikan, Juneau, Petersburg, Wrangell, Sitka, Skagway, Valdez, Seward, and Cordova. The information thus furnished daily appears to have been of value, and the service met with approval throughout Alaska. Being desirous of extending this work and having it receive official recognition from Congress, the Bureau submitted an estimate for an appropriation of \$600 for the establishment in Alaska of a local fishery intelligence agency. The appropriation was not made, the work was not authorized, and the Bureau was criticized for the efforts already put forth.

A comprehensive report on the fisheries of Alaska and the Bureau's activities in relation thereto has been prepared by the chief agent of the Alaska service and has been published as a public document under the title "Alaska Fisheries and Fur Industries in 1918." This report should be consulted by those who desire detailed information.

#### MAGNITUDE OF THE ALASKAN FISHERIES IN 1918.

When the 1918 season closed, a new record was established in the fisheries of Alaska, for every branch of the industry advanced over the year which had previously shown the highest development, namely, 1917. The following figures for 1918, with comparisons for 1917, show the persons employed, the capital invested, and the value of the product as prepared for market:

Items.	1918	1917	Increase of 1918 over 1917.
Persons employed.....	31,213	29,491	1,722
Investment.....	\$73,750,789	\$54,937,549	\$18,813,240
Value of output.....	\$59,154,859	\$51,466,980	\$7,677,879

It is the salmon industry which gives to the fisheries of Alaska their great importance, and it was the salmon industry that contributed most notably to the increases that occurred in 1918. The value of all salmon products was \$53,514,812, of which \$51,041,949 represented canned fish to the number of 6,605,835 cases. Thus, 50 years after Alaska became a part of our national domain, the salmon resources alone yielded a product valued at over  $7\frac{1}{2}$  times the purchase price of the territory. The 135 salmon canneries in operation were 17 more than in 1917. The changes in apparatus of capture included an increase in pound and trap nets and seines and a decrease in gill nets. The relative importance of the different kinds of gear remained about the same. Seines took 38 per cent of the salmon in southeast Alaska and 39 per cent in central Alaska, but only 4 per cent in western Alaska; pound trap nets are credited with 58 per cent, 48 per cent, and 4 per cent in the respective regions; while gill nets, which took only 2 per cent in southeast Alaska and 11 per cent in central Alaska, took 90 per cent in western Alaska.

The number of salmon taken for commercial use in Alaska in 1918 was 101,454,688, against 92,600,495 in 1917. The red salmon aggre-

gated 35,338,065, and the output decreased 1,158,982; the humpbacks or pinks numbered 48,316,362 and increased 3,441,091; the cohos or silvers numbered 2,911,681 and increased 807,428; the catch of chums, ranking third, amounted to 14,160,818 fish, an increase of 5,633,240; while of the kings, the largest species, 727,762 were taken, an increase of 131,416 over the previous year. The total catch in southeast Alaska was less than in 1917, while both central and western Alaska showed a larger output. Placed end to end, the salmon taken in Alaska in 1918 would extend more than  $1\frac{1}{2}$  times around the world at the equator.

Owing to increased attention received during 1918 by the herring, the output of that species took second rank among the fisheries of Alaska, displacing the halibut, which for many years had held that position. The advance was due to a greatly increased pack of pickled herring, in response to the Bureau's efforts to introduce and establish the Scotch cure in Alaska. This stimulus to the herring industry was exhibited also in the much larger quantity of herring pickled after the Norwegian method, which had previously been the only one followed. The year's herring output was valued at \$1,819,538, of which amount \$748,605 represented Scotch-cured herring.

The Alaska halibut fishery in 1918 was engaged in by 118 steam and gas vessels, and represented an investment of \$2,594,292. The catch, amounting to upward of 13,869,000 pounds, valued at \$1,667,686, exceeded the 1917 output by 716,000 pounds and \$517,000.

The cod fishery has shown but slight fluctuation in recent years. In 1918 the vessel catch in Bering Sea, usually about two-thirds of the total output, was somewhat under that of the previous season, while the catch at the shore stations, chiefly on the southern shore of the Alaska peninsula, was sufficiently increased over 1917 to offset the vessel shortage. The aggregate output of the cod fishery was upward of 14,000,000 pounds, valued at \$957,000. Dry-salted fish constituted the bulk of the products, namely, nearly 11,000,000 pounds, with a market value of \$778,000.

The only other branch of the Alaska fisheries of prime importance is whaling, which is conducted wholly from shore stations. The number of whales taken was 448, most of which were finbacks; this was 25 more than in 1917. The value of all whale products was \$834,000.

#### FISHERY PATROL.

The patrol maintained by the Bureau during the fishing season of 1918, while by no means adequate or satisfactory, was more effective and comprehensive than ever before. The regular vessels were supplemented by hired craft and the regular force of wardens and agents was augmented by special employees, as far as the funds available would permit.

A detailed statement of the work of the patrol in 1918 in detecting violations of laws and regulations and in prosecuting the offenders in the Alaskan courts is given in the special report on the activities of the Alaska service for that year. There have been numerous convictions, mostly for failure to observe the weekly close season, for setting gear within prohibited distances of other gear, for fishing in closed waters, etc., and substantial fines have been imposed.

The great need of the Bureau in its task of enforcing laws and regulations for the protection and control of the salmon fisheries of Alaska is larger appropriations for providing additional facilities in men and vessels, so that every important fishing district may be fully covered.

Late in the fiscal year, plans were made to inaugurate a vigorous patrol for the fishing season of 1919, but these for the most part could not be put into effect until the season was well advanced, owing to the failure of the appropriations to become available. Among the new features of the 1919 patrol was the use by the Navy Department, at the solicitation of the Department of Commerce, of submarine chasers in enforcing the fishery laws and regulations, employees of the Alaska service being carried on these vessels.

#### NEW REGULATIONS FOR SALMON FISHERIES.

Following announcements and hearings in accordance with law, and on the recommendation of the Commissioner of Fisheries, the Secretary of Commerce has promulgated orders providing new regulative measures for the perpetuation of the salmon supply in streams of southeastern Alaska, the Copper River, and the Yukon River. The text of the several orders is as follows:

##### SOUTHEASTERN ALASKA WATERS. (ORDER PROMULGATED DEC. 21, 1918.)

A hearing having been given at Seattle, Wash., November 25, 1918, after due notice in accordance with law, for the purpose of determining the advisability of making salmon-breeding reserves of certain waters in Alaska, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An Act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in all hereinafter-described waters of southeastern Alaska east of the longitude of Cape Spencer, be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. That fishing with all forms of apparatus is prohibited in all streams less than 500 feet in width at the mouth at mean low tide and in all lakes and other waters tributary to such streams.
2. That all fishing with purse seines and drift gill nets and all other movable fishing appliances, other than set nets and beach seines, is prohibited within 200 yards outside the mouth at mean low tide of all streams less than 500 feet in width at their mouth, except at the mouths of the Chilkat and Chilkoot Rivers, where the prohibited distance for all fishing appliances shall be 500 yards.
3. That all fishing with traps, stake nets, and other fixed fishing appliances, and set nets and beach seines is prohibited within 500 yards outside of the mouth at mean low tide of all streams less than 500 feet in width at their mouth. No exceptions will be made in favor of any fixed fishing appliances heretofore operated within the prohibited areas.
4. That the driving of salmon downstream and the causing of salmon to move outside the protected area at the mouth of any stream are expressly prohibited.
5. That this order does not supersede but supplements sections 3 and 4 of the order promulgated by the Secretary of Commerce on November 18, 1912, which, respectively, prohibit all commercial fishing for salmon or other fishing in the prosecution of which salmon are taken or injured "in Anan or Humpback Creek, its lagoon, lakes, and tributary waters, together with the region within 500 yards of the mouth of said creek," and "in Naha stream, its lagoon, lakes, and tributary waters, above a line connecting the points known respectively as Loring Point and House Point." Likewise this order does not supersede but supplements the order promulgated by the Secretary of Commerce on October 25, 1915, which similarly prohibits fishing (a) "in all waters tributary to Barnes Lake, Prince of Wales Island," (b) "in Hetta Creek, its tributary waters, and the region within 500 yards of the mouth of said creek," and (c) "in Sockeye Creek, its tributary Boca de Quadra hatchery waters, and the region within 500 yards of the mouth of said creek."

This order becomes effective January 1, 1919.

## COPPER RIVER. (ORDER PROMULGATED DEC. 20, 1918.)

A hearing having been given at Seattle, Wash., November 22, 1918, after due notice in accordance with law, for the purpose of determining the advisability of amending the order of December 29, 1917, effective January 1, 1918, establishing a salmon-breeding reserve and limiting fishing in the Copper River, Alaska, its delta and its tributary waters, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An Act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon or other fishing in the prosecution of which salmon are taken or injured, in the Copper River and its delta and all tributary waters, Alaska, be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. Commercial fishing is prohibited in waters of the Copper River delta from 6 a. m. on January 1 to 6 a. m. on June 10 of each year, and in the waters of Miles Lake and Abercrombie Canyon from 6 a. m. on January 1 to 6 a. m. on June 15 of each year.

2. Commercial fishing in the waters of the delta shall be limited to set nets and drift gill nets. No such net shall exceed 800 feet in length. The lateral distance interval between all set nets in the waters of the delta herein referred to shall be not less than 600 feet.

3. All fishing is prohibited from the head of the delta to the foot of Miles Lake at all times.

4. All fishing in Miles Lake shall be limited to set nets. No such net shall exceed 800 feet in length, and only one such net shall be extended out from shore from one location. No offshore nets will be permitted in the lake. Throughout the fishing season the shore of the lake shall be considered as it was on June 15. The lateral distance interval between all nets in Miles Lake shall be not less than 600 feet. No fishing will be permitted along the west and north shores of Miles Lake from the north end of Mile 49 bridge to the north end of Miles Glacier, nor along the islands and sand bars between the bridge and the head of the lake.

5. Fishing in Abercrombie Canyon shall be restricted to the use of dip nets operated by hand, such nets not to exceed 16 inches in greatest diameter. No fishing will be permitted at any point on the east side of the canyon or river above the head of the lake.

6. No fishing will be permitted at any time in the waters of the Copper River above Abercrombie Canyon, or in any of the waters tributary thereto, except in the case of local residents who may take limited numbers of salmon for domestic use: *Provided*, That such fishing shall at no time be upon the spawning grounds of any salmon.

7. No net shall be placed in any other than substantially a straight line.

8. For the purposes herein considered, the delta of the Copper River shall be regarded as including all waters south of an east and west line passing through Mile 27 on the Copper River & Northwestern Railway, as at present established, and inside of a line 500 yards off the mouth of each slough and outlet of the Copper River beginning with Alaganik Slough on the west and ending with Gus Wilson Slough on the east, including Pete Dahl, Walhalla, Gus Stevenson, Little King Salmon, Castle, Storey, Big King Salmon (or Copper River proper), Duck, Russian, and all unnamed sloughs between. For the purposes of this order, the mouth of each slough will be regarded as at the edge of the grass banks at the line of mean high tide.

9. The lower end of Miles Lake shall be considered as at the bridge of the Copper River & Northwestern Railway at Mile 49. The head of Miles Lake shall be considered as at the point where the river enters the lake, this point to be as indicated by notices posted by duly authorized representatives of the Bureau of Fisheries.

10. Abercrombie Canyon shall be considered as extending from the head of Miles Lake to Tunnel Point on the Copper River & Northwestern Railway.

11. For the purposes of this order the following definitions are adopted: "Stake net," a gill net attached or affixed to piles or stakes. "Set net," an anchored gill net, one end of which may if desirable be fastened to a stake or other object on shore.

This order becomes effective January 1, 1919, and supersedes the order of December 29, 1917.

## YUKON RIVER. (ORDER PROMULGATED DEC. 14, 1918.)

A hearing having been given at Seattle, Wash., November 20, 1918, after due notice in accordance with law, for the purpose of determining the advisability of establishing a salmon-breeding reserve of certain waters in Alaska, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An Act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon or other fishing

in the prosecution of which salmon are taken or injured, in the Yukon River and all tributary waters, and in all waters of its delta to and including the area 500 yards outside each mouth or slough of the delta at mean high tide, be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. That in 1919, and in each year thereafter unless otherwise ordered in the manner prescribed by law, not to exceed 30,000 cases (48 one-pound cans per case, or the equivalent thereof) of canned salmon, 1,000 barrels (200 pounds net weight each) of pickled or hard-salted salmon, and 200 tierces (800 pounds net weight each) of mild-cured salmon, of all species, shall be prepared for commercial purposes or export; these quantities to be apportioned, after a conference with the local representative of the Bureau of Fisheries, as equitably as practicable among the persons or companies with established plants. Promptly at the end of each calendar week each individual or company shall submit a statement to the said representative of the Bureau of Fisheries showing the number of cases, barrels, and tierces of salmon thus prepared to date, and shall submit also a record of the number of salmon of each species taken daily.

2. That no salmon to be prepared by canning, pickling, or mild curing for shipment from Alaska shall be caught above the junction of the Clear River with the Yukon River near Andreafski.

3. That commercial fishing in the waters of the Yukon delta shall be limited to Kwikluak Pass, commonly known as the south mouth or channel.

4. That the use of traps or pound nets in the Yukon River and its delta is prohibited.

5. That no gill net, seine, or other net used in the Yukon River and its delta shall exceed 700 feet in length.

6. That all commercial fishing, except for local requirements, is prohibited after August 31 of each year.

This order becomes effective January 1, 1919.

#### PRIVATE SALMON HATCHERIES.

In conformity with law, the two private salmon hatcheries operated by canning companies in southeastern Alaska have been inspected, their methods have been approved, and the issuance of tax rebate certificates has been recommended. The hatcheries on Naha Stream and Quadra Lake liberated 35,057,000 red-salmon fry in the year ending June 30, 1919, and were entitled to remission of taxes to the amount of \$14,022.80. A third private hatchery, on Hetta Lake, was not running in the year named.

The conditions under which the private salmon hatcheries were established and have since been allowed a rebate of taxes in proportion to the number of red-salmon fry hatched and planted no longer carry weight. The owners should be relieved of this responsibility, and such hatcheries as may be necessary should be Government owned and operated. The existing hatcheries, if found desirable, should be taken over by the Government at a fair valuation.

#### COMMERCIAL FISHING IN ALASKAN RESERVATIONS.

During the fiscal year 1919, the Secretary of Commerce, on the recommendation of the Bureau, issued five permits for fishing operations in the Aleutian Islands Reservation, pursuant to the regulations issued jointly by the Departments of Commerce and Agriculture under the terms of the Executive order of March 3, 1913. The number of such permits in force on June 30, 1919, was 24.

In the Afognak Reservation licenses were issued to about 45 natives who desired to engage in commercial salmon fishing. They made a fair catch and had good financial returns owing to the action of the Food Administration in fixing the price of salmon at a higher figure than the natives had ever before received. The number of salmon taken was 126,700, of which 70,790 were humpbacks and

50,660 were sockeyes. Most of the catch was sold to a fishing company at Kodiak. The natives seem satisfied with the Bureau's plan for apportioning the fishing grounds among the fishermen, so that overfishing is prevented and all enjoy an equal opportunity.

#### ALASKA FISHERY LEGISLATION.

For about eight years legislation affecting the fisheries of Alaska has been pending in Congress. Protracted hearings have been held, and a large amount of testimony and data has been presented to the appropriate committees of the two houses. The necessity for a radical revision of the existing salmon law has been especially pointed out by various agencies and persons interested in the welfare of the fisheries of Alaska, and congressional committees have made favorable reports on bills embodying new legislation.

No new fishery laws have, however, been enacted; and the fisheries of Alaska, at the most critical period of their history, remain subject to laws which have been shown to be obsolete and inadequate. The Bureau of Fisheries is thus placed at a great disadvantage in administering the salmon fisheries of Alaska and can not justly be held accountable for conditions, practices, and developments which, while having the full sanction of law, are not necessarily compatible with the perpetuation of the supply and in some respects are directly opposed thereto.

The law of June 14, 1906, prohibiting aliens from engaging in the fisheries of Alaska, should be amended so as to give full force to its beneficent purpose. The high prices recently commanded by salmon have attracted an unusually large number of persons to the fisheries of Alaska, including many aliens. Instances have come to light where persons who renounced their declaration of intention to become citizens in order to escape the selective draft, and have not since changed their civic status, are claiming or exercising the privilege of operating independently in the fisheries of Alaska, a right that should be restricted to bona fide citizens.

It is the consensus of opinion among persons well informed regarding the halibut fishery conducted off the Alaskan coast that there are wasteful features of the fishery which are imperiling the halibut supply. The situation is difficult to handle, but at least one measure of protection is feasible and meets with general approbation, namely, a close season during several winter months when the fishery is most hazardous, least productive, and most wasteful. This matter was fully considered by the American-Canadian Fishery Conference which held hearings on the Pacific coast in 1918 and recommended remedial legislation which, to be effective, should be uniform in the United States and Canada. This matter should receive the early attention of Congress.

#### ALASKA FUR-SEAL SERVICE.

##### OUTLINE OF ACTIVITIES.

In the general administration of the Pribilof Islands, the duties devolving on the Bureau are extremely varied. They comprise (1) the purchase, transportation, and distribution of supplies for the

natives of the seal islands; (2) the transportation of Government employees and natives to and from the islands; (3) the maintenance of schools; (4) the maintenance of a medical staff; (5) the general care of the natives; (6) the handling and investment of funds belonging to the natives; (7) the care of buildings and other Government property; (8) the supervision and protection of the seal herds; (9) the maintenance of a patrol for the protection of the islands against possible raids; (10) the taking, preserving, packing, shipping, and selling of sealskins; (11) the operation of a by-products plant for utilizing seal carcasses; (12) the protection and care of herds of blue foxes, and the taking, shipment, and sale of their pelts; (13) the care, utilization, and improvement of reindeer herds; (14) the construction of roads, the maintenance of proper sanitary conditions, the improvement of landing facilities, etc. The activities in these and other lines are discussed at length in the report entitled "Alaska Fisheries and Fur Industries in 1918," by the chief agent of the Alaska service.

The advance in the cost of practically every article required for the Pribilof Islands has for several years necessitated a reduction in the requisitions to a point that makes impossible the purchasing of any reserve supplies. When, as in 1919, the passage of the bill carrying the appropriation for this service is delayed until mid-summer, a serious situation arises from the exhaustion of the stocks of food, medicine, fuel, and clothing. This emphasizes the need for a substantial reserve supply of indispensable commodities, to be used in emergencies, and should give force to the Bureau's appeal to Congress for a small special appropriation for this purpose.

Most of the supplies destined for the Pribilof Islands and the products therefrom were transported on the Bureau's steamer *Roosevelt*, which made two voyages to the islands during the fiscal year. In the spring of 1919 the *Roosevelt* was surveyed with a view to determining necessary repairs. It was found that dry-rot had started in the ship's timbers to such an extent as to make repairs inadvisable. The vessel was accordingly sold at public auction at Seattle on July 15, the sum of \$28,000 being realized.

The appropriation of \$20,000 that became available on July 1, 1918, for the construction or purchase of a power vessel for the Pribilof Islands proved inadequate, and Congress subsequently provided a supplemental appropriation of \$7,500. This has enabled the Bureau to obtain by purchase an acceptable craft, which will be extremely useful.

The increase in the seal herd and in the commercial sealing operations, taken in connection with the important international aspects of the matter, warrant and demand the presence at the islands of an increased personnel competent to deal with the seals in the most efficient manner from the scientific and industrial standpoints. In the estimates of appropriations for the fiscal year beginning July 1, 1920, provision is made for additional members of the staff, including a superintendent, to have general direction and coordinate the administrative affairs of the Pribilof Islands, and a biologist whose continuous studies and observations would be the Bureau's guide in the management of the seals and other animals of the islands. The recent acquisition of means for independent interisland communication at all times makes possible the employment, to better advantage than formerly, of general officials.

## CONDITION OF THE FUR-SEAL HERD.

The growth of the seal herd under the conditions now existing is continuous and satisfactory, averaging about 10 per cent annually. The census in recent years has been under the supervision of Dr. G. Dallas Hanna, and represents a vast amount of painstaking field and office work. The methods of the census, the basis for the various computations and estimates, the results, and a discussion of the figures and their significance may be found in the report cited in a special section devoted to the census.

The revised figures of the 1918 census indicated that the seal herd comprised 496,432 animals of all ages as of date of August 10, in addition to 33,881 seals taken for commercial purposes during the year. The unrevised but substantially correct figures of the 1919 census give the full strength of the herd, as of date of August 10, as 524,260 seals of all ages, exclusive of 26,390 taken for commercial purposes during the census year, a net increase of 27,828. The number of pups born in 1919 was 157,172, as against 142,915 in 1918, the respective figures for breeding cows being the same.

The great disproportion in the number of old male seals, arising from the total prohibition of commercial sealing during the period of five years ending in 1917, has occasioned much concern and received special consideration. In the taking of seals, efforts have been directed to the establishment of a proper proportion of breeding animals, through a reduction in the number of old surplus males.

## QUOTA AND TAKE OF SEALSKINS.

The 1918 quota of seals to be killed was first fixed at 25,000 and later increased to 35,000. The number actually taken to August 10 was 33,881, 26,881 on St. Paul Island and 7,000 on St. George Island; in addition to which there were taken on St. Paul Island 622, and on St. George 387, a total of 1,009 seals, in the fall of 1918 for the food purposes of the natives.

The quota for 1919 was set tentatively at 35,000 skins, but the number taken through August 10 was only 25,381, of which 22,027 were on St. Paul Island and 3,354 on St. George Island. Seals were present in sufficient numbers easily to meet the quota, but there was a scarcity of labor on the islands owing to the quarantine during the influenza epidemic, which prevented the transportation of additional native workmen from the Aleutian Islands, and also made it impossible for white assistants from St. Louis to reach the Pribilofs. Furthermore, there was much additional labor involved in taking and handling the skins of the larger surplus seals whose utilization is demanded. These circumstances reduced the number of skins that could have been taken under normal working conditions.

## FOXES AND REINDEER.

The blue foxes of the Pribilof Islands are regarded as having fur of better quality than those from any other region. They are trapped, under careful supervision, during a short period in winter, the natives being paid \$5 apiece for each fox skin secured. The foxes on St. George Island are more numerous and in better physical condition than on St. Paul Island. In the winter of 1918-19 trap-

ping was conducted for five days in December on St. Paul Island, and 119 blue-fox and 25 white-fox pelts were obtained. On St. George Island trapping was done during parts of December, January, and February, and 548 blue and 5 white pelts were taken. Efforts are being directed to the improvement of the breed of foxes on St. Paul Island.

The reindeer, of which 40 were introduced on the Pribilofs in 1911, have flourished and increased, and the surplus males are now furnishing a limited amount of fresh meat. It is believed that in a short time, with the present rate of increase, these animals will become a much more important factor in the food supply. In the summer of 1918 there were on St. Paul Island 160 reindeer, including 40 fawns, while St. George Island reported 114 reindeer of all ages at the end of the calendar year. Twenty animals were used for food on both islands in 1918.

#### RECEIPTS FROM SALE OF PRODUCTS.

During the calendar year 1918 two public auction sales of fur-seal skins were held at St. Louis by Funsten Bros. & Co., agents of the Government. The skins, numbering 8,100 and representing seals taken during 1917, were offered in a dressed, dyed, and machined condition, ready to be made into garments; the gross price received was \$375,385, an average of \$46.34 per skin. The net proceeds were \$257,333.21. A feature of each sale was a small lot of "wigs"—skins of the largest size, taken from old bulls—which brought the highest prices, although in former years, when "wigs" were disposed of abroad in a raw state, they were in little demand and were sold at only \$6 to \$10. The demonstration by Funsten Bros. & Co. that the skins of old bulls have an excellent fur and that they can be made available for all the purposes for which the pelts of younger males are used is one of the most interesting and important developments of the American sealskin industry.

In the calendar year 1919 there have been two auction sales of sealskins taken in the previous calendar year. The skins numbered 15,275, and the net proceeds therefrom amounted to \$1,026,728.84. At the last sale, held in September, the average price of sealskins was \$91.35, an advance of 30 per cent over the first sale, in April. The estimated net value of all the seals taken in 1918, allowing for the unsold skins at the prices received at the September sale, is \$2,467,334.45.

The fox pelts resulting from the previous season's trapping were sold at public auction in St. Louis on October 7, 1918. They numbered 692 blues and 19 whites, and brought \$57,099.50 and \$1,080, respectively, gross, and \$51,898.64 net for the two grades. The average gross price for blues was \$82.51. The fox pelts taken during the fiscal year 1919 were sold on September 10, 1919, and brought the highest prices ever obtained, averaging \$195.90 for blues, an advance of 135 per cent over the previous year's sale. The approximate net revenue from this sale is \$123,285.

The seal-island natives have been encouraged to collect old seal bones when their other duties permit, and are paid for such collections. During 1918 they obtained about 300,000 pounds, which were shipped to Seattle and San Francisco on Government vessels and sold under contract, netting \$3,891.03.

**MINOR FUR-BEARING ANIMALS OF ALASKA.****COMMERCIAL VALUE OF THE MINOR FUR BEARERS.**

The Bureau collects statistics of the furs shipped out of Alaska each year, using for this purpose special blanks that are supplied to postmasters, express offices, commercial companies, and individual shippers. Postmasters have cooperated effectively in securing full reports on all mail shipments, and the customhouse records are available for checking up other shipments.

The quantities of furs sent out of Alaska in 1918 were in excess of the records for previous years, with the exception of lynxes and foxes and their value surpassed all other seasons. The compiled figures, exclusive of the fur seals taken on the Pribilof Islands, indicate \$1,363,600 as the value of the furs shipped out of Alaska. Most important of the fur bearers were red fox, worth \$342,496; white fox, \$181,240; lynx, \$199,992; mink, \$159,718; and muskrat, \$103,948.

Fur farming is receiving much attention in Alaska, but the results, as a whole, are not very satisfactory. The Bureau has had reports of many more or less unsuccessful ventures. Foxes are the favorite animals handled, with occasionally martens, minks, and muskrats. At the end of the calendar year 1918 three islands under the jurisdiction of the Department were under lease for the propagation of fur-bearing animals. A number of other islands are available for this purpose.

**REGULATIONS AND VIOLATIONS.**

The 1917 regulations for the taking of fur-bearing animals were substantially unchanged for 1918. The period of total prohibition of beaver trapping was extended to November 1, 1923. On the recommendation of the Governor of Alaska and other disinterested persons, the open season for taking foxes in the region draining into the Arctic Ocean north of the sixty-eighth parallel was extended 30 days, so as to include April 14. On September 18, 1918, there was issued a new order prohibiting the use of dogs in pursuing or killing any fur-bearing animals for which a close season is prescribed.

There have been various prosecutions and seizures of furs for violation of the regulations for the protection of fur-bearing animals. The principal infractions of the regulations are sale of unprime skins obviously taken out of season and possession or sale of beaver, marten, and fur-seal skins. The confiscated furs have been disposed of at public auction in Seattle, and have yielded several thousand dollars in revenue to the Government.

**TRANSFER OF CONTROL.**

The Bureau is administering to the best of its ability the laws relating to the terrestrial and arboreal fur bearers of Alaska, but the duty is incongruous to its legitimate functions. The pursuit of foxes does not constitute a fishery. The cultivation of minks can not be successfully conducted in a fish hatchery. If Congress desires to retain jurisdiction over these animals, control should be vested in the Bureau of Biological Survey of the Department of Agriculture. The proper alternative course would be to transfer the jurisdiction to the Territory.

## MISCELLANEOUS MATTERS.

## APPROPRIATIONS AND ALLOTMENTS.

The appropriations for the Bureau of Fisheries for the fiscal year 1919 aggregated \$1,183,140, as follows:

Salaries.....	\$437, 940
Miscellaneous expenses:	
Administration.....	10, 000
Propagation of food fishes.....	400, 000
Maintenance of vessels.....	95, 000
Inquiry respecting food fishes.....	50, 000
Statistical inquiry.....	7, 500
Protecting sponge fisheries.....	3, 000
Protecting seal and salmon fisheries of Alaska (including deficiency of \$44, 700).....	144, 700
Improvements at the Berkshire (Mass.) trout hatchery.....	2, 500
Establishment of an auxiliary hatchery, Lake Champlain.....	5, 000
Vessel for Pribilof Islands (including deficiency of \$7,500).....	27, 500

A detailed statement of the expenditures under the regular and deficiency appropriations will be submitted in accordance with law.

Three allotments from the appropriation for the national security and defense were made by the President during the year, as follows: On July 2, 1918, \$125,000 for a fishery-products laboratory in Washington, D. C.; on July 2, 1918, \$25,000 for increasing the food-fish supply; and on January 11, 1919, \$10,000 for the same purpose.

## VESSEL SERVICE.

The steamer *Roosevelt* reached Seattle on July 7, 1918, from the Pribilof Islands and at once made ready for another trip, taking on a miscellaneous cargo of general supplies, lumber, machinery, salt, coal, etc. Departure was made July 26, and the vessel arrived at Unalaska August 21, where she took on additional fuel and a shipment of salt which had been sent by commercial freight to that place. Two additional round trips between the island and Unalaska were made to transport the freight stored there. On the return voyage a large shipment of sealskins and a quantity of old bones were carried from St. Paul Island. Bad weather was encountered which prevented the bringing out of any products from St. George Island. The vessel reached Seattle at midnight, October 3. On her next voyage the *Roosevelt* left Seattle October 15, and arrived at the islands November 3. The landing of cargo was delayed by storms, and it was necessary to go to Akutan for additional fuel before discharging all freight. Final departure from the islands was made on December 12, the vessel reaching Seattle with a cargo of sealskins, bones, etc., on January 3, 1919.

On January 17 the master of the *Roosevelt* reported the vessel to be in need of overhauling, refitting, and repairs to put her in seaworthy condition, and this report was confirmed by officers in the Steamboat-Inspection Service who surveyed the vessel. Arrangements were made to have the required work done at the Bremerton Navy Yard, but an examination of the ship by construction officers of the Navy elicited the report that repairs amounting practically to rebuilding would be necessary to put her in satisfactory condition and that

the cost and time involved would not be justified. Accordingly, on June 4 the *Roosevelt* was condemned and after the customary advertising was sold at public auction to the highest bidder on July 15, 1919, for \$28,000.

Four vessels of the Bureau which were placed at the disposal of the Navy Department for the period of the war have been returned in good condition. It is understood that the military services of all, as part of the auxiliary fleet, were important and useful. The *Albatross* was under naval control from November 19, 1917, to June 23, 1919; the *Fish Hawk* from July 18, 1918, to July 1, 1919; the *Halcyon* from May 14, 1917, to August 5, 1919; and the *Phalarope* from December 6, 1917, to July 29, 1919. Both the *Fish Hawk* and the *Phalarope* were employed in Navy work for considerable periods prior to their being formally taken over.

With the special appropriation for a vessel for the Pribilof Islands, the power schooner *Eider* was purchased at Seattle for \$26,500. This boat, formerly a deep-sea halibut vessel known as the *Idaho*, was built in 1913 and is of particularly seaworthy construction. She is 88 feet long, and 19 feet beam, and is equipped with a 110-horsepower Frisco standard engine with the usual auxiliary machinery and fuel tanks of sufficient capacity to give a cruising radius of 5,500 miles. She will be further equipped with wireless apparatus, and as part of her duty will be guarding the fur-seal rookeries, she will be furnished with a light gun.

There have been transferred to the Bureau by the Navy Department the motor boats *Enterprise* (S. P. 790), *Polly* (S. P. 690), *Cobra* (S. P. 626), and *Calypto* (S. P. 632). The two former will be used in fish-cultural work on the Maine coast, and at Cape Vincent, N. Y., respectively, and the two latter as patrol boats in southeast Alaskan waters.

#### COOPERATION WITH OTHER GOVERNMENT AGENCIES.

The Bureau of Fisheries cooperates with numerous other Government bureaus, and is glad to acknowledge the helpful attitude which exists throughout the public service.

Relations of public importance have been maintained with the National Park Service, Department of the Interior, in Yellowstone and Glacier National Parks, where the Bureau conducts hatcheries and supplies fish for the stocking of park waters, while the National Park Service affords various facilities to this end. Shipments of fish are made to other national parks on the request of the proper officials. The attraction which the national parks have for the general public is increased by the angling facilities they afford; and the Bureau is in cordial accord with the movement to secure larger patronage for our unrivaled national recreation grounds.

The Bureau of Indian Affairs has entered into an agreement with the Bureau to promulgate better fishing regulations on the Quinault River in Washington, where a salmon hatchery is maintained for the benefit of the Indians. It became necessary to revise the regulations governing fishing by the Indians, and this was successfully accomplished after many conferences between officials of both bureaus.

The Reclamation Service has tendered assistance in planting fish in streams and reservoirs that come under its control, and has published articles prepared by the Bureau in regard to the stocking of waters.

The Forest Service has taken the greatest interest in the stocking of streams in forest reservations throughout the country. Its district forest supervisors have been receiving fish at the railroad stations and taking them back into mountain streams, by pack horse in many instances, in especially constructed cans belonging to the Forest Service. This work has extended throughout the Rocky Mountain region, to Minnesota and Wisconsin, to the White Mountains, and to the Alleghanies in North Carolina. The fish thus handled by the Forest Service are placed in mountain streams and such waters as are heavily fished by tourists, thus affording much pleasure to a large and appreciative public. The increased use of automobiles by touring parties, and the movement to construct good roads through the forest reservations are causing more people to seek the reservations each year, and angling is one of the principal attractions.

With the Bureau of Chemistry the Bureau has cooperated in the examination of various fishery foods, with reference to the correctness of labels and the suitability for human consumption. The two bureaus worked together in introducing half a million pounds of Gulf fish into interior markets.

The States Relations Service South of the Department of Agriculture and the Bureau of Fisheries have cooperated effectively in various ways, the principal one being in giving demonstrations of the methods of preparing and cooking fish; these demonstrations being at points in Florida, Mississippi, Georgia, and in Washington, D. C.

The Bureau of Animal Industry has cooperated with this Bureau in bringing about an increased production of fish meal and calling the attention of agriculturists to the value of this product as animal food. The part taken by the Bureau of Fisheries has been to interest persons in the fishery industries in the production of this product, while the Bureau of Animal Industry carries on feeding tests and finds markets for such material as is produced.

Reference is made elsewhere to the work of the Bureau, undertaken in connection with the Public Health Service, in eradicating mosquitoes in the extra-plantation zone at Camp Hancock, Ga. Experiments in mosquito control are being jointly conducted by the Bureau of Entomology and the Bureau of Fisheries in Louisiana.

The Coast Guard has rendered invaluable service, as heretofore, in connection with the Alaska work of the Bureau, more particularly with regard to transportation of persons and supplies to the Pribilof Islands.

In October, 1918, the Coast Guard cutter *Bear* made a special trip to Seattle for the purpose of bringing out Assistant Agent A. C. Reynolds for urgent medical treatment. A small shipment of fur-seal skins from St. George Island was also carried. In response to a request from the Secretary of Commerce, on February 12, 1919, the Secretary of the Navy advised on March 3 that the commodore commandant of the Coast Guard had been directed to detail the cutters *Unalga* and *Bear* to maintain the usual patrol for the protection of the seal herd. The *Bear* sailed from Seattle on May 14

and carried as passengers for the Bureau four employees from the plant of Funsten Bros. & Co., who were to assist in the sealing work on the islands. A small quantity of emergency supplies also was transported. Because of the quarantine established on account of the epidemic of influenza, these passengers could not be landed at the islands by the *Bear*, and were taken to Nome and subsequently returned to Seattle.

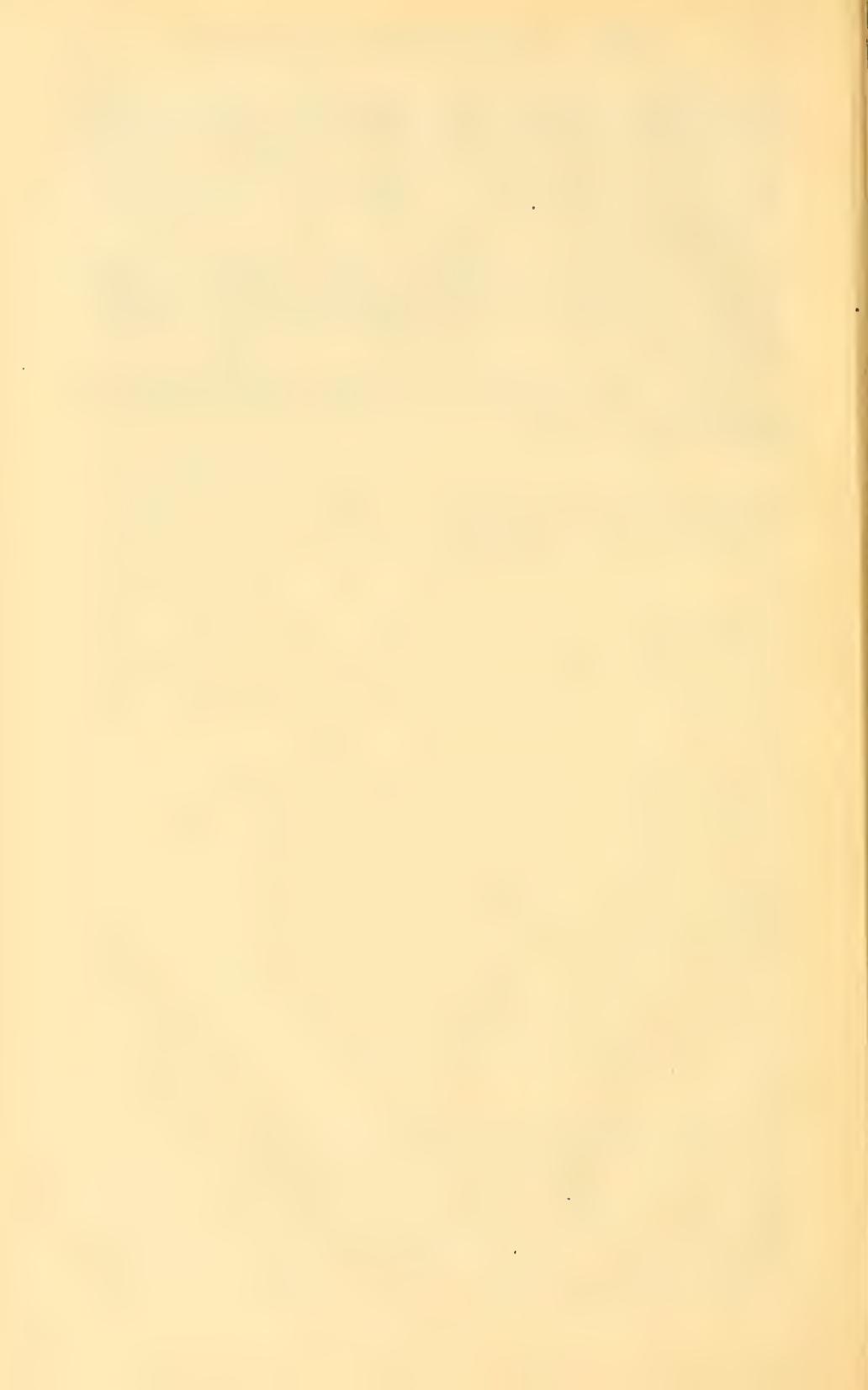
The Fuel Administration issued orders making it imperative that the Bureau's stations and distribution cars be supplied with coal in such quantities and at such times as might be required. Had this not been done many of the stations would have been compelled to shut down, and the car service would have been crippled in its efforts to distribute fish.

The Food Administration and the Bureau together worked out regulations governing fishing during the war period, and cooperated in other ways.

Respectfully submitted.

H. M. SMITH,  
*Commissioner of Fisheries.*

To Hon. WILLIAM C. REDFIELD,  
*Secretary of Commerce.*



**DISTRIBUTION OF FISH AND FISH EGGS DURING  
THE FISCAL YEAR 1919**

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**GLEN C. LEACH**

*Assistant in Charge of Fish Culture*

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**Appendix I to the Report of the U. S. Commissioner of Fisheries for 1919**

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<sup>a</sup> Distributed as crappie.

# DISTRIBUTION OF FISH AND FISH EGGS DURING THE FISCAL YEAR 1919.

## DESCRIPTION OF WORK.

### EXTENT AND CHARACTER OF OPERATIONS.

During the fiscal year 1919 the Bureau of Fisheries produced at its fish-cultural stations 5,876,985,350 fish and fish eggs and disseminated them throughout the country, its distributions embracing every section of the United States and the coastal regions of Alaska.

Approximately 95 per cent of this output consisted, as heretofore, of the salmons, shad, whitefish, pike perch, yellow perch, lake trout, cod, pollock, haddock, and winter flounder, which constitute the more important commercial species; all of which fishes were planted by the Bureau either on or adjacent to the spawning grounds from which the eggs originated or in nonproductive waters where the natural conditions appear to favor the development of new and profitable fisheries.

Though relatively small in numbers of fishes produced, that branch of the work pertaining to the production of fishes suitable for stocking interior waters is in reality a very important part of the Bureau's activities. Aside from its economic value, which is large and is constantly increasing, its prosecution necessarily involves contact and cooperation with the general public, thus serving to arouse and stimulate an interest in the fisheries which can not be other than beneficial in its effect. Among the fishes most extensively propagated for stocking ponds, lakes, and streams, both public and private, are the various trouts—brook, rainbow, and blackspotted—the largemouth and smallmouth black bass, rock bass, sunfish, crappie, and catfish. Various other species are also handled in limited numbers.

While the output of the pondfish cultural stations is annually expanding, it is far from being sufficient to meet public requirements. The deficiency is made up to some extent from the collections of young food fishes which are found in large numbers in the temporary lagoons existing during certain seasons of the year in the high-water zones along the Mississippi River and some of its tributaries. Early in the year these rivers overflow their banks and spread out over miles of territory, and in the warm shallows thus formed many varieties of native food and game fishes deposit their spawn. With the subsidence of the floods the young fishes resulting from such spawn are imprisoned in the thousands of depressions existing, at depths ranging from a few inches to several feet. Here they are exposed for several months to the depredations of game birds and aquatic enemies and, if not removed, all of them finally perish with the drying and freezing of the pools. The great bulk of the immense numbers of fishes

which the Bureau annually rescues from these temporary waters is returned to the original streams, but a small percentage is used to supplement stock for distribution to applicants, and it is only in this way that the heavy demands for pondfishes can be met.

This work of conserving fish life in the Mississippi River Valley, instituted on a small scale by the Federal fishery department many years ago, has been gradually expanded as facilities permitted, so that during the fiscal year 1919 the results of such operations aggregated 55,818,817 fish rescued, of which all but 610,021 were returned to their native waters. This latter comparatively small number was transported for distribution in other sections of the United States by means of the Bureau's distribution cars.

Inquiries recently instituted by the Bureau show that remarkable success is being attained in the stocking of interior waters with fish furnished from its stations. Most of the reports received on this branch of the work are favorable, but the results in the case of farm ponds are especially encouraging. Thousands of such ponds, though formerly destitute of fish life, are now claimed by the owners to be yielding an abundant supply.

#### ASSIGNMENT OF FISHES TO APPLICANTS.

On receipt of a request for fish, the Bureau supplies a blank calling for a complete description of the waters to be stocked, and when the application is submitted the information contained therein is used as a basis for determining the species to be assigned.

#### SELECTION OF SPECIES.

The experience of the Bureau has demonstrated that in nearly every case it is preferable to introduce a species native to the locality of the waters to be stocked, and in specifying his choice of fish the applicant should bear this in mind. Nonindigenous fishes are furnished only upon the recommendation of his State fishery authorities, and, even with such indorsement, the Bureau reserves the right to exercise its judgment in the matter.

Predacious fishes like black bass and perch are not suitable for waters inhabited by trout, and the Bureau refuses to entertain applications for these or any of the other spiny-rayed fishes for introduction into waters in Idaho, Washington, Oregon, California, or the western portions of Montana and Wyoming, believing that their presence in such waters might prove harmful to the important salmon and trout fisheries of those States. Species belonging to the Salmonidæ are not supplied for waters which already contain fishes that are known to prey upon them. In order to obtain carp for a private pond or lake, an applicant must first secure the indorsement of his State fishery authorities and must satisfy the Bureau that there is no way for them to escape into public waters. The right is also reserved to substitute a more desirable food and game species in place of the carp if the description of the waters named in the application indicates that they are suitable therefor.

Eggs of certain species of fish are furnished to State hatcheries on request and occasionally to applicants who have hatching facilities, with the understanding that the product will be deposited in public waters.

## SIZE OF ALLOTMENTS.

In planning for its distributions the waters from which the Bureau's egg collections are obtained must have first consideration. After such provision has been made the remainder of the available stock is allotted to applicants for stocking public or private waters.

In determining the size of allotments to be made on applications the Bureau is governed by the number and size of the requested species available for distribution, by the extent of the water area to be stocked, and by the distance to which the fish must be transported. In every case the Bureau aims to supply only a sufficient number of young fish for the establishment of a brood stock, and it is expected that the recipient will take steps for their protection until they have had time to mature and stock the waters through natural reproduction.

## TIME AND METHOD OF DELIVERY.

Certain species, notably the brook trout and rainbow trout, are planted whenever possible during the fingerling stage; but, as the rearing facilities are limited, the stock must be reduced in the early spring to prevent overcrowding. Thus a part of the output is annually shipped in the fry stage. The distribution of the basses and other pondfishes begins about three weeks after they are hatched, and extends over a period of several months, the last lots of fish sent out ranging from 2 to 4 inches in length. The basses, sunfishes, crappie, yellow perch, and other fishes rescued from landlocked ponds and pools in the Mississippi River Valley are from 3 to 6 inches long when distributed.

It is the policy of the Bureau to fill applications in the order of their receipt and to deliver the fish assigned as soon thereafter as possible, but there are certain conditions connected with the distribution work which should be thoroughly understood by prospective applicants.

The cost involved in making shipments of fish compels the Bureau to exercise the utmost economy in arranging its distribution work. The delivery of special consignments and those intended for distant points must be delayed until a sufficient number of applications from the same section of the country have been received to warrant the expense of a messenger shipment. The Bureau can not carry a stock of fish for delivery on demand, and when the supply of one year is exhausted no more are available until the crop of the succeeding year is ready to be sent out. The shipment of trout from the Bureau's eastern stations begins early in March, and all applications received after that time are carried over until the following year. Trout distributions from stations in the Rocky Mountain regions are made between May and October, and, in order to insure early attention, applications from that part of the country should be in the Washington office of the Bureau not later than May 1. The so-called warm-water fishes, including black bass, sunfish, and crappie, are shipped between May and December, and requests for them should be submitted prior to May 1.

The fish are shipped in railroad cars especially designed for the purpose or in baggage cars, accompanied by a messenger, and the delivery is made at the applicant's railroad station without expense to him. When an application for fish is received by the Bureau the

person submitting it is immediately notified of the species assigned thereon and the approximate time when delivery may be expected. Full directions for the reception and care of the fish are also sent to him. Prior to the shipment a second notice is sent, usually a telegram, specifying the exact time when the assignment will arrive at his railroad station. In the event that for some unforeseen reason it becomes necessary to postpone the delivery the applicant is notified accordingly.

#### CHARACTER AND SIZE OF OUTPUT.

During the fiscal year 1919 the Bureau propagated and distributed some 60 species of fish and lobster, as shown in the following list. Fishes rescued from overflowed lands in the Mississippi Basin and restored to original waters or distributed in other sections of the United States are included.

#### LIST OF SPECIES HANDLED.

##### THE CATFISHES (SILURIDÆ):

- Horned pout, bullhead (*Ameiurus nebulosus*).
- Marbled catfish (*Ameiurus nebulosus marmoratus*).
- Mississippi catfish (*Ameiurus lacustris*).
- Spotted catfish, channel catfish (*Ictalurus punctatus*).
- Yellow catfish (*Leptops olivaris*).

##### THE SUCKERS (CATOSTOMIDÆ):

- Mongrel buffalofish (*Ictiobus urus*).
- Common buffalofish (*Ictiobus cyprinella*).
- Smallmouth buffalofish (*Ictiobus bubalus*).
- Common sucker, white sucker (*Catostomus commersonii*).
- Common red horse, mullet (*Moxostoma aureolum*).
- Black sucker (*Hypentelium nigricans*).

##### THE CARPS (CYPRINIDÆ):

- Asiatic carp (*Cyprinus carpio*).

##### THE SHADS AND HERRINGS (CLUPEIDÆ):

- Shad (*Alosa sapidissima*).
- Alewife (*Pomolobus pseudoharengus*).
- Skipjack (*Pomolobus chrysochloris*).

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

- Common whitefishes (*Coregonus albus* and *C. clupeiiformis*).
- Lake herring, cisco (chiefly *Leucichthys arctedi*).
- Chinook salmon, king salmon, quinnat salmon (*Oncorhynchus tshawytscha*).
- Silver salmon, coho (*Oncorhynchus kisutch*).
- Humpback salmon (*Oncorhynchus gorbuscha*).
- Chum salmon (*Oncorhynchus keta*).
- Blueback salmon, redfish, sockeye (*Oncorhynchus nerka*).
- Steelhead salmon (*Salmo gairdneri*).
- Rainbow trout (*Salmo shasta*).
- Atlantic salmon (*Salmo salar*).
- Landlocked salmon (*Salmo sebago*).
- Blackspotted trout, redthroat trout (*Salmo lewisi*).
- Loch Leven trout (*Salmo levenensis*).
- Lake trout, Mackinaw trout (*Cristivomer namaycush*).
- Brook trout (*Salvelinus fontinalis*).

##### THE GRAYLINGS (THYMALLIDÆ):

- Montana grayling (*Thymallus montanus*).

##### THE SMELTS (OSMERIDÆ):

- Smelt (*Osmerus mordax*).

##### THE MACKERELS (SCOMBRIDÆ):

- Common mackerel (*Scomber scombrus*).

##### THE SUNFISHES, BLACK BASSES, AND CRAPPIES (CENTRARCHIDÆ):

- Crappie (*Pomoxis annularis*).
- Strawberry bass (*Pomoxis sparoides*).
- Rock bass (*Ambloplites rupestris*).
- Smallmouth black bass (*Micropterus dolomieu*).
- Largemouth black bass (*Micropterus salmoides*).

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

Bluegill sunfish (*Lepomis pallidus*).Redspotted sunfish (*Lepomis humilis*).Longeared sunfish (*Lepomis megalotis*).Common sunfish (*Eupomotis gibbosus*).Warmouth, goggle-eye (*Chænobryttus gulosus*).

## THE PERCHES (PERCIDÆ):

Pike perch (*Stizostedion vitreum*).Yellow perch (*Perca flavescens*).

## THE PIKES (LUCIDÆ):

Little pickerel (*Lucius vermiculatus*).Common pickerel (*Lucius lucius*).Muskallunge (*Lucius masquinongy*).

## THE BASSES (SERRANIDÆ):

Striped bass, rockfish (*Roccus lineatus*).White bass (*Roccus chrysops*).White perch (*Morone americana*).Yellow bass (*Morone interrupta*).

## THE DRUMS (SCIAENIDÆ):

Fresh-water drum, lake sheephead (*Aplodinotus grunniens*).

## THE CODS (GADIDÆ):

Cod (*Gadus callarias*).Haddock (*Melanogrammus æglefinus*).Pollock (*Pollachius virens*).

## THE FLOUNDERS (PLEURONECTIDÆ):

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

## CRUSTACEANS:

American lobster (*Homarus americanus*).

The following table gives the different fish-cultural stations and substations operative in 1919, the period of operation of each, and the number of fish and eggs, by species, furnished for distribution by each station, through propagation, through collections from auxiliary stations, and through rescuing fish from overflowed lands of the Mississippi Basin. It will be noted that transfers of fish and eggs from station to station are frequent. Such transfers are made in the interest of economy and convenience where the shipments consist of eggs, and give advantageous distribution centers in the case of young fish.

## STATIONS OPERATED AND OUTPUT OF EACH FOR FISCAL YEAR 1919.

[NOTE.—See explanations of reference characters on p. 12.]

Station and period of operation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Afognak, Alaska: <sup>a</sup>					
Entire year.....	Humpback salmon.....		2, 142, 000		2, 142, 000
	Sockeye salmon.....	20, 700, 000	11, 906, 000	13, 677, 000	46, 283, 000
Atchafalaya, La.:					
Mar.-Apr.....	Buffalofish.....		110, 940, 000		110, 940, 000
Baird, Calif.:					
Entire year.....	Chinook salmon.....			2, 280, 000	2, 280, 000
Battle Creek, Calif.—	do.....	638, 000		4, 509, 000	5, 147, 000
Entire year.....	do.....				
Mill Creek, Calif.—	do.....	11, 164, 500		3, 498, 800	14, 662, 800
Entire year.....	do.....			86, 500	86, 500
Baker Lake, Wash.:					
Entire year.....	Sockeye salmon.....			8, 622, 000	8, 622, 000
Birdsview, Wash. <sup>b</sup> —					
Entire year.....	Blackspotted trout.....			154, 000	154, 000
	Chinook salmon.....		24, 320	162, 000	186, 320
	Chum salmon.....		848, 840		848, 840
	Humpback salmon.....		1, 969, 000		1, 969, 000
	Silver salmon.....		4, 687, 520	769, 600	5, 457, 120
	Sockeye salmon.....			45, 560	45, 560
	Steelhead salmon.....	25, 000		198, 865	223, 865

## STATIONS OPERATED AND OUTPUT OF EACH FOR FISCAL YEAR 1919—Continued.

[NOTE.—See explanations of reference characters on p. 12.]

Station and period of operation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Baker Lake, Wash.—Con.					
Darrington, Wash.— Mar.—June.....	Chum salmon.....		619,000		619,000
	Silver salmon.....		18,900		18,900
Duckabush, Wash.— Entire year.....	Chum salmon.....		2,780,000	2,803,160	5,583,160
	Humpback salmon.....			369,958	369,958
	Silver salmon.....			208,380	208,380
Quilcene, Wash. c— Entire year.....	Chinook salmon.....		18,250		18,250
	Chum salmon.....		1,545,000	860,600	2,405,600
	Humpback salmon.....		385,500		385,500
	Silver salmon.....			354,000	354,000
	Steelhead salmon.....	50,000		170,000	220,000
Sultan, Wash.— Entire year.....	Chinook salmon.....		246,430		246,430
	Silver salmon.....		2,157,600		2,157,600
	Steelhead salmon.....			92,500	92,500
Berkshire, Mass.: Entire year.....	Brook trout.....			542,300	542,300
	Rainbow trout.....		10,500	1,500	12,000
	Smallmouth black bass.....		2,000		2,000
Boothbay Harbor, Me.: Entire year.....	Alewife.....		25,000		25,000
	Cod.....		1,067,000		1,067,000
	Flounder.....		1,279,256,000		1,279,256,000
	Haddock.....		192,000		192,000
	Lobster.....		7,500,000		7,500,000
	Pollock.....		1,714,000		1,714,000
Bozeman, Mont.: d Entire year.....	Blackspotted trout.....			945,750	945,750
	Brook trout.....			688,350	688,350
	Grayling.....		275,000		275,000
	Rainbow trout.....	1,580,000		869,750	2,449,750
Glacier Park, Mont.— Mar.—June.....	Brook trout.....		350,000		350,000
Yellowstone, Wyo. e— July—Sept.....	Blackspotted trout.....	12,000	200,000		212,000
Bryans Point, Md.: f Feb.—May.....	Shad.....		44,864,550		44,864,550
	Yellow perch.....		153,679,500		153,679,500
Cape Vincent, N. Y.: g Entire year.....	Brook trout.....		658,500		658,500
	Chinook salmon.....		627,600	150,000	777,600
	Lake herring.....	146,700,000	86,180,000		232,880,000
	Lake trout.....		467,975		467,975
	Whitefish.....	25,150,000	41,670,000		67,120,000
	Yellow perch.....		7,000,000		7,000,000
	Miscellaneous fishes.....		1,000,000		1,000,000
Central Station, Wash- ington, D. C.: Entire year.....	Brook trout.....			16,000	16,000
	Rainbow trout.....			11,500	11,500
	Shad.....		300,000		300,000
	Whitefish.....		750,000		750,000
	Yellow perch.....		2,500,000		2,500,000
Clackamas, Oreg.: h Entire year.....	Blackspotted trout.....			80,000	80,000
	Brook trout.....			64,400	64,400
	Chinook salmon.....			3,081,000	3,081,000
	Rainbow trout.....			110,800	110,800
	Steelhead salmon.....			25,000	25,000
Applegate, Oreg.— Entire year.....	Chinook salmon.....			30,850	30,850
	Silver salmon.....			494,650	494,650
	Steelhead salmon.....	500,000		32,000	532,000
Big White Salmon, Wash.— Entire year.....	Chinook salmon.....			9,102,000	9,102,000
Little White Salmon, Wash. i— Entire year.....	do.....			9,177,500	9,177,500
	Chum salmon.....		460,800		460,800
	Sockeye salmon.....			939,960	939,960
Rogue River, Oreg.— Entire year.....	Blackspotted trout.....			37,700	37,700
	Chinook salmon.....			1,002,100	1,002,100
	Rainbow trout.....			48,000	48,000
	Silver salmon.....			87,500	87,500
	Steelhead salmon.....			775,000	775,000

## STATIONS OPERATED AND OUTPUT OF EACH FOR FISCAL YEAR 1919—Continued.

[NOTE.—See explanations of reference characters on p. 12.]

Station and period of operation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Clackamas, Oreg.—Contd.					
Upper Clackamas, Oreg.—					
Entire year.....	Chinook salmon.....			1,211,000	1,211,000
	Silver salmon.....			2,200	2,200
	Steelhead salmon.....			10,500	10,500
St. Helens, Oreg.—					
July-June.....	Shad.....		11,716,700		11,716,700
Willamette, Oreg.—					
July-June.....	do.....		3,449,000		3,449,000
Washougal, Wash.—					
May-June.....	Steelhead salmon.....	205,000	100,000		305,000
Cold Springs, Ga.:					
Entire year.....	Black bass.....		87,000	126,450	213,450
	Catfish.....			8,904	8,904
	Crappie.....			400	400
	Sunfish.....			66,900	66,900
Milltown, Ga.—					
May.....	Black bass.....			37,100	37,100
Craig Brook, Me.:					
Entire year.....	Atlantic salmon.....		2,390,000	700	2,390,700
	Brook trout.....		516,000	63,200	579,200
	Landlocked salmon.....		90,925		90,925
Duluth, Minn.:					
Entire year.....	Brook trout.....		202,500	67,500	270,000
	Lake trout.....	1,550,000	10,327,500	692,500	12,570,000
	Pike perch.....	5,000,000	12,500,000		17,500,000
	Whitefish.....		8,500,000		8,500,000
Edenton, N. C.:					
Entire year.....	Black bass.....		4,000	19,585	23,585
	Shad.....		23,694,000		23,694,000
	Sunfish.....			12,700	12,700
	White perch.....		2,035,000		2,035,000
	Yellow perch.....			114	114
Weldon, N. C.—					
Apr.-May.....	Striped bass.....		13,540,000		13,540,000
Erwin, Tenn.:					
Entire year.....	Black bass.....		11,200	4,755	15,955
	Brook trout.....			236,250	236,250
	Rainbow trout.....			373,900	373,900
	Rock bass.....			22,935	22,935
	Smallmouth black bass.....	1,000		6,300	7,300
	Sunfish.....			12,200	12,200
Fairport, Iowa:					
Entire year.....	Black bass.....			10,346	12,346
	Buffalofish.....		160,000	48,745	208,745
	Carp.....		899,000	299,002	1,198,002
	Catfish.....			195,165	195,165
	Crappie.....			106,030	106,030
	Pike and pickerel.....			540	540
	Smallmouth black bass.....			2,190	2,190
	Sunfish.....			38,679	38,679
	White bass.....			1,035	1,035
	Yellow perch.....			3,110	3,110
	Miscellaneous.....			7,145	7,145
Gloucester, Mass.:					
Entire year.....	Cod.....	243,870,000	42,880,000		286,750,000
	Flounder.....		138,990,000		138,990,000
	Haddock.....	200,390,000	129,400,000		329,790,000
	Pollack.....		702,258,000		702,258,000
Green Lake, Me.:					
Entire year.....	Brook trout.....		901,200		901,200
	Landlocked salmon.....	405,125	322,000	100,441	827,568
	Smelt.....	3,000,000	6,437,000		9,437,000
	Steelhead salmon.....			11,232	11,232
Grand Lake Stream, Me.:					
Entire year.....	Brook trout.....		48,480		48,480
	Landlocked salmon.....		18,947	72,757	91,704
	Steelhead salmon.....			34,938	34,938
Homer, Minn.:					
Entire year.....	Black bass.....			174,366	174,366
	Buffalofish.....			586,890	586,890
	Carp.....			10,083,500	10,083,500
	Catfish.....			6,615,225	6,615,225
	Crappie.....			8,037,335	8,037,335
	Drum.....			18,500	18,500
	Pike and pickerel.....			327,250	327,250
	Rock bass.....			4,600	4,600
	Sunfish.....			627,200	627,200

## STATIONS OPERATED AND OUTPUT OF EACH FOR FISCAL YEAR 1919—Continued.

[NOTE.—See explanations of reference characters on p. 12.]

Station and period of operation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Homer, Minn.—Contd. Entire year.....	White bass.....			1,500	1,500
	Yellow perch.....			2,213,280	2,213,280
	Miscellaneous.....			70,400	70,400
La Crosse, Wis.: Entire year.....	Black bass.....			45,990	45,990
	Brook trout.....		112,170	264,500	376,670
	Buffalofish.....			3,000	3,000
	Carp.....			2,450,000	2,450,000
	Catfish.....			793,900	793,900
	Crappie.....			1,514,500	1,514,500
	Pike perch.....		5,000,000	10,710	5,010,710
	Pike and pickerel.....			30,700	30,700
	Rainbow trout.....			55,500	55,500
	Rock bass.....			170	170
	Sunfish.....			16,000	16,000
Leadville, Colo.: <sup>a</sup> Entire year.....	Yellow perch.....			79,790	79,790
	Miscellaneous.....			352,600	352,600
	Blackspotted trout.....			774,100	774,100
	Brook trout.....	100,000		1,902,500	2,002,500
	Lake trout.....			20,000	20,000
Louisville, Ky.: Entire year.....	Loch Leven trout.....			60,000	60,000
	Rainbow trout.....			195,000	195,000
	Black bass.....			700	700
	Brook trout.....			150	150
	Crappie.....			75	75
Cairo, Ill.— Sept.—Oct.....	Pike perch.....		1,700,000		1,700,000
	Rainbow trout.....			4,250	4,250
	Rock bass.....			6,050	6,050
	Smallmouth black bass.....		30,000		38,200
	Sunfish.....			49,100	49,100
	Yellow perch.....		380,000		380,000
	White bass.....			100	100
Mammoth Spring, Ark.: Entire year.....	Buffalo fish.....			45,500	45,500
	Catfish.....			1,110,000	1,110,000
	Crappie.....			299,500	299,500
	Sunfish.....			183,000	183,000
	White bass.....			1,000	1,000
	Black bass.....		2,000		23,070
Manchester, Iowa: <sup>o</sup> Entire year.....	Rock bass.....			1,910	1,910
	Smallmouth black bass.....		47,600	2,200	49,800
	Brook trout.....			404,390	404,390
	Pike perch.....		1,900,000		1,900,000
Bellevue, Iowa— July—Dec.....	Rainbow trout.....	72,000		247,390	319,390
	Rock bass.....			17,250	17,250
	Smallmouth black bass.....			2,820	2,820
	Sunfish.....			140	140
	Black bass.....			60,852	60,852
North McGregor, Iowa— July—Dec.....	Buffalo fish.....			823,850	823,850
	Carp.....			4,961,660	4,961,660
	Catfish.....			1,296,245	1,296,245
	Crappie.....			4,548,420	4,548,420
	Drum.....			477	477
	Pike and pickerel.....			947	947
	Sunfish.....			84,338	84,338
	White bass.....			4,130	4,130
	Yellow perch.....			1,268	1,268
	Miscellaneous.....			89,105	89,105
	Meredosia, Ill.: <sup>p</sup> Entire year.....	Black bass.....			72,730
Buffalo fish.....				1,066,000	1,066,000
Carp.....				1,941,100	1,941,100
Catfish.....				1,170,035	1,170,035
Crappie.....				1,258,200	1,258,200
Pike and pickerel.....				16,500	16,500
Sunfish.....				14,710	14,710
White bass.....				1,000	1,000
Yellow perch.....				42,390	42,390
Miscellaneous.....				228,000	228,000
Meredosia, Ill.: <sup>p</sup> Entire year.....	Black bass.....			58,149	58,149
	Buffalo fish.....			17,400	17,400
	Carp.....			18,800	18,800
	Catfish.....			1,329,600	1,329,600

## STATIONS OPERATED AND OUTPUT OF EACH FOR FISCAL YEAR 1919—Continued.

[NOTE.—See explanations of reference characters on p. 12.]

Station and period of operation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Meredosia, Ill.—Cont'd.					
Entire year.....	Crappie.....			41,975	41,975
	Sunfish.....			39,150	39,150
	Yellow bass.....			600	600
	Yellow perch.....			14,600	14,600
Nashua, N. H.:					
Entire year.....	Brook trout.....			664,825	664,825
	Landlocked salmon.....			6,800	6,800
	Rainbow trout.....			13,224	13,224
	Smallmouth black bass.....		63,500	625	64,125
Neosho, Mo.: <i>q</i>					
Entire year.....	Black bass.....			19,012	19,012
	Catfish.....			800	800
	Crappie.....			6,550	6,550
	Rainbow trout.....	82,700		125,286	207,986
	Rock bass.....			9,340	9,340
	Smallmouth black bass.....			3,200	3,200
	Sunfish.....			24,464	24,464
	Yellow perch.....	160,000	130,000		290,000
Northville, Mich.:					
Entire year.....	Brook trout.....		193,000	249,500	442,500
	Rainbow trout.....		14,000	23,000	37,000
	Smallmouth black bass.....			18,075	18,075
Charlevoix, Mich.: <i>r</i>					
Entire year.....	Lake trout.....	1,518,000	17,700,000		19,218,000
	Pike perch.....		10,000,000		10,000,000
	Steelhead salmon.....		28,125	24,358	52,583
	Whitefish.....	15,280,000	20,000,000		35,280,000
Detroit, Mich.— Apr.—May.....	Pike perch.....		3,800,000		3,800,000
Bay City, Mich.— Apr.....	do.....	348,800,000			348,800,000
Orangeburg, S. C.:					
Entire year.....	Black bass.....			226,300	226,300
	Catfish.....			1,080	1,080
	Sunfish.....			48,500	48,500
Put in Bay, Ohio: <i>s</i>					
Entire year.....	Carp.....		22,800,000		22,800,000
	Pike perch.....	23,100,000	70,300,000		93,400,000
	Whitefish.....	70,920,000	126,300,000		197,220,000
	Yellow perch.....		12,000,000		12,000,000
Quinalt, Wash.:					
Entire year.....	Chinook salmon.....		100,000	109,400	209,400
	Silver salmon.....		600,000	419,400	1,019,400
	Sockeye salmon.....		1,200,000	5,678,000	6,878,000
St. Johnsbury, Vt.: <i>t</i>					
Entire year.....	Brook trout.....	7,000	1,108,700	52,715	1,168,415
	Lake trout.....			2,210	2,210
	Landlocked salmon.....			1,256	1,256
	Rainbow trout.....		14,000		14,000
	Smallmouth black bass.....		6,000		6,000
	Steelhead salmon.....			3,011	3,011
Holden, Vt.— Entire year.....	Brook trout.....		81,000	24,725	105,725
	Lake trout.....			10,700	10,700
	Landlocked salmon.....			1,300	1,300
	Steelhead salmon.....			31,586	31,586
Lakewood, Vt.— Apr.—May.....	Pike perch.....	29,300,000	71,500,000		100,800,000
	Yellow perch.....	22,500,000	3,600,000		26,100,000
San Marcos, Tex.:					
Entire year.....	Black bass.....		1,950	107,743	109,693
	Crappie.....			280	280
	Rock bass.....			1,411	1,411
	Sunfish.....		3,050	6,765	9,815
Saratoga, Wyo.: <i>u</i>					
Entire year.....	Blackspotted trout.....			369,000	369,000
	Brook trout.....			693,000	693,000
	Rainbow trout.....	805,000		226,000	226,000
	Steelhead salmon.....			41,000	41,000
Spearfish, S. Dak.:					
Entire year.....	Blackspotted trout.....			261,000	261,000
	Brook trout.....			668,100	668,100
	Lake trout.....			41,975	41,975
	Loch Leven trout.....			13,000	13,000
	Rainbow trout.....			223,790	223,790
	Steelhead salmon.....			43,300	43,300
Springville, Utah: <i>v</i>					
Entire year.....	Blackspotted trout.....	121,000		253,550	374,550
	Brook trout.....			82,750	82,750
	Rainbow trout.....	400,000		308,650	708,650

## STATIONS OPERATED AND OUTPUT OF EACH FOR FISCAL YEAR 1919—Continued.

[NOTE.—See explanations of reference characters below.]

Station and period of operation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Springville, Utah—Contd.					
Paris, Idaho— Feb.—May	Whitefish.....		1,495,000		1,495,000
Tupelo, Miss.: Entire year.	Black bass.....		319,700	73,165	392,865
	Crappie.....			675	675
	Sunfish.....			56,650	56,650
	Warmouth bass.....			1,059	1,059
Friar Point, Miss.— July—Dec.	Black bass.....			30,443	30,443
	Buffalofish.....			4,950	4,950
	Catfish.....			121,276	121,276
	Crappie.....			26,389	26,389
	Rock bass.....			440	440
	Sunfish.....			69,125	69,125
White Sulphur Springs, W. Va.: Entire year.	Brook trout.....			861,300	861,300
	Rainbow trout.....			137,050	137,050
	Rock bass.....			2,400	2,400
	Smallmouth black bass.....		50,500	840	51,340
	Sunfish.....			900	900
Woods Hole, Mass.: Entire year.	Cod.....		20,384,000		20,384,000
	Flounder.....		1,235,946,000		1,235,946,000
	Mackerel.....		9,508,000		9,508,000
Wytheville, Va.: <sup>w</sup> Entire year.	Black bass.....			12,925	12,925
	Brook trout.....			103,300	103,300
	Rainbow trout.....			464,200	464,200
	Rock bass.....			10,350	10,350
	Smallmouth black bass.....			360	360
	Sunfish.....			3,115	3,115
Yes Bay, Alaska:z Entire year.	Humpback salmon.....		930,000		930,000
	Sockeye salmon.....	3,440,100	26,650,000	8,679,700	39,829,700
Gross total.		1,177,870,545	4,548,516,830	151,832,593	5,878,219,968
Loss in transit.			1,176,505	58,113	1,234,618
Net output.		1,177,870,545	4,547,340,325	151,774,480	5,876,985,350

## NOTES TO REFERENCE CHARACTERS IN PRECEDING TABLE.

For convenience in handling, transfers were made as follows:

- a Alognak to Baker Lake, 5,760,000 humpback salmon; to Quinault, 5,000,000 sockeye-salmon eggs.  
 b Birdsvie to Charlevoix, 25,000; to St. Johnsbury, 50,000 steelhead-salmon eggs.  
 c Quilcene to Holden, 50,000; to Green Lake, 50,000 steelhead-salmon eggs.  
 d Bozeman to Spearfish, 25,000; to Manchester, 25,000; to Clackamas, 200,000; to Northville, 25,000; to Wytheville, 75,000; to White Sulphur Springs, 25,000; to Rogue River, 100,000; to Birdsvie, 50,000 rainbow-trout eggs.  
 e Yellowstone to Spearfish, 345,000; to Saratoga, 427,000; to Birdsvie, 105,000; to Clackamas, 105,000; to Glacier Park, 265,000 blackspotted-trout eggs.  
 f Bryans Point to Central Station, 875,000 shad eggs, 3,120,000 yellow-perch eggs.  
 g Cape Vincent to Central Station, 500,000 whitefish eggs, 1,500,000 lake-herring eggs.  
 h Clackamas to Central Station, 20,000 chinook-salmon eggs.  
 i Little White Salmon to Cape Vincent, 820,000 chinook-salmon eggs.  
 j Duluth to Leadville, 25,000 lake-trout eggs; to Manchester, 2,000,000; to La Crosse, 5,000,000 pike-perch eggs.  
 k Erwin to Cold Springs, 2,000 rock-bass fingerlings.  
 l Gloucester to Boothbay Harbor, 2,100,000 pollock eggs.  
 m Grand Lake Stream to Craig Brook, 100,000 landlocked-salmon eggs.  
 n Leadville to Glacier Park, 500,000 brook-trout eggs; to Saratoga, 206,000 rainbow-trout eggs; to Cedar Island Lodge, 100,000 brook-trout eggs in exchange for rainbow-trout eggs.  
 o Manchester to Northville, 24,700; to La Crosse, 100,000 rainbow-trout eggs.  
 p Meredosia to Neosho, 1,000 catfish fingerlings.  
 q Neosho to Meredosia, 5,000 rock-bass fingerlings; to Erwin, 51,000; to Central Station, 15,000 rainbow-trout eggs.  
 r Charlevoix to Holden, 50,000 lake-trout eggs.  
 s Put-in-Bay to Duluth, 22,400,000; to Charlevoix, 64,680,000; to Central Station, 800,000 whitefish eggs; to Louisville, 2,000,000; to La Crosse, 7,000,000 pike-perch eggs.  
 t St. Johnsbury to Berkshire, 50,000; to Central Station, 17,960 brook-trout eggs.  
 u Saratoga to St. Johnsbury, 50,000; to Leadville, 206,000 rainbow-trout eggs.  
 v Springville to Saratoga, 608,400 brook-trout eggs.  
 w Wytheville to Erwin, 23,000; to Neosho, 22,000; to Manchester, 24,000; to Central Station, 10,000 rainbow-trout eggs.  
 z Yes Bay to Birdsvie, 406,000 humpback-salmon eggs; to Little White Salmon, 1,059,900 sockeye-salmon eggs.

The eggs hatched at the main stations and substations listed in the foregoing table are in many cases obtained from auxiliary sources, usually temporary stations occupied during the season only or, in some instances, mere camps, which are shifted from year to year. In the Great Lakes and off the New England coast collections are made by the Bureau's vessels or boats in favorable localities. The following temporary stations and collecting points operative for the periods indicated, furnished eggs of the given species for the main hatcheries during 1919:

## EGG-COLLECTING STATIONS FOR FISCAL YEAR 1919.

Station.	Period of operation.	Species handled.
Baker Lake, Wash.:		
Brinnon, Wash. ....	November to June.....	Chum, silver, and steelhead salmon.
Illabott Creek, Wash. ....	November to February.....	Chum and silver salmon.
Bozeman, Mont.:		
Madison Valley, Mont. ....	March to June.....	Grayling, rainbow trout.
Clear Creek, Wyo. ....	July and June.....	Blackspotted trout.
Columbine Creek, Wyo. ....	do.....	Do.
Cub Creek, Wyo. ....	do.....	Do.
Pelican Creek, Wyo. ....	do.....	Do.
Soda Butte, Wyo. ....	do.....	Do.
Cape Vincent, N. Y.:		
Bygotts Point, N. Y. ....	November.....	Whitefish.
Chaumont Bay, N. Y. ....	do.....	Lake herring, whitefish.
Fair Haven Bay, N. Y. ....	do.....	Lake herring.
Fishing Creek, N. Y. ....	do.....	Whitefish.
Grass Bay, N. Y. ....	May.....	Yellow perch.
Henderson Harbor, N. Y. ....	November.....	Lake herring.
Pigeon Island, N. Y. ....	do.....	Lake trout, whitefish.
Sodus Point, N. Y. ....	do.....	Lake herring.
South Bay, N. Y. ....	do.....	Whitefish.
Stony Island, N. Y. ....	October to November.....	Lake trout.
Three Mile Bay, N. Y. ....	do.....	Lake herring, whitefish.
Clackamas, Oreg.:		
Eagle Creek, Oreg. ....	March to June.....	Steelhead salmon.
Elk Creek, Oreg. ....	October to April.....	Blackspotted trout, silver and steelhead salmon.
Leadville, Colo.:		
Antero Lakes, Colo. ....	May to June.....	Blackspotted and rainbow trouts.
Crystal Lake, Colo. ....	November.....	Brook trout.
Engelbrecht Lakes, Colo. ....	October to November.....	Do.
Evergreen Lake, Colo. ....	do.....	Do.
Northfield Lake, Colo. ....	do.....	Do.
Turquoise Lake, Colo. ....	do.....	Do.
Woodland Park, Colo. ....	do.....	Do.
Northville, Mich.:		
Alpena, Mich. ....	do.....	Lake trout, pike perch.
Cheboygan, Mich. ....	do.....	Do.
Detour, Mich. ....	do.....	Do.
Frankfort, Mich. ....	do.....	Do.
Hammond Bay, Mich. ....	November.....	Whitefish.
Leeland, Mich. ....	do.....	Lake trout.
Manistique, Mich. ....	October to November.....	Do.
Mackinaw City, Mich. ....	do.....	Do.
Naubinway, Mich. ....	November.....	Whitefish.
Northport, Mich. ....	do.....	Lake trout.
St. Ignace, Mich. ....	do.....	Whitefish.
St. James, Mich. ....	do.....	Lake trout, whitefish.
Scotts Point, Mich. ....	do.....	Whitefish.
Put in Bay, Ohio:		
Catawba Island, Ohio ....	November to December.....	Do.
Kellys Island, Ohio ....	do.....	Do.
Isle St. George, Ohio ....	November, December, April.....	Whitefish, pike perch.
Middle Bass, Ohio ....	do.....	Whitefish.
Monroe, Mich. ....	do.....	Do.
Fort Clinton, Ohio ....	November to December, April and June.....	Whitefish, pike perch, carp.
Toledo, Ohio ....	November, December, April.....	Whitefish, pike perch.
St. Johnsbury, Vt.:		
Chittenden Dam, Vt. ....	April to May.....	Steelhead salmon.
Darling Pond, Vt. ....	September to November.....	Brook trout.
Lake Mitchell, Vt. ....	do.....	Do.
Saratoga, Wyo.: Lake Creek, Wyo.	April to May.....	Rainbow trout.
Spearfish, S. Dak.:		
Kingsley Lake, S. Dak. ....	October to December.....	Brook and Loch Leven trouts.
Schmidt Lakes, S. Dak. ....	do.....	Do.
LaPlant Ranch, S. Dak. ....	do.....	Brook trout.
Springville, Utah: Paris, Idaho.	November to April.....	Whitefish.
Woods Hole, Mass.: Wickford, R.I.	February, May.....	Flounder.

## DISTRIBUTION OF OUTPUT.

The following table shows in summarized form the total disposition of all fish and eggs propagated and of all fish rescued from overflowed lands and restored to original waters during the fiscal year ended June 30, 1919, or, in other words, the total output with all losses in transportation deducted:

SUMMARY, BY SPECIES, OF TOTAL DISTRIBUTION OF FISH AND EGGS, FISCAL YEAR 1919.

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Catfish.....			12,639,830	12,639,830
Carp.....		23,699,000	19,754,060	43,453,060
Buffalofish.....		111,100,000	2,596,335	113,696,335
Shad.....		84,024,250		84,024,250
Alewife.....		25,000		25,000
Whitefish.....	111,650,000	198,715,000		310,365,000
Lake herring (cisco).....	146,700,000	86,180,000		232,880,000
Silver salmon.....		7,464,020	2,345,730	9,809,750
Chinook salmon.....	11,802,500	1,016,600	31,400,150	47,219,250
Sockeye salmon.....	24,140,100	39,756,000	37,642,220	101,638,320
Humpback salmon.....		5,426,500	369,960	5,796,460
Chum salmon.....		6,253,640	3,663,760	9,917,400
Steelhead salmon.....	805,000	128,125	1,493,290	2,426,415
Atlantic salmon.....		2,390,000	700	2,390,700
Landlocked salmon.....	405,125	424,870	182,560	1,012,555
Rainbow trout.....	2,939,820	38,500	3,409,190	6,387,510
Blackspotted trout.....	133,000	200,000	2,875,100	3,208,100
Loch Leven trout.....			73,000	73,000
Lake trout.....	3,068,000	28,495,475	765,180	32,328,655
Brook trout.....	107,000	4,158,050	7,638,615	11,903,665
Grayling.....		275,000		275,000
Smelt.....	3,000,000	6,437,000		9,437,000
Pike and pickerel.....			375,935	375,935
Fresh-water drum.....			18,975	18,975
Crappies.....			15,837,865	15,837,865
Largemouth black bass.....		425,045	1,100,420	1,525,465
Smallmouth black bass.....		195,700	43,745	239,445
Rock bass.....			75,460	75,460
Warmouth bass.....			1,060	1,060
Sunfish (bream).....		3,050	1,350,115	1,353,165
Pike perch.....	406,200,000	175,550,000	10,710	581,760,710
Yellow perch.....	22,660,000	179,289,500	2,353,800	204,303,300
White perch.....		2,035,000		2,035,000
White bass.....			8,865	8,865
Yellow bass.....			600	600
Striped bass.....		13,540,000		13,540,000
Mackerel.....		9,508,000		9,508,000
Cod.....	243,870,000	64,331,000		308,201,000
Pollock.....		703,972,000		703,972,000
Haddock.....	200,390,000	129,592,000		329,982,000
Winter flounder.....		2,654,192,000		2,654,192,000
Miscellaneous fishes.....		1,000,000	747,250	1,747,250
Lobster.....		7,500,000		7,500,000
<b>Total.....</b>	<b>1,177,870,545</b>	<b>4,547,340,325</b>	<b>151,774,480</b>	<b>5,876,985,350</b>

For convenience in reference the three tables immediately following give summaries of certain phases of the total disposition of fish and eggs for the fiscal year 1919—(1) allotments of fish and eggs to State fish commissions; (2) shipments of fish and eggs to foreign countries; and (3) fish rescued from overflowed lands.

## ALLOTMENTS OF FISH AND FISH EGGS TO STATE FISH COMMISSIONS, FISCAL YEAR 1919.

[Eggs are indicated by an asterisk (\*); fry, by a dagger (†); all others are fingerlings.]

State and species.	Number.	State and species.	Number.
California: Chinook salmon.....	*11,802,500	New York:	
Connecticut:		Lake herring.....	*32,500,000
Catfish.....	1,100	Lake trout.....	*1,800,000
Crappie.....	3,600	Landlocked salmon.....	*15,000
Sunfish.....	1,400	Pike perch.....	*60,000,000
Yellow perch.....	1,625	Steelhead salmon.....	*200,000
Idaho: Rainbow trout.....	*50,000	Strawberry bass.....	100
Illinois: Whitefish.....	*5,000,000	Sunfish.....	100
Indiana: Pike perch.....	*8,050,000	Whitefish.....	*9,000,000
Iowa:		Ohio: Whitefish.....	*10,800,000
Pike perch.....	*5,000,000	Oklahoma:	
Rainbow trout.....	*70,000	Black bass (largemouth).....	3,600
Rock bass.....	13,000	Black bass (smallmouth).....	400
Kentucky:		Rainbow trout.....	7,800
Brook trout.....	150	Oregon:	
Rainbow trout.....	4,250	Blackspotted trout.....	*121,000
Yellow perch.....	†100,000	Rainbow trout.....	*765,000
Maine: Landlocked salmon.....	*405,125	Sockeye salmon.....	*3,440,100
Maryland:		Pennsylvania:	
Rainbow trout.....	*50,000	Lake herring.....	*88,700,000
Rock bass.....	2,900	Pike perch.....	*15,050,000
Sunfish.....	1,415	Whitefish.....	*37,070,000
Miscellaneous fishes.....	†1,000,000	Rhode Island:	
Massachusetts: Pike perch.....	*5,100,000	Pike perch.....	†200,000
Michigan:		Black bass (smallmouth).....	†7,500
Lake trout.....	*1,000,000	South Dakota:	
Pike perch.....	*288,800,000	Brook trout.....	45,000
Whitefish.....	*20,000,000	Rainbow trout.....	50,000
Minnesota:		Tennessee: Rainbow trout.....	*42,700
Black bass.....	6,500	Vermont:	
Lake trout.....	*250,000	Pike perch.....	*16,200,000
Rainbow trout.....	*50,000	Steelhead salmon.....	*50,000
Steelhead salmon.....	*125,000	Washington:	
Missouri: Yellow perch.....	{ *160,000 †40,000	Rainbow trout.....	*100,000
Montana:		Steelhead salmon.....	*230,000
Black bass.....	3,000	Wisconsin:	
Brook trout.....	2,400	Black bass.....	5,000
Catfish.....	1,300	Catfish.....	7,200
Crappie.....	780	Whitefish.....	*20,000,000
Yellow perch.....	*1,000,000	Wyoming:	
Rainbow trout.....	*25,000	Rainbow trout.....	*100,000
Nevada: Rainbow trout.....		Steelhead salmon.....	*50,000
New Hampshire:		Total.....	{ *670,716,425 †1,362,500 165,545
Pike perch.....	*6,000,000		
Rainbow trout.....	2,225		
New Jersey:			
Rainbow trout.....	*35,000		
Steelhead salmon.....	*25,000		
Yellow perch.....	*21,500,000		

## SHIPMENTS OF FISH AND FISH EGGS TO FOREIGN COUNTRIES, FISCAL YEAR 1919.

[Eggs are indicated by an asterisk (\*); all others are fingerlings.]

Country and species.	Number.	Country and species.	Number.
Canada: Canadian Government—		Mexico: Nacozari—	
Lake herring.....	*25,500,000	Black bass.....	5,000
Sockeye salmon.....	*20,700,000	Strawberry bass.....	5,000
Whitefish.....	*9,000,000	Total.....	{ *55,200,000 10,000

## DISPOSITION OF FISH RESCUED, FISCAL YEAR 1919.

Species.	Restored to original waters.	Delivered to applicants.	Species.	Restored to original waters.	Delivered to applicants.
Black bass.....	173,443	272,511	Smallmouth black bass....	2,190	.....
Buffalofish.....	2,593,360	2,975	Sunfish.....	936,692	80,960
Carp.....	19,752,602	960	White bass.....	8,665	.....
Catfish.....	12,479,146	138,300	Yellow bass.....	.....	600
Crappie.....	15,725,416	92,875	Yellow perch.....	2,333,598	20,840
Drum.....	18,977	.....	Miscellaneous.....	747,250	.....
Pike perch.....	10,710	.....	Total.....	55,208,796	610,021
Pike.....	375,937	.....			
Rock bass.....	810	.....			

On the pages following is shown in detail the distribution of fish eggs, fry, fingerlings, yearlings, and adults, by species, by States or countries, and by municipalities, alphabetically arranged, and by waters, for the fiscal year ended June 30, 1919.

The distribution was composed largely of fingerlings, yearlings, and adults, though quite a number of eggs and fry of some species were distributed. In succeeding pages figures preceded by an asterisk (\*) indicate an egg distribution; those preceded by a dagger (†), a fry distribution. All other enumerations represent fingerlings, yearlings, and adults.

## TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919.

## CATFISH.

Disposition.	Number.	Disposition.	Number.
Alabama:		Connecticut:	
Abanda, Harris's pond.....	125	Hartford, State fish commission.....	1,100
Andalusia, Langston's pond.....	450	Winsted, Park Pond.....	1,000
Calhoun, Cane Creek.....	125	Florida:	
Dadeville, Knight's pond.....	125	DeFuniak Springs, Chipley Park	
Eufaula, Clark's pond.....	200	Lake.....	240
Gurley, Flint River.....	200	Lakeland, Mirror Lake.....	150
Peterman, Rumbley Pond.....	120	Georgia:	
Phil Campbell, Morrison's pond.....	300	Augusta, Tarver's pond.....	70
Red Level, Butler's pond.....	81	Boneville, Wilson's pond.....	70
Sellers, Mineral Pond.....	400	Columbus, Hollywood Pond.....	150
Arizona:		Covington, Herford Lake.....	75
Benson, Murray's pond.....	150	Crawfordville, Chapman Creek.....	70
Bisbee, Artesta Pond.....	150	Decatur, Morgan's pond.....	200
Cochise, Bonny Rancho Ponds.....	300	Gibson, Walker's pond.....	600
Burney's pond.....	150	Halloca, King's pond.....	225
Dreamy Waters Pond.....	150	Hamilton, Spears's pond.....	75
Globe, Roosevelt Lake.....	1,950	Harris, Bonner's pond.....	225
Nogales, Alamo Lake.....	300	La Grange, Lee's pond.....	300
Pasture Pond.....	150	Lumpkin, Perkins's pond.....	200
Skull Valley, Coughlan's pond.....	400	Monroe, Felkers's pond.....	50
Tempe, Tempe Drainage Canal.....	150	Newman, Bar Pond.....	300
Arkansas:		Palmetto, Roan's pond.....	300
Black Rock, Black River.....	a 490	Sparta, Archer's pond.....	140
Conway, Cypress Pond.....	400	Waco, Bailey's pond.....	210
Everton, Anderson's pond.....	500	Warm Springs, Cane Creek.....	600
Harrison, Mih Creek.....	300	Flow Lake.....	600
Heber Springs, Peter Creek.....	100	Warm Creek.....	148
Higden, Little Red River, South		Illinois:	
Fork.....	200	Alexander, Bergschneider's pond.....	600
Kerlin, Price's pond.....	80	Alpha, Crescent Lake.....	800
Poe, Indian Creek.....	200	Apple River, Apple River.....	600
St. Joe, Buffalo River.....	1,000	Aquauka, Mississippi River.....	a 2,100
Tokio, McLarty's pond.....	500	Blanding, Mississippi River.....	a 129,600
California: Summit, Deep Creek Pond.....	400	Cairo, Mississippi River.....	a 97,000
Colorado:		Carrollton, Walnut Hall Lake.....	600
Debeque, Libbey's pond.....	600	Council Hill, Apple River.....	750
Elizabeth, Greyhound Lake.....	300	Freeport, Richland Creek.....	150
Flagler, Crystal Spring Creek.....	300	Galena, Mississippi River.....	a 226,430
Republican River, South Fork.....	600	Hudgens, Hudgens Lake.....	200
Hillside, Angico Pond.....	2,000	McConnell, Pecatonica River.....	150
Longmont, Dawson Lake.....	700	Meredosia, Illinois River.....	a 1,287,800

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## CATFISH—Continued.

Disposition.	Number.	Disposition.	Number.
Illinois—Continued.			
Meredosia, Meredosia Bay	a 2,600	Nebraska:	
Murrayville, Webster's pond	200	Bingham, Dimond Lake	300
Napierville, DuPage River	8,400	Home Lake	600
New Boston, Mississippi River	a 122,910	Lower Anderson Lake	600
Red Oak, Richland Creek	225	Taylor Lake	300
Sand Prairie, Mississippi River	a 596,200	Nevada: Thorne, Fletcher Pond	900
Seales Mound, Fevre River	600	New Hampshire: Nashua, Nashua River	360
Stonefort, Johnson's pond	200	New Mexico:	
Indiana:			
Mott Station, Binkley's pond	200	Abbott, Abbott Lake	800
Piercetown, Webster Lake	600	Albuquerque, Rio Grande River	600
Romney, Hazelwood Pond	750	Centreville, Forker's pond	150
Russellville, Maple Lawn Pond	200	Clayton, Boggs's pond	200
Terre Haute, Blue Hole Pond	500	Engle, Elephant Butte Lake	400
Lake Junietta	500	Jal, Bryant's pond	150
Iowa:			
Bellevue, Mississippi River	a 48,250	Las Cruces, Hay Stack Pond	200
Fairport, Mississippi River	a 41,500	Rouault's pond	400
Harpers Ferry, Mississippi River	a 64,000	Onava, Armstrong Lake	400
Hurstville, Mississippi River	a 51,900	Portales, Eden Valley Ranch Pond	150
Lime Springs, Upper Iowa River	3,000	King's pond	150
McDolans Dam, Mississippi River	a 41,000	New York:	
Manchester, Maquoketa River	7,035	Cohocton, Cohocton River	400
North McGregor, Mississippi River	a 779,451	Cornwall, Popolo Lake	750
Smiths Ferry, Mississippi River	a 142,000	Hamilton, Chenango Canal	400
Sny Magill, Mississippi River	a 29,000	Hancock, Sumner Lake	400
Kentucky:			
East Cairo, Ohio River	a 688,000	Newark, Coffey Lake	400
Haags Spur, Clear Lake	a 325,000	North Carolina:	
Hodgenville, Nolin River	200	Badin, Tallassee Lake	30
Shelbyville, Caplinger's pond	200	Burnsville, Bay Mine Lake	300
Soldier, Ashland Pond	200	Corinth, Buckhorn Pond	30
Maryland:			
Catoctin, Potomac River	250	Pee Dee, Blewett Falls Lake	30
Glendale, Folly Run	800	Raleigh, Millburnie Pond	30
Hoods Mill, Patapsco River	400	Statesville, Catawba River	1,500
Massachusetts:			
Fitchburg, Ashburnham Pond	180	North Dakota: Ross, Robertson's pond	200
Knops Pond	100	Ohio:	
Notown Pond	180	Blanchester, Moormeir's pond	100
Paradise Pond	180	Bremen, Fairview Lake	200
Whalom Lake	180	Columbus, Little Walnut Creek	600
Wrights Pond	180	Cridersville, Moyer's pond	200
Lenox, Lake Mahkeenac	400	Findlay, Reeg's pond	100
Norton, Spot Pond	60	Greenfield, Paint Creek	900
Worcester, Lake Quinsigamond	430	St. Marys, Miami and Erie Canal	900
Michigan:			
Bruce Crossing, Kennedy Lake	200	Woodsfield, Waterworks Pond	100
Cressey, Crooked Lake	300	Oklahoma:	
Jackson, Vandercook Lake	400	Cleveland, Mead's pond	200
Sidnaw, Sidnaw Creek	200	Mill Creek, Blue River	900
Vanderbilt, Round Lake	300	Muldrow, McDole's pond	200
Smolsz Pond	200	Seminole, Silvers's pond	200
Minnesota:			
Cass Lake, Lake Mabel	150	Shawnee, Dunlap's pond	400
Homer, Mississippi River	a 6,500,575	Stillwater, Hunter's pond	200
Red Wing, Mississippi River	a 28,165	Usna, Hilton's pond	100
Mississippi:			
Brookhaven, Smith's pond	250	Pennsylvania:	
Centreville, Ashwood Pond	500	Arcola, Perkiomen Creek, Keysers Dam	600
Friar Point, Mississippi River	a 112,425	Perkiomen Creek, Plush Dam	600
Natchez, Lake Stowers	750	Skipack Creek	600
Woodville, Ogden's pond	500	Burnside, Susquehanna River	800
Missouri:			
Bevier, Nisbeth's pond	300	Collegeville, Perkiomen Creek	600
Boonville, Orchard Pond	600	Skipack Creek	600
Montana:			
Baker, Baker Lake	1,050	Doylestown, Randt Mill Pond	100
Billings, Yellowstone River	750	Robin Run	100
Glendive, Yellowstone River	1,200	Gap, Pequea Creek	1,380
Lavina, Old Channell Pond	900	Gratersford, Perkiomen Creek, Lower Dam	600
Malta, Alkali Lake	900	Perkiomen Creek, Upper Dam	600
West Alkali Lake	1,050	Green Lane, Perkiomen Creek, Lower Dam	600
Miles City, Yellowstone River	1,200	Perkiomen Creek, Upper Dam	600
Roy, Box Elder Creek	750	La Porte, Celestia Pond	200
		Lake Mokomo	200
		Moscow, Ergood Pond	400
		Oaks, Perkiomen Creek	600
		Schuykill River	600
		Orwigsburg, Moyer Pond	340
		Pen Argy, Johnsonville Pond	100
		Lake Pauponoming	100

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## CATFISH—Continued.

Disposition.	Number.	Disposition.	Number.
Pennsylvania—Continued.			
Pen Argyl, Seguin Pond.....	100	Utah: American Fork, Utah Lake....	3,000
Smalls Pond.....	100	Vermont:	
Perkiomenville, Perkiomen Creek.....	600	Brattleboro, Connecticut River.....	180
Phoenixville, French Creek.....	600	Lily Pond.....	40
Rahns Station, Perkiomen Creek.....	600	Virginia:	
St. Clair, Kaufman Pond.....	680	Byllesby, New River, Buck Dam....	400
Schwenksville, Perkiomen Creek.....	600	New River, Byllesby Dam.....	400
Lower Dam.....	600	Coeburn, Gibson Pond.....	250
Perkiomen Creek, Upper Dam.....	600	Ivanhoe, Cripple Creek.....	400
Sewickley, Clinton Pond.....	800	Elk Creek.....	400
Spring Mount, Perkiomen Creek.....	600	New River.....	400
Valley Forge, Schuylkill River.....	900	New Market, Strickler's pond.....	200
Valley Creek Pond.....	300	Woodsplane, Travis Mill Pond.....	800
Yerkes, Perkiomen Creek.....	600	Wytheville, Reed Creek, Stones Dam.	500
South Carolina:			
Chester, Welch Fork Creek.....	80	West Virginia:	
Eureka, Slaton's pond.....	1,000	Berkeley Springs, Sleepy Creek.....	1,000
Lowndesville, Rocky River.....	800	Cowen, Barbe's pond.....	300
Salley, Cook's pond.....	1,600	Littleton, Wolf Run.....	150
South Dakota:			
Conata, Huether's pond.....	300	Philippi, Sugar Creek.....	900
Dallas, Valley View Lake.....	800	Sleepy Creek, Sleepy Creek.....	1,000
Faith, Stewart's pond.....	200	Wisconsin:	
Fort Pierre, Reese's pond.....	500	Bagley, Mississippi River.....	a 70,000
Sorensen Pond.....	500	Beaver Dam, Beaver Dam Lake.....	2,400
Quinn, Johnston's pond.....	300	Boulder Junction, Grassy Lake.....	1,000
Reeder, Duck Pond.....	400	Campia, Hemlock Lake.....	600
Laisey's pond.....	400	Clayton, Mississippi River.....	a 82,100
Spearfish, Johnson's pond.....	300	Hazelhurst, Little Wind Pudding	
Nelson's pond.....	300	Lake.....	800
Trip, Mogeck's pond.....	400	La Crosse, Mississippi River.....	a 764,100
Tyndall, Merkel Lake.....	400	State fish commission.....	7,200
Wall, Babcock's pond.....	300	Lynxville, Mississippi River.....	a 70,000
Tennessee:			
Cleveland, Mitchell's pond.....	1,000	Narrows, Balsam Lake.....	600
McMinnville, Collier's pond.....	250	New Lisbon, Lemonweir River.....	900
Ramer, Huggins's pond.....	500	Prairie du Chien, Mississippi River.....	a 101,000
Springfield, Old Deerlick Pond.....	250	Solon Springs, Lower Twin Lake.....	150
Tullahoma, Cumberland Mill Spring		Tomah, Water Mill Pond.....	10,800
Pond.....	1,250	Wyoming:	
Walling, Orchard Lake.....	500	Rozet, Jackson's pond.....	300
Texas: Belcherville, Belcherville Lake	400	South Hay Creek Pond.....	600
		Upton, Goss's pond.....	300
		Total b.....	12,639,830

## CARP.

Arkansas: Black Rock, Black River..	a 885	Maryland: Lanham, Cook's pond.....	200
Illinois:			
Aquaka, Mississippi River.....	a 1,345	Massachusetts: Norfolk, Hillside Pond.	15
Blanding, Mississippi River.....	a 189,000	Minnesota:	
Dallas City, Lake Keokuk.....	a 1,235	Clearbrook, Olson Lake.....	240
Galena, Mississippi River.....	a 2,205,000	Homer, Mississippi River.....	a 10,083,300
Meredosia, Illinois River.....	a 18,700	Red Wing, Mississippi River.....	a 271,460
New Boston, Mississippi River.....	a 21,390	North Carolina: Monroe, Shute's pond.	
Sand Prairie, Mississippi River.....	a 1,445,000	Ohio:	
Iowa:			
Clutier, Simsen's pond.....	375	Oak Harbor, Portage River.....	† 11,000,000
Fairport, Mississippi River.....	† 899,000	Port Clinton, Portage River.....	† 11,800,000
Mississippi River.....	a 2,687	South Carolina: Macedon, Bogy Branch	
Hurstville, Mississippi River.....	a 65,000	Pond.....	
Lanesville, Mississippi River.....	a 107,000	15	
McDolons Dam, Mississippi River.....	a 29,000	Wisconsin:	
North McGregor, Mississippi River.....	a 1,230,000	Bagley, Mississippi River.....	a 410,000
Pleasant Creek, Mississippi River.....	a 148,900	Clayton, Mississippi River.....	a 86,500
Smiths Ferry, Mississippi River.....	a 801,100	Frenchtown, Mississippi River.....	a 24,000
Waukon, Mississippi River.....	a 15,000	La Crosse, Mississippi River.....	a 2,450,000
Kansas: Tribune, Rafter's pond.....			
	100	Lynxville, Mississippi River.....	a 146,600
		Total.....	( 19,754,060
			† 23,699,000

a Rescued from overflowed lands and restored to original waters.

b Exclusive of 2,400 lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

BUFFALOFISH.

Disposition.	Number.	Disposition.	Number.
Arkansas: Black Rock, Black River.....	a 4,850	Louisiana: Atchafalaya, Atchafalaya River and tributaries.....	†110,940,000
Illinois:		Minnesota:	
Aquauka, Mississippi River.....	a 80	Homer, Mississippi River.....	a 584,690
Blanding, Mississippi River.....	a 150,100	Red Wing, Mississippi River.....	a 4,075
Cairo, Mississippi River.....	a 24,000	Mississippi: Friar Point, Mississippi River.....	a 4,950
Columbia, Diehl's pond.....	200	North Carolina:	
Dallas City, Lake Keokuk.....	a 1,480	Badin, Tallasse Lake.....	125
Galena, Mississippi River.....	a 76,700	Corinth, Buckhorn Pond.....	75
Highland, Dubach's pond.....	100	Pee Dee, Blewett Falls Lake.....	125
Meredosia, Illinois River.....	a 17,000	Raleigh, Milburne Pond.....	75
Meredosia Bay.....	100	Rock Hill, Catawba River.....	75
New Boston, Mississippi River.....	35,035	Ohio:	
Sand Prairie, Mississippi River.....	a 323,600	Port Clinton, Lake Erie.....	1,110
Iowa:		Sandusky Bay.....	1,110
Bellevue, Mississippi River.....	a 10,075	Wisconsin:	
Fairport, Mississippi River.....	†160,000	Clayton, Mississippi River.....	a 104,000
McDolons Dam, Mississippi River.....	3,205	La Crosse, Mississippi River.....	3,000
North McGregor, Mississippi River.....	a 812,000	Lynxville, Mississippi River.....	a 18,000
Pleasant Creek, Mississippi River.....	a 136,500	Prairie du Chien, Mississippi River.....	a 80,000
Smiths Ferry, Mississippi River.....	a 126,400	Wyalusing, Mississippi River.....	a 24,000
Sny Magill, Mississippi River.....	a 2,000		
Kentucky:		Total.....	†111,100,000
East Cairo, Ohio River.....	a 20,000		2,596,335
Haags Spur, Prairie Lake.....	a 1,500		

SHAD.

District of Columbia: Highway Bridge, Potomac River.....	†300,000	Oregon:	
Maryland:		St. Helens, Willamette River.....	†11,716,700
Broad Creek, Potomac River.....	†4,632,730	Willamette Falls, Willamette River.....	†3,449,000
Dogue Creek, Potomac River.....	†8,385,330	Virginia:	
Pascataway Creek, Potomac River.....	†10,355,600	Craney Island, Potomac River.....	†816,840
Pomonkey Creek, Potomac River.....	†3,744,280	Little Hunting Creek, Potomac River.....	†3,549,520
Swan Creek, Potomac River.....	†4,207,450	Ocequan, Potomac River.....	†4,879,970
North Carolina: Edenton, Albemarle Sound.....	†23,694,000	Pohick, Potomac River.....	†4,292,770
		Total.....	†84,024,250

ALEWIFE.

Maine: Damariscotta Mills, Damariscotta River.....	†25,000		
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WHITEFISH.

Idaho: Fish Haven, Bear Lake.....	†1,295,000	New York:	
Illinois: Spring Grove, State fish commission.....	*5,000,000	Allan Otty Shoal, Lake Ontario.....	†560,000
Michigan:		Bear Point, Lake Ontario.....	†4,300,000
Alpena, Lake Huron.....	†3,611,000	Cape Vincent, State fish commission.....	*9,000,000
Cheboygan, Hammond Bay.....	†3,611,000	Charity Shoal, Lake Ontario.....	†900,000
Crystal Falls, Anderson Lake.....	†240,000	Dutch Point, Lake Ontario.....	†3,250,000
Fortune Lake.....	†240,000	East Charity Shoal, Lake Ontario.....	†2,000
Detroit, Aquarium.....	*280,000	Fuller Bay, Lake Ontario.....	†2,550,000
State fish commission.....	*20,000,000	Galloo Island, Lake Ontario.....	†3,150,000
Escanaba, Lake Michigan.....	†2,128,800	Grenadier Island, Lake Ontario.....	†875,000
Gibchrist, Lake Michigan.....	†1,216,400	Hardscrabble Shoal, Lake Ontario.....	†100,000
Gould City, Lake Michigan.....	†912,300	Hayes Point, Lake Ontario.....	†525,000
Houghton, Lake Superior.....	†3,750,000	Henderson Harbor, Lake Ontario.....	†3,150,000
Marquette, Lake Superior.....	†3,750,000	Mud Creek Bay, Lake Ontario.....	†800,000
Norwood Reef, Lake Michigan.....	†3,000,000	New York, Lake Ontario.....	*500,000
St. Ignace, Lake Huron.....	†1,520,500	Niagara Falls, Niagara River.....	†750,000
Sand Bay, Lake Michigan.....	†4,000,000	Plattsburg, Lake Champlain.....	†750,000
Minnesota:		Point Peninsula, Lake Ontario.....	†800,000
Duluth, Lake Superior.....	†10,000	Port Henry, Lake Champlain.....	†400,000
Turner, Wilson Lake.....	†300,000	Pulaski, Lake Ontario.....	†1,000,000

\* Rescued from overflowed lands and restored to original waters.

## TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

## WHITEFISH—Continued.

Disposition.	Number.	Disposition.	Number.
New York—Continued.		Ohio—Continued.	
Rouses Point, Lake Champlain.....	†350,000	Put in Bay, State fish commission..	*10,800,000
Three Mile Bay, Lake Ontario.....	†1,510,000	Toledo, Lake Erie.....	†10,000,000
Tibbetts Point, Lake Ontario.....	†2,000,000	Pennsylvania: Erie, State fish commission.....	
Van Schaick Shoal, Lake Ontario.....	†3,000,000	Utah: Provo, Utah Lake.....	
Watkins, Seneca Lake.....	†750,000	Wisconsin:	
Wilson Bay, Lake Ontario.....	†4,350,000	Amnicon River, Lake Superior.....	
Ohio:		Madison, State fish commission....	
Isle St. George, Lake Erie.....	†6,300,000	Canada: South Bay, Dominion of	
Kelley's Island, Lake Erie.....	†25,000,000	Canada.....	
Marblehead, Lake Erie.....	†10,000,000	Total.....	
North Bass, Lake Erie.....	†25,000,000	*111,650,000	
Fort Clinton, Lake Erie.....	†15,000,000	†198,715,000	
Put in Bay, Lake Erie.....	†35,000,000		

## LAKE HERRING (CISCO).

New York:		New York—Continued.	
Allan Otty Shoal, Lake Ontario.....	†1,800,000	Point Peninsula, Lake Ontario.....	†1,495,000
Bear Point, Lake Ontario.....	†7,900,000	Three Mile Bay, Lake Ontario.....	†3,500,000
Charity Shoal, Lake Ontario.....	†4,200,000	Tibbetts Point, Lake Ontario.....	†4,500,000
Dunkirk, State fish commission.....	*32,500,000	Van Schaick Shoal, Lake Ontario.....	†2,100,000
East Charity Shoal, Lake Ontario.....	†500,000	Wilson Bay, Lake Ontario.....	†9,650,000
Fair Haven, Lake Ontario.....	†1,225,000	Pennsylvania: Erie, State fish commission.....	
Fox Island, Lake Ontario.....	†9,400,000	Canada: Kingsville, Canadian Government.....	
Fuller Bay, Lake Ontario.....	†9,350,000	Total.....	
Gallo Island, Lake Ontario.....	†7,500,000	*146,700,000	
Grenadier Island, Lake Ontario.....	†14,800,000	†86,180,000	
Hayes Point, Lake Ontario.....	†540,000		
Henderson Harbor, Lake Ontario.....	†1,320,000		
Mud Creek Bay, Lake Ontario.....	†6,400,000		

## SILVER SALMON.

Oregon:		Washington—Continued.	
Applegate, Applegate Creek.....	494,650	Hamilton, Alder Creek.....	†2,087,000
Estacada, Clackamas River.....	2,200	Quilcene, Big Quilcene River.....	274,000
Trail, Rogue River.....	97,500	Little Quilcene River.....	80,000
Washington:		Quinault, Quinault Lake.....	
Birdsview, Day Creek.....	15,000	Sultan, Elwell Creek.....	
Grandy Creek.....	†2,600,520	Total.....	
	754,600	†7,464,020	
Brimnon, Walcotts Slough.....	55,000	2,345,730	
Darrington, Bennetts Slough.....	†18,900		
Duckabush, Duckabush River.....	153,380		

## CHINOOK SALMON.

California:		Oregon:	
Baird, McCloud River.....	2,280,000	Applegate, Applegate Creek.....	30,850
Battle Creek, Battle Creek.....	4,500,000	Clackamas, Clackamas River.....	2,981,000
Mill Creek, Mill Creek.....	3,498,800	Willamette River.....	100,000
Sisson, State fish commission.....	*11,802,500	Estacada, Clackamas River.....	889,500
New York:		River Mill, Clackamas River.....	
Allan Otty Shoal, Lake Ontario.....	†58,000	Trail, Rogue River.....	
Cape Vincent, St. Lawrence River.....	†133,000	Washington:	
Carlton Island, St. Lawrence River.....	†39,300	Baker Lake, Baker Lake.....	
Charity Shoals, Lake Ontario.....	†40,500	Big White Salmon, Big White Salmon River.....	
	30,000	9,102,000	
Dutch Point, Lake Ontario.....	8,500	Birdsview, Alder Creek.....	
Fox Island, Lake Ontario.....	†135,000	Grandy Creek.....	
	24,000	†24,320	
Fuller Bay, Lake Ontario.....	†35,000	Little White Salmon, Little White Salmon River.....	
	15,000	9,177,500	
Grenadier Island, Lake Ontario.....	†70,000	Quilcene, Big Quilcene River.....	
	34,000	†100,000	
Hardscrabble, Lake Ontario.....	†33,000	Quinault, Quinault Lake.....	
Hayes Point, Lake Ontario.....	†28,800	Sultan, Elwell Creek.....	
Tibbetts Point, Lake Ontario.....	†35,000	†246,430	
	5,000	*11,802,500	
Van Schaick Shoal, Lake Ontario.....	25,000	†1,016,600	
Wilson Bay, Lake Ontario.....	8,000	†34,400,150	
		Total.....	

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

BLUEBACK SALMON.

Disposition.	Number.	Disposition.	Number.
Alaska:		Washington—Continued.	
Afognak, Hatchery Creek.....	†3,971,000	Little White Salmon, Little White Salmon River.....	939,960
Letnik Lake.....	†12,745,000	Quinault, Quinault Lake.....	†1,200,000
Yes Bay, Hatchery Creek.....	8,327,000	Canada: Frasier River, Canadian Government.....	*5,678,000
Lake McDonald.....	†26,650,000		
Oregon: Bonneville, State fish commission.....	8,679,700		
Washington:	*3,440,100		
Baker Lake, Baker Lake.....	8,622,000	Total.....	*24,140,100
Birdsview, Grandy Creek.....	45,560		†39,756,000
			37,642,220

HUMPBACK SALMON.

Alaska:		Washington—Continued.	
Afognak, Hatchery Creek.....	†483,000	Duckabush, Duckabush River.....	369,958
Letnik River.....	†1,659,000	Quilcene, Big Quilcene River.....	†385,500
Yes Bay, Hatchery Creek.....	†930,000		
Washington:		Total.....	†5,426,500
Birdsview, Grandy Creek.....	†1,969,000		369,960

CHUM SALMON.

Washington:		Washington—Continued.	
Birdsview, Grandy Creek.....	†848,840	Quilcene, Big Quilcene River.....	†1,165,000
Brimson, Walcotts Slough.....	†1,830,000	Little Quilcene River.....	†380,000
Darrington, Bennetts Slough.....	†619,000		390,000
Duckabush, Duckabush River.....	†930,000		
Little White Salmon, Little White Salmon River.....	2,803,160	Total.....	†6,253,640
	†460,800		3,663,760

STEELHEAD SALMON.

Maine:		Vermont:	
Farmington, Clearwater Lake.....	1,011	Brattleboro, Newton Pond.....	1,000
Grand Lake, Grand Lake.....	34,938	Castleton, Lake St. Catherine.....	4,500
Hiram, Hancock Brook.....	400	Holden, Chittenden Dam.....	10,086
Otis, Green Lake.....	11,232	Middlebury, Leicester River.....	4,500
Massachusetts: Woronoco, Big Pond..	1,300	Middlebury River.....	4,500
Michigan:		Readsboro, West River.....	600
Charlevoix, Paddock Creek.....	†28,125	Roxbury, State fish commission....	*50,000
Pine Lake.....	24,358	Washington:	
Minnesota: St. Paul, State fish commission.....	*125,000	Birdsview, Grandy Creek.....	198,865
Nebraska:		Quilcene, Big Quilcene River.....	170,000
Alliance, Niobrara River.....	4,800	Stevenson, Skamania County waters..	*103,000
Andrews, Russell Lake.....	6,000	Sultan, Elwell Creek.....	92,500
White River.....	9,000	Vancouver, Clarke County waters....	*102,000
New Jersey: Hackettstown, State fish commission.....	*25,000	Washougal, Washougal River.....	†100,000
New York:		Yakima, Naches River.....	*25,000
Albany, State fish commission.....	*200,000	Wyoming:	
Oakdale, applicant.....	*100,000	Beulah, Miller Creek.....	2,500
Pawling, Cow Pond.....	440	Lander, Atlantic Lake.....	6,000
Hockey Pond.....	880	Harrison Lake.....	3,000
Port Henry, Lincoln Lake.....	4,500	Lander Creek.....	3,000
Rosedale, Clear Creek.....	880	Popo Agie River.....	6,000
Tuxedo, applicant.....	*25,000	Silas Lake.....	3,000
Oregon:		Rock Springs, Fremont Lake.....	20,000
Applegate, Applegate Creek.....	32,000	Saratoga, Upper Lake Creek.....	5,000
Clackamas, Clackamas River.....	5,000	North Platte River.....	16,000
Mecca, Shitike Creek.....	20,000	Sheridan, State fish commission....	*50,000
Trail, Rogue River.....	775,000		
Upper Clackamas, Clackamas River..	10,500	Total.....	*805,000
			†128,125
			1,493,290

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## ATLANTIC SALMON.

Disposition.	Number.	Disposition.	Number.
<b>Maine:</b>		<b>Maine—Continued.</b>	
Blanchard, Piscataqua River.....	† 52, 500	Monson, Davis Stream.....	† 52, 500
Salmon Brook.....	† 52, 500	Oakfield, Mattawamkeag River, East Branch.....	† 243, 100
Cherryfield, Pleasant River.....	† 325, 500	Orland, Orland River.....	700
Cherryfield, Narraguagus River.....	† 137, 500	Shirley, Piscataqua River, West Branch.....	† 52, 000
Columbia Falls, Pleasant River.....	† 437, 500		
Dennysville, Dennys River.....	† 437, 500		
Dover, Sebec Lake.....	† 52, 500		
Grindstone, Penobscot River, East Branch.....	† 194, 400		
Katahdin Iron Works, Pleasant River	† 52, 500	Total.....	{ † 2, 390, 000 700

## LANDLOCKED SALMON.

Disposition.	Number.	Disposition.	Number.
<b>Maine:</b>		<b>Maine—Continued.</b>	
Belgrade, Great Lake.....	† 6, 000	Princeton, Big Lake.....	† 10, 500
Brooks, Passagassawauke Lake.....	† 6, 000	Grand Falls Pond.....	† 6, 000
Brownfield, Burt Meadow Pond.....	† 2, 400	Sebago Lake, Sebago Lake.....	† 9, 600
Caribou, State fish commission.....	* 405, 127	Stockholm, Square Lake.....	† 18, 000
Danforth, Grand Lake.....	† 24, 000	Walkers, Squa Pan Lake.....	† 9, 000
Dedham, Green Lake.....	32, 000	Webster, Chemo Lake.....	† 7, 500
Dexter, Lake Wassookeag.....	† 6, 000	<b>New Hampshire:</b>	
Main Brook.....	† 10, 500	Bristol, Newfound Lake.....	456
Puffer Pond.....	† 6, 000	Canaan, Clark Pond.....	† 1, 000
East Orland, Toddy Pond.....	† 69, 925	Cumming Pond.....	† 1, 000
Ellsworth, Beech Hill Lake.....	† 10, 500	Lynne Pond.....	800
Farmington, Clearwater Lake.....	† 6, 000	Sweet Pond.....	800
Crystal Lake.....	† 6, 000	Tewksbury Pond.....	800
Forest, Farrar Lake.....	† 6, 000	Colebrook, Diamond Pond.....	† 2, 400
Franklin, Molasses Pond.....	† 20, 000	Harrisville, Long Pond.....	5, 000
Grand Lake Stream, Dobsis Lake.....	† 7, 500	Laconia, Winnisquam Lake.....	6, 000
Grand Lake.....	{ 17, 000	Newport, Cold Pond.....	5, 000
	{ † 11, 445	Potter Place, Pleasant Lake.....	5, 400
	{ 28, 738	<b>New York:</b>	
Guilford, Piper Pond.....	† 6, 000	Forestport, Honnedaga Lake.....	† 6, 000
Hartland, Great Moose Lake.....	† 15, 000	Nehasane, Big Rock Lake.....	† 3, 000
Holeb, Holeb Lake.....	† 3, 000	Lake Lila.....	† 4, 500
Houlton, Drews Lake.....	† 12, 000	North Creek, Moose Pond.....	† 3, 000
Indian Landing, Indian Landing Brook.....	† 7, 000	Newcomb Lake.....	† 3, 000
Island Falls, Mattawamkeag Lake.....	† 10, 500	Port Henry, Lincoln Lake.....	† 6, 000
Jackman, Lake Wood.....	† 5, 000	Port Jervis, Cahoonzie Lake.....	400
Kineo Station, Moosehead Lake.....	† 7, 500	Thurman, State fish commission.....	† 15, 000
Moose River.....	† 5, 000	<b>Vermont:</b>	
Lambert Lake, Lambert Lake.....	† 10, 500	Beecher Falls, Connecticut Lake.....	† 2, 400
Livermore Falls, Basin Pond.....	† 3, 000	Canaan, Big Averill Lake.....	{ † 3, 600 500
Nicolin, Nicolin Lake.....	† 10, 000	Little Averill Lake.....	{ † 3, 600 300
North Anson, Embden Pond.....	† 9, 000	Newport, Salem Pond.....	300
Norway, Virginia Lake.....	19	Orleans, Willoughby Lake.....	600
Otis, Green Lake.....	58, 443		
Ox Brook, Ox Brook Stream.....	10, 000		
Pembroke, Boyden Lake.....	† 8, 000		
Pork Barrel Brook, Pork Barrel Brook.....	10, 000	Total.....	{ * 405, 125 † 424, 870 182, 560

## RAINBOW TROUT.

Alabama: Munford, Salt Creek.....	7, 200	Arkansas—Continued.	
Arizona:		Saint Joe, Richland Creek.....	1, 200
Ash Fork, Chino Creek.....	2, 000	Tomahawk Creek.....	3, 000
Sycamore Creek.....	2, 000	<b>Colorado:</b>	
Benson, Kiper's Pond.....	5, 000	Alma, Lake Emma.....	3, 000
Clarkdale, Black Canyon Creek.....	2, 000	Basalt, Frying Pan River.....	1, 000
Globe, Ash Creek.....	10, 000	Bear Creek, Bear Creek.....	1, 000
Grand Canyon, Hermit Creek.....	2, 000	Buffalo, Wigwam Creek.....	1, 000
Tempe, Salt River.....	3, 000	Cebolla, Cebolla Creek.....	1, 000
Arkansas:		East Elk Creek.....	1, 000
Cravette, Spavins Creek.....	1, 685	Gunnison River.....	1, 000
Decatur, Spring Creek Pond.....	500	Cimarron, Little Cimarron River.....	1, 000
Harrison, Buffalo River.....	1, 500	Colorado Springs, Cheyenne Lake.....	2, 000
Crooked Creek.....	9, 000	Cotopaxi, Lake Creek Lake.....	2, 000
Loug Creek.....	7, 800	Spruce Creek Lake.....	1, 000
Rogers, Spout Springs Pond.....	100	Creede, Rio Grande River.....	2, 000

\* Exclusive of 7,000 fry lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## RAINBOW TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
<b>Colorado—Continued.</b>			
Denver, Bear Creek.....	1,000	Kentucky:	
Durango, Cascade Creek.....	1,500	Bowling Green, Drakes Creek.....	4,050
Hermosa Creek.....	1,500	Jennings Creek.....	115
Potato Lake.....	1,000	South Union, Clear Creek.....	85
Edwards, Eagle River.....	2,000	Maine: Portland, Pleasant River.....	800
Lake Creek.....	2,000	Maryland:	
Fairplay, South Platte River.....	3,000	Baltimore, State fish commission.....	*50,000
Fort Collins, Cache La Poudre River.....	2,000	Brown, Turkey Branch.....	4,000
Gunnison, South Beaver Creek.....	1,000	Carrollton, Greens Run.....	600
Tomichi Creek.....	1,000	Friendsville, Savages Pond.....	700
Hillside, Dismore Creek Ponds.....	4,000	Kensington, Cedar Pond.....	500
Leadville, Evergreen Lake.....	10,000	Oakland, Big Younghoeheny River.....	2,100
Hall Moon Creek.....	1,000	Muddy Creek.....	1,400
Turquoise Lake.....	15,000	Rawlings, Mill Creek.....	1,400
Lovelead, Big Thompson River and branches.....	5,000	Ruxton, Callendar House Pond.....	500
Buckhorn River.....	1,000	Takoma Park, Sligo Creek.....	300
Buckhorn River, North Fork.....	1,000	Massachusetts:	
Cedar Creek.....	1,000	Athol, Lake Ellis.....	†3,000
Cow Creek.....	1,000	Great Barrington, Williams River.....	†1,500
Fox Creek.....	1,000	Lowell, Burgess Pond.....	600
Mullin Fork Creek.....	1,000	Forge Pond.....	700
North Creek.....	1,000	Long Pond.....	700
West Creek.....	1,000	Long Sought For Pond.....	700
Lyons, North St. Vrain Creek.....	1,000	Spectacle Pond.....	600
Ouray, Lake Lenore.....	2,000	Woronoco, Big Pond.....	†6,000
Parlin, Tomichi Creek.....	1,000	Michigan:	
Parshall, Grand River.....	2,000	Amasa, Little Hemlock River.....	300
Puzzler, Forest Lake.....	500	Bessemer, Pine Creek.....	300
Ruedi, Ruedi Lake.....	1,000	Powder Mill Creek, East Branch.....	300
Salida, Little Cochetopa Creek.....	1,000	Buchanan, McCoyes Creek.....	†2,000
Marshall Creek.....	2,000	Sampson Creek.....	†2,000
Poncha Creek.....	2,000	Crystal Falls, Michigamme River.....	2,400
Sapinero, Gunnison River.....	1,000	Paint River.....	300
Soap Creek.....	1,000	Grayling, Pillula Lake.....	8,000
Snowmass, Capitol Creek.....	1,500	Houghton, Dees Pond.....	1,750
Sopris Creek.....	1,500	Lake Paine.....	1,200
Woody Creek.....	1,500	Redridge Lake.....	1,800
Steamboat Springs, Maida Dawn Lake.....	1,000	Indian River, Sturgeon River.....	2,000
Sulphur Springs, Big Slough Pond.....	1,000	Iron River, Paint River.....	300
Deep Slough Pond.....	1,000	Marquette, Bagdad Lake.....	150
Grand River.....	2,000	Niles, Dowagiac Creek.....	†4,000
Tabernash, Ranch Creek.....	1,000	Madison Creek.....	†2,000
Tolland, Newcomb Creek.....	1,000	Pokagon Creek.....	†2,000
West South Boulder Creek.....	1,000	Summerville Creek.....	†2,000
Trinidad, Purgatory River, Middle Fork.....	3,000	Petersburg, Crystal Pond.....	1,000
Troublesome, Birdseye Creek.....	1,000	Petosky, Heber Creek.....	4,000
Cold Water Creek.....	1,000	Republic, Black River.....	400
Troublesome Creek.....	1,000	Stambaugh, Bush Creek.....	300
Walsenburg, Orchard Lake.....	1,000	Traverse City, Beardman River.....	4,000
Wasatch, Beaver Dam Lake.....	1,000	Shelby, Powers pond.....	1,000
Clear Lake.....	1,000	Sidnaw, Sidnaw Creek.....	3,600
Woodland Park, Bear Lake.....	2,000	Six Lakes, Flat River.....	2,000
Northfield Lake.....	3,000	Wakefield, Jackson Creek, West Branch.....	2,400
<b>Georgia:</b>			
Dillard, Beanert Creek.....	2,500	Minnesota:	
Helen, Chalahochie River.....	15,000	Benidje, Burdette Creek.....	1,034
Lakemont, Tiger Creek.....	2,000	Deep Lake.....	1,133
Rabun Gap, Betyys Creek.....	2,500	Caledonia, Crooked Creek.....	450
Rome, Mountain Lake.....	3,600	Crooked Creek, South Fork.....	450
<b>Idaho:</b>			
Ashton, Sand Creek.....	2,500	Crystal Valley Creek.....	450
Boise, Arrowrock Lake.....	17,000	Dexter Creek.....	450
Fish Haven, Bear Lake.....	1,000	East Beaver Creek.....	450
Payette, Shamberger's pond.....	6,000	Thompson Creek.....	450
Pocatello, Rabbit Creek.....	28,000	West Beaver Creek.....	450
Sand Point, State fish commission.....	*50,000	Winnebago Creek.....	450
Spencer, applicant.....	*25,000	Clearbrook, Falk Lake.....	1,133
<b>Iowa:</b>			
Cedar Rapids, applicant.....	*2,000	Dover, Bear Creek.....	1,700
McLeod Springs Pond.....	400	Cascade Creek.....	2,125
Jackson Junction, Goddard Creek.....	2,000	North Branch.....	1,000
Lansing, State fish commission.....	*70,000	Ely, Garden Lake.....	3,000
Manchester, Spring Branch.....	2,800	Lewiston, Enterprise Creek.....	850
North McGregor, Bloody Run.....	1,275	Hemingway Creek.....	850
Gard Creek.....	3,250	Whitewater Creek, Middle Branch.....	1,275
		Whitewater Creek, South Branch.....	1,700
		Minneapolis, Nine Mile Creek.....	1,700
		Nine Mile Creek, Right Branch.....	1,275
		Minnesota City, Bear Creek.....	850
		Middle Valley Creek.....	850
		Rupprechts Creek.....	850

## TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

## RAINBOW TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
<b>Minnesota—Continued.</b>		<b>Montana—Continued.</b>	
Minnesota City, Speltz Valley Creek	1,275	Bozeman, Middle Creek	10,000
Pillager, Peterson Creek	1,275	North Cottonwood Creek	2,000
Plainview, Watterwater River, North Branch	3,000	North Twin Lake	2,000
Preston, Camp Creek	850	Ole Olson Lake	2,000
North Branch	425	Pass Creek	2,000
Partridge Creek	425	Pine Creek	2,000
South Branch	425	Reese Creek	2,000
Spring Creek	425	Rocky Creek	2,000
Trout Run Creek	425	Ross Creek	10,000
Watson Creek	850	Sage Creek	2,000
Willow Creek	850	Sales Creek	2,000
Rushford, Beaver Creek	425	Sixteen Mile Creek	2,000
Coolidge Creek	425	Sour Dough Creek	8,000
Daley Creek	425	South Meadow Creek	2,000
Enterprise Creek	425	South Taylor Creek	2,000
Ferguson Creek	425	South Twin Lake	2,000
Gribbin Creek	425	Specimen Creek	2,000
Hazzard Creek	425	Spring Hill Creek	2,000
Hemingway Creek	425	Stony Lake	2,000
Meade Creek	425	Sun River, North Fork	50,000
Onstine Creek	425	Taylor Creek	2,000
Opheim Creek	425	Tepee Creek	2,000
Overland Creek	425	Thomas Creek	8,000
Pine Creek	850	West Bear Creek	2,000
Rush Creek	850	Butte, Big Hole River	*230,000
Trout Run Creek	850	Darby, Rye Creek Ponds	3,750
West Beaver Creek	425	Forest Grove, Bear Creek	1,500
St. Paul, State fish commission	*50,000	McDonald Creek, South Fork	10,500
Stockton, Stockton Creek	850	Harlowton, Agnes Creek	1,500
Stockton Creek, East Branch	850	American Forks Creek	2,250
Stockton Creek, South Branch	1,275	Big Elk Creek	2,250
Straight Valley Creek	850	Careless Creek	2,250
Winona, Big Trout Creek	1,275	Crooked Creek	2,250
Cedar Creek	1,275	Daisy Dean Creek	2,250
East Burns Valley Creek	1,275	Fish Creek	2,250
Harvey Creek	1,275	Haymaker Creek	2,250
Hicks Valley Creek	850	Hopley Creek	6,000
Little Trout Creek	850	Lebo Creek	2,250
Morey Creek	1,275	Lebo Lake	2,250
Morrison Creek	425	Little Elk Creek	2,250
Murray Valley Creek	850	Little Spring Creek	1,500
Pine Creek	425	McVey Creek	1,500
Pleasant Valley Creek	850	Meadow Creek	1,500
Wisoy Creek	850	Mexican John Creek	2,250
<b>Missouri:</b>		Miller Creek	2,250
Aurora, Spring River	10,000	Muddy Creek	1,500
Crane, Crane Creek	1,600	Musselshell River	2,250
Greer, Greer Springs Creek	10,000	Spring Creek	3,000
Joplin, Arrowhead Lake	300	Swimming Woman Creek	2,250
Spring Pond	100	Lennep, Allebaugh Creek	2,250
Lebonon, Ha Ha Tonka Lake	12,000	Castle Creek	2,250
Neosho, Capps Creek	5,000	Comb Creek	2,250
Hickory Creek	2,051	Coyote Creek	3,000
Momahon Spring Creek	430	Hensley Creek	2,250
Newburg, Yancey Mill Lake	6,000	Musselshell River, South Fork	2,250
Pierce City, Shoal Creek	10,000	Robinson Creek	2,250
Quail Spur, McCord Branch	10,000	Libby, Bootjack Lake	5,000
Rolla, Little Piney Creek	8,000	Martinsdale, Checkerboard Creek	3,000
St. James, Meramec Creek	4,000	Cottonwood Creek	1,500
Seligman, Mint Spring Pond	8,000	Cottonwood Lake	2,250
Verona, Spring River	800	Du Rand Lake	1,500
Wayne, Roaring River	1,200	Flagstaff Creek	1,500
Mikes Creek	1,200	Musselshell River, North Fork	2,250
<b>Montana:</b>		Spring Creek	12,000
Anaconda, State fish commission	*1,000,000	Missoula, Belmont Creek	4,000
Belgrade, Cottonwood Creek	16,000	Blackfoot River	6,000
Billings, Andersen's pond	2,000	Blackfoot River, North Fork	8,000
Spring Creek	4,000	Clearwater River	6,000
Bozeman, Asbestos Creek	2,000	Cottonwood Lake	2,000
Brackett Creek	2,000	Crow Creek	4,000
Bridger Creek	8,000	Elbow Lake	8,000
Buck Creek	2,000	Elk Creek	4,000
Dalley Creek	2,000	Lake Inez	10,000
East Bear Creek	6,000	Mission Creek	4,000
Fish Creek	4,000	Nine Mile Creek	4,000
Lake Alva	10,000	Owl Creek	6,000
Lava Lake	2,000	Placid Lake	10,000
		Post Creek	4,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## RAINBOW TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Montana—Continued.		New York—Continued.	
Missoula, Rock Creek.....	14,000	Hornell, Canisteo Creek.....	3,900
Seeley Lake.....	10,000	Canisteo River.....	5,200
Norris, Madison Lake and tributaries.....	48,000	Carr Valley Brook.....	2,600
Meadow Creek.....	48,000	Seeley Creek.....	2,600
Ravalla, Would Fish Lake.....	8,000	Hunter, Schoharie River.....	5,200
Townsend, Crow Creek.....	12,000	Ilion, Millers Mill Creek.....	5,200
Deep Creek.....	12,000	Ithaca, Enfield Creek.....	3,900
Spring Creek.....	10,500	Napanock, Youngs Ponds.....	1,300
Whitefish, Beaver Lake.....	7,500	New York, Aquarium.....	*5,000
Whitefish Lake.....	23,750	North Lansing, Nelson Metzlar Creek.....	2,600
Whitefish River.....	10,000	Salmon Creek.....	2,600
White Sulphur Springs, Sheep Creek.....	14,000	Oneida, Cowasselon Creek.....	3,900
Smith River.....	10,000	Oneida Creek.....	3,900
Winston, Meyers pond.....	1,500	Sconondoa Creek.....	3,900
Yellowstone, Lower Grayling Creek.....	7,500	Racquette Lake, Lako Mohegan.....	*25,000
Madison Creek, South Fork.....	10,500	Shekomeko, Pugsley Hill Creek.....	1,500
Nebraska:		Syracuse, Butternut Creek.....	7,800
Andrews, Russel Ranch Lake.....	1,400	Limestone Creek.....	9,100
White River.....	7,000	Tramansburg, Mecklenburg Creek.....	2,600
Chadron, Ash Creek.....	2,800	Reynoldsville Creek.....	2,600
Beaver Creek.....	2,100	Watertown, Black Creek.....	6,500
Chadron Creek.....	2,800	Hubbard Creek.....	3,900
Trunk Butte Creek.....	2,100	Wellsville, Brimmer Creek.....	2,600
Colclessor, Pine Creek.....	2,520	Cryder Creek.....	2,600
Crawford, White River.....	1,400	Dykes Creek.....	2,600
Glenn, White River.....	8,000	Fords Creek.....	1,300
Gordon, Snake River.....	3,500	Fulmer Valley Creek.....	2,600
Nevada:		Genesee River.....	2,600
Ely, State fish commission.....	*25,000	Knights Creek.....	1,300
Verdi, Truckee River.....	*25,000	Marsh Creek.....	1,300
New Hampshire:		Pikeville Creek.....	2,600
Lebanon, Cole Pond.....	4,000	Vandermark Creek.....	2,600
Nashua, Silver Lake.....	2,224	North Carolina:	
Newport, Sugar River.....	2,000	Bessemer City, Toms Creek Lake.....	10,000
Pike, Lake Christine.....	†6,000	Black Mountain, Long Branch.....	4,000
Suncook, Hampshire Brook.....	300	Swannanoa River, North Fork.....	10,000
Kenison Brook.....	300	Swannanoa River, Sugar Fork.....	4,000
Moore's Brook.....	300	Boone, Howard Creek.....	1,000
New Jersey:		Cranberry, Blevins Creek.....	1,000
Hackford, Rahway River.....	3,600	Ela, Cooper Creek.....	4,000
Hackettstown, State fish commission.....	*35,000	Little Creek.....	4,000
Oak Ridge, Stony Brook Lake.....	600	Newton Mill Creek.....	4,000
New Mexico:		Elk Park, Blovins Creek.....	15,000
Bernalillo, Los Huertos Creek.....	2,000	Elk River.....	3,600
Carizosa, Eagle Creek.....	2,000	Little Elk Creek.....	8,400
Chama, Brazos River.....	2,000	Franklin, Rabbit Creek.....	3,750
Chama River.....	3,000	Green Mountain, Toe River.....	4,500
Chavez Creek.....	2,000	Horseshoe, Mills River.....	7,000
Nutrias Creek.....	3,000	Hot Springs, Little Creek.....	6,000
Cimarron, Urracca Lake.....	2,000	Long Branch.....	4,000
East Las Vegas, Coyote River.....	6,000	Lansing, Big Horse Creek.....	4,000
Gallinas River and branches.....	5,000	Little Horse Creek.....	3,500
Lujon Valley Creek.....	2,000	Lenoir, Gragg Creek.....	2,000
Mora River.....	3,000	Rock House Creek.....	1,000
Rio de La Casa.....	6,000	Wilson Creek.....	2,500
Rio de Las Lunas and branches.....	4,000	Yadkin River.....	6,000
Tecoleto Creek.....	3,000	Linville Falls, Linville River.....	1,000
Stewart Lake.....	1,000	Marshville, Thomas Pond.....	1,000
High Rolls, Fresno Creek.....	1,000	Micaville, Locust Creek.....	6,000
Mountainair, Tajique Creek.....	2,000	South Toe River.....	10,500
Perea, Los Nutrias Creek.....	4,000	Montezuma, Lindville River.....	5,000
Santa Fe, Santa Fe Lake.....	2,000	North Wilkesboro, Reddies River.....	7,200
Taos Junction, Ben Hur Lake.....	1,000	Pickens, Estate Creek.....	7,500
Water Bird Lake.....	2,000	Whitewater River.....	7,500
Tularosa, Rio Tularosa.....	1,000	Poplar, Flat Branch.....	4,500
Ute Park, Cimarron River.....	3,000	Spruce Pine, Grassy Creek.....	4,000
New York:		Tuxedo, Cabin Creek.....	6,250
Ardley, Sawmill River.....	3,000	Green River.....	16,250
Batavia, Goulds Brook.....	2,600	Rock Creek.....	3,750
Benson Mines, Twin Lakes.....	2,600	Waynesville, McElroy Creek.....	4,000
Deposit, Oquaga Creek.....	3,900	North Dakota: Fullerton, Maple River.....	640
Summit Creek.....	3,900	Ohio: Middlefield, Orchard Pond.....	1,000
Trout Creek.....	3,900	Oklahoma: Oklahoma City, State fish commission.....	7,800
Elmira, South Creek.....	3,900	Oregon:	
Genoa, Little Salmon Creek.....	2,600	Booneville, State fish commission.....	*765,120
Hornell, Big Creek.....	3,900	Clackamas, Spring Creek.....	5,000
Canacadea Creek.....	3,900		

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## RAINBOW TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
<b>Oregon—Continued.</b>		<b>Pennsylvania—Continued.</b>	
La Grande, Catherine Creek.....	25,000	Johnstown, Mill Creek.....	400
Fern Springs Pond.....	1,000	Miller Run.....	400
Lake Union.....	5,000	Mishler Run.....	400
Meacham Creek.....	7,500	Pickens Run.....	400
Powder River.....	7,500	Powder Mill Run.....	400
Mecca, Shitika Creek.....	10,000	Richer Run.....	400
Warm Springs River.....	10,000	Roaring Run.....	400
Medford, Crater Lake.....	20,000	Salt Lick Run.....	400
Oregon City, Clackamas River.....	20,000	Shannon Run.....	400
Trail, Rogue River.....	28,000	Sugar Run.....	400
<b>Pennsylvania:</b>		Tab Mill Run.....	400
Cedar Hollow, Valley Creek and branches.....	2,400	King of Prussia, Trout Creek and branches.....	2,400
Coburn, Elk Creek.....	2,000	Listonburg, Whites Creek.....	4,400
Penns Creek.....	2,000	Mance, Wills Creek.....	6,000
Coudersport, Allen Creek.....	800	Marietta, Shooks Mills Creek.....	3,000
Bly Run.....	600	Mill Hill, Fishing Creek.....	4,200
Carner Run.....	1,000	Heards Creek.....	700
Cold Spring Run.....	600	Long Run.....	2,100
Cole Run.....	800	Mill Lane, Valley Creek.....	3,600
Coyal Creek.....	600	New Centerville, Gulph Creek and branches.....	2,400
Crouch Run.....	1,000	Trout Creek and branches.....	2,400
Davis Run.....	600	New Ringgold, Cold Run.....	1,200
Estes Run.....	800	Oil City, Hemlock Creek.....	2,800
Hilliger Creek.....	600	Norway Run.....	1,400
Kenyon Creek.....	1,000	Porcupine Run.....	2,100
Netzgar Creek.....	1,000	Paoli Roads, Valley Creek and branches.....	1,800
Reeves Run.....	600	Pittston, Poor House Creek.....	3,600
Salter Creek.....	800	Spring Run.....	7,800
Sherwood Branch.....	600	Ralphton, Quemahoning Creek, North Branch.....	1,200
Short Run.....	1,000	Renova, Drury's Run.....	1,000
South Branch.....	2,000	Hyner Run.....	1,200
Stevens Run.....	600	Ringtown, Dark Run.....	1,200
Swift Run.....	600	Girard Pond.....	1,200
Whitney Creek.....	2,000	Little Catawissa Creek.....	1,200
Whitney Creek, East Branch.....	1,000	Trexler Run.....	1,200
Whitney Creek, West Branch.....	1,000	St. Peters, Rock Run.....	1,800
Woodard Run.....	600	Smithfield, Mill Run.....	2,100
Ebensburg, Roaring Run.....	1,000	Somerset, Beans Run.....	1,200
Gouldsboro, Lehigh River.....	4,200	Blue Hole Run.....	1,200
Hamburg, Maiden Creek.....	1,800	Kimberly Run.....	1,200
Pine Creek.....	1,200	Milford Creek.....	1,200
Hoadleys, Middle Creek.....	1,800	Trout Run, Four Mile Run.....	500
Holidaysburg, Cave Run.....	1,400	Grays Run.....	500
Honesdale, Everhart Run.....	1,800	Lycoming Creek.....	500
Howellville, Valley Creek and branches.....	3,000	Six Mile Run.....	500
Hydetown, Anderson Run.....	400	Trout Run.....	500
Carroll Run.....	400	Uniontown, Big Sandy Creek.....	800
Dunham Run.....	400	Seaton Lake.....	800
Fenton Run.....	400	Waterville, Dam Run.....	500
Glen Run.....	400	Little Pine Creek.....	500
Hummer Run.....	400	Long Fork Creek.....	500
McLaughlin Run.....	400	Lower English Run.....	500
Mooley Run.....	400	Otter Run.....	500
Morris Run.....	400	Sebring Creek.....	500
Shirley Run.....	400	Williamsport, Mill Creek.....	500
Stony Hollow Run.....	400	Scotch Mill Creek.....	500
Tubbs Run.....	400	Sugar Camp Run.....	500
Indian Head, Camp Run.....	600	Waller Run.....	500
Indian Creek.....	600	Windber, Big Paint Creek.....	1,400
Mountain Run.....	400	Dark Shade Creek.....	700
Ivyland, Pleasant Plains Pond.....	600	Little Paint Creek.....	1,400
Jersey Shore, Larrys Creek.....	1,600	Little South Fork Run.....	2,100
Johnstown, Alvine Run.....	400	Piney Run.....	1,400
Baker Run.....	400	Shade Creek.....	700
Bens Creek and branches.....	1,200	Sienna Run.....	2,100
Big Mill Creek.....	400	Tab Run.....	700
Big Spring Run.....	400	Wentz Run.....	1,400
Canfield Run.....	400	<b>South Dakota:</b>	
Card Machine Run.....	400	Buffalo Gap, Beaver Creek.....	10,000
Clear Shade Creek.....	400	Custer, Dolls Pond.....	600
Dalton Run.....	400	Englewood, Ward Creek.....	1,200
Henaries Creek.....	400	Fruitdale, Park Spring Branch.....	500
Hinckson Run.....	400	Hill City, Spring Creek.....	16,800
Johns Mill Run.....	400	Merriman, Lake Creek Pond.....	2,000
Laurel Run (A).....	400		
Laurel Run (B).....	400		

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## RAINBOW TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
South Dakota—Continued.		Virginia—Continued.	
Mystic, Little Rapid Creek.....	3,600	Charlottesville, Tiverton Branch.....	3,000
Newell, Kirby Lake.....	1,200	Dillwyn, Eldridge Pond.....	650
Pine Ridge, Spring Creek.....	1,640	East Falls Church, Holmes Run.....	150
Yellow Thunder Creek.....	1,640	Four Mile Run.....	150
Rapid City, Barker Pond.....	2,800	Fairwood, Wilson Creek.....	11,900
Box Elder Creek.....	2,250	Lorton, Charles Run.....	400
Cottonwood Lake.....	2,800	Marion, Holston Creek.....	1,000
Keenan Pond.....	500	Narrows, Dry Branch.....	3,000
Lower Box Elder Creek.....	2,250	Kimberling Creek.....	3,000
Minneclusa Creek.....	1,700	Natural Bridge, Crawford Creek.....	8,000
Rapid Creek.....	2,250	Pearisburg, Clendenin Creek.....	4,000
Schambers Creek.....	700	Ding Branch.....	2,000
Scott Pond.....	2,800	Mill Creek.....	4,500
Spring Canyon Creek.....	2,100	Nobusiness Creek.....	2,000
Victoria Creek.....	2,100	Pemberton, Little Bend Creek.....	2,000
Spearfish, Chicken Creek.....	3,500	Pembroke, Little Stony Creek.....	1,500
Cold Spring Creek.....	840	Pohick, Pohick Creek.....	6,000
Coxs Lake.....	2,100	Purelle, Reed Creek.....	6,000
Hilton Gulch Creek.....	4,000	Speedwell, Peach Bottom Creek.....	1,600
Hulls Branch.....	840	Stuart Draft, Coles Run.....	1,200
Oak Creek.....	700	Sugar Grove, Dickey Creek.....	4,200
Riverview Branch.....	1,400	Teas, Holston River, South Branch.....	28,000
Stannus's pond.....	560	Timber Ridge, Lackey's pond.....	1,000
State fish commission.....	50,000	Trout Dale, Fox Creek.....	22,500
Stucco Creek.....	700	Laurel Creek.....	3,500
Summers's pond.....	700	Pierce Creek.....	4,200
Wears Branch.....	1,400	Pugh Creek.....	2,800
Webb Knight Branch.....	6,000	Ripshine Creek.....	2,800
Sturgis, Bear Butte Creek.....	11,100	Staley Creek.....	5,600
Morse Pond.....	1,000	Wallace, Beaver Creek.....	1,500
Spring Draw Creek.....	500	White Top Gap, Burgess Creek.....	1,500
Waterworks Lake.....	6,000	Wilda, South River.....	9,000
Tilford, Morris Creek Pond.....	500	Washington:	
Vale, Cottonwood Creek.....	8,000	Boyds, Sherwood Creek.....	10,000
Wall, Miller Reservoir.....	500	Colville, County Game Commission.....	* 50,000
Tennessee:		Lind, York Lake.....	10,000
Chattanooga, Rainbow Lake.....	3,000	Moab, Newman Lake.....	12,000
Crabtree, Roaring Creek.....	1,000	Montesano, Satsop River.....	12,000
Elkmont, Little River.....	13,000	Orient, Meadow Lake.....	8,000
State fish commission.....	* 42,700	Republic, Deep Lake.....	14,000
Erwin, Birchfield Creek.....	5,400	Tacoma, Clear Lake.....	7,500
Birchfield Pond.....	5,800	Vancouver, Battle Grounds Lake.....	* 50,000
North Indian Creek.....	20,400	Walla Walla, Ford's pond.....	300
Rock Creek.....	6,000	West Virginia:	
Etowah, Bullet Creek.....	500	Bemis, Cheat River, Shavers Fork.....	1,000
Farner, Conasuga Creek.....	10,000	Berkeley Springs, Brushy Fork Run.....	2,800
Turtletown Creek.....	10,000	Fayette, Wolf Creek.....	800
Greenville, Nolachucky River.....	4,500	Hazleton, Beaver Creek.....	2,100
Paint Creek.....	4,500	Martinsburg, Tuscarora Creek.....	3,500
McFarland, Big Lost Creek.....	9,000	Mill Creek, Tygarts Valley River and branches.....	9,000
Lost Creek.....	6,000	Richwood, Big Laurel Creek.....	12,000
Maryville, Sycamore Pond.....	6,000	Cranberry River.....	8,000
Sevierville, Little Pigeon River.....	20,000	Terra Alta, Dority Creek.....	1,400
Somerville, Loosahatchie River.....	8,000	Thomas, Boyer's pond.....	800
Tellico Plains, Lake Tellico.....	1,200	Leadmine Creek.....	1,500
Wartrace, Ellwood Pond.....	2,000	Wolf Run.....	2,000
Utah:		Webster Springs, Gauley River.....	4,800
Lehi, Mill Pond.....	3,900	White Sulphur Springs, Howard Creek.....	10,250
Logan, Hyde Park Ponds.....	1,125	Wisconsin:	
Logan River.....	1,125	Aniwa, Plover River.....	300
Murray, Froiseth's pond.....	1,500	Arcadia, American Valley Creek.....	450
Ogden, Lofgren's pond.....	500	Davis Valley Creek.....	1,000
Mill Pond.....	400	English Creek.....	675
Read's pond.....	1,000	Glencoe Creek.....	1,450
Winter's pond.....	600	Lewis Valley Creek.....	1,675
Provo, Provo River.....	10,000	North Branch Creek.....	1,000
Springville, Hobbie Creek.....	10,000	Rainy Valley Creek.....	1,000
Spring Creek.....	277,500	Riley Creek.....	1,000
Vermont: Groton, Wells River.....	† 8,000	Stony Creek.....	1,000
Virginia:		Tomponp Valley Creek.....	1,000
Abingdon, streams along Va.-Car.Ry.....	51,500	Travis Creek.....	1,000
Alleghany, Sweet Chalybeate Creek.....	12,000	Trout Creek.....	450
Atkins, Smider-Murror Pond.....	500	Waumandee Creek.....	1,000
Blacksburg, Big Run Creek.....	500	Zellers Creek.....	1,000
Boone Mill, Boon's pond.....	200	Athens, Black Creek.....	3,000
Buchanan, Purgatory Creek.....	2,000	Bangor, Brush Hollow Creek.....	600
Buena Vista, Hollow Branch.....	8,000		
Bylesby, Chestnut Creek.....	7,000		

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## RAINBOW TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Wisconsin—Continued.		Wisconsin—Continued.	
Black River Falls, Allen Creek.....	900	River Falls, Kinnickinnick River,	
Robinson Creek.....	1,125	Corcoran Branch.....	1,200
Blue Mounds, Bohoris Creek.....	2,000	Rocky Branch.....	1,200
Framos Creek.....	1,000	Salmo, Raspberry Creek.....	900
McKinley Creek.....	1,000	Sioux River.....	900
Royjacks Creek.....	1,000	Solon Springs, Moose River.....	1,800
Ryans Creek.....	1,000	Stanley, Scovins Creek.....	600
Topper Creek.....	1,000	Stone Lake, Hovey Lake.....	1,800
Brule, Brule River.....	6,000	Tigerton, Steinke Creek.....	300
Little Brule River.....	2,400	Tomahawk, Armstrong Creek.....	450
McDougal Lake.....	3,000	Lanweh Creek.....	675
Chippewa Falls, Duncan Creek.....	1,800	Pickrel Creek.....	675
Paint Creek.....	1,800	Rickie Creek.....	675
Couderay, Devils Creek.....	2,000	Spirit River, Middle Fork.....	675
Eddy Creek.....	1,000	Spirit River, North Fork.....	675
Hay Creek.....	1,000	Spirit River, South Fork.....	675
King Creek.....	2,000	Waukesha, Genesee Creek.....	5,000
Squaw Creek.....	2,000	Jerico Creek.....	3,000
Windfall Creek.....	2,000	Sorensen Creek.....	1,000
Donaldson, Big Tamarack Creek.....	200	Wales Creek.....	2,000
Black Oak Lake.....	600	Waterville Creek.....	4,000
Little Tamarack Creek.....	200	Waupaca, Chain of Lakes.....	500
Mill Creek.....	200	Hartman Creek.....	2,000
Pickrel Creek.....	1,400	Little Wolf River, South Branch.....	6,100
Portage Creek.....	2,800	Westby, Aarnes Creek.....	500
Spring Creek.....	200	Bakkin Creek.....	500
Ettrick, Affeldts Creek.....	850	Black Bottom Creek.....	500
Beaver Creek, South Branch.....	1,700	Boggs Creek.....	500
Langs Creek.....	850	Bohemian Creek.....	500
Larsons Creek.....	850	Brookville Creek.....	500
McCannon Creek.....	425	Brush Creek.....	500
Olson Creek.....	425	Cannon Valley Creek.....	500
Fond du Lac, Brownsville Creek.....	100	Clark Creek.....	500
Camp Ground Creek.....	200	Clements Creek.....	500
Gillett Creek.....	100	Duck Egg Creek.....	500
Milwaukee River.....	100	Esofea Creek.....	500
Parson Creek.....	100	Freming Creek.....	1,000
St. Cloud Creek.....	100	Goplen Creek.....	1,000
Silver Creek.....	100	Hagen Creek.....	500
Woolen Mill Creek.....	100	Hanson Creek.....	500
Hawthorne, Three Buck Lake.....	2,000	Harrison Creek.....	500
Independence, Bennett Creek.....	675	Hay Creek.....	500
Cooke Creek.....	675	Hornby Creek.....	500
Itakenson Creek.....	675	Jensen Creek.....	1,000
Solfest Creek.....	675	Jugg Creek.....	500
Traverse Creek.....	675	Kiekappo River, West Fork.....	500
Wickham Creek.....	675	Knapp Creek.....	500
Ladysmith, Hemlock River.....	1,800	Laughter Creek.....	500
Laona, Peshtigo River.....	300	Lunde Creek.....	500
Lavalle, Carr Valley Creek.....	675	McGeary Creek.....	500
Jenson Creek.....	1,125	Miner Creek.....	500
Maiden Rock, Lost Creek.....	1,125	Norlinsky Creek.....	500
Travis Spring Creek.....	900	North Bear Creek.....	500
Minocqua, Johnson Creek.....	1,200	North Billings Creek.....	500
Norwalk, Brieske Creek.....	500	Oium Creek.....	500
Buckholz Creek.....	500	Otter Creek.....	500
Dreier Creek.....	1,000	Paulsrud Creek.....	500
Fairbanks Creek.....	500	Rudrud Creek.....	500
Folz Creek.....	1,900	Ruland Creek.....	500
Halderman Creek.....	500	Sandbakken Creek.....	500
Hidden Creek.....	500	Seas Creek.....	500
Kraeger Creek.....	500	Sending Creek.....	500
Pine Creek.....	500	Sherve Creek.....	500
Rice Creek.....	1,000	Sidle Creek.....	500
Rock Creek.....	1,000	Simonson Creek.....	1,000
Schell Creek.....	500	Skaug Creek.....	500
Spring Creek.....	900	South Bear Creek.....	500
Tar Creek.....	1,000	South Billings Creek.....	500
Woodliff Creek.....	1,000	Spillman Creek.....	500
Zitlow Creek.....	1,400	Sveum Creek.....	500
Oakfield, Fond du Lac River.....	200	Swenson Creek.....	1,000
Pembine, Paulson Creek.....	300	Thorson Creek.....	500
Smith Creek.....	300	Timber Coulee Creek.....	1,000
Trestle Creek.....	300	Twenty-Four Valley Creek.....	500
Rice Lake, Long Lake Creek.....	2,400	Van Ruden Creek.....	1,000
Red Cedar River.....	2,400	Weaster Creek.....	500
Spring Creek.....	1,200	Wyoming:	
Yellow River.....	1,800	Alladdin, Caldwell's pond.....	3,000
River Falls, Kinnickinnick River.....	3,000	Beulah, La Plant Creek.....	8,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

RAINBOW TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Wyoming—Continued.		Wyoming—Continued.	
Beulah, Sand Creek.....	10,000	Lander, Popo Agie River, North Fork.....	2,100
Willow Pond.....	1,500	Sage Creek.....	2,100
Big Lake, Big Lake.....	250	Spring Creek.....	2,100
Cody, Belknap Creek.....	12,000	Squaw Creek.....	2,800
Bob Cat Creek.....	6,000	Sweetwater River.....	2,800
Boulder Creek.....	12,000	Wind River.....	2,800
Britticher Creek.....	12,000	Laramie, Bear Lake.....	20,000
Elk Fork Creek.....	12,000	Lost Lake.....	21,000 <sup>a</sup>
Fall Creek.....	12,000	State fish commission.....	*100,000
Fish Hawk Creek.....	12,000	Telephone Lake.....	20,000
Green Creek.....	12,000	Manderson, State fish commission.....	*113,000
Jim Creek.....	12,000	Opal, State fish commission.....	*227,000
Rock Creek.....	12,000	Ranchester, Wolf Creek.....	9,000
Shoshone River, North Fork.....	12,000	Rock Springs, Half Moon Lake.....	8,000
Crystal Springs Lake, Crystal Springs Lake.....	280	Sand Creek, Sand Creek.....	1,680
Evenston, Chesney's pond.....	4,000	Saratoga, Cedar Creek.....	14,000
Jackson, Crystal Creek.....	10,000	Jack Creek.....	15,000
Lander, Beaver Creek.....	2,800	Lake Creek.....	5,000
Big Wind River.....	2,100	North Platte River.....	75,000
Bull Lake Creek.....	2,100	South Jack Creek.....	15,000
Dinwoodie Creek.....	2,100	South Spring Creek.....	15,000
Dunoir Creek.....	2,100	Spring Creek.....	15,000
Horse Creek.....	2,100	South Redwater Creek, South Redwater Creek.....	560
Little Popo Agie River.....	2,500	Sundance, Miller Creek.....	2,800
Little Wind River.....	2,100		
Lost Creek.....	2,800		
Fine Creek.....	2,800		
Popo Agie River.....	2,800		
		Total <sup>a</sup> .....	{ *2,939,820 †38,500 3,409,190

BLACKSPOTTED TROUT.

Arizona: Douglas, Turkey Creek (West).....	6,000	Colorado—Continued.	
Colorado:		Hillside, Dismore Creek ponds.....	3,000
Austin, Dirty George Creek.....	6,000	Hotchkiss, Clear Fork Creek.....	6,000
La Reux Creek.....	12,000	Smith Fork Creek.....	8,000
Surface Creek.....	10,000	Hot Springs, California Creek.....	4,000
Ward Creek.....	8,000	Carnero Creek, Middle Fork.....	4,000
Youngs Creek.....	8,000	Carnero Creek, South Fork.....	6,000
Colorado Springs, Cheyenne Creek, North Fork.....	4,500	Hodding Creek.....	4,000
Little Fountain Creek.....	6,000	Middle Creek.....	6,000
Crested Butte, Coal Creek.....	6,000	Miners Creek.....	4,000
East River.....	12,000	Saguache Creek.....	6,000
Cripple Creek, Fig Pond.....	2,000	Sheep Creek.....	4,000
Woods Lake.....	10,000	Idaho Springs, Bear Creek.....	6,000
De Beque, Big Creek.....	3,000	Fall Creek.....	3,000
Big Creek Lake.....	2,000	Leadville, Big Union Creek.....	2,000
Bull Creek.....	3,000	Box Creek.....	12,000
Buzzard Creek.....	3,000	Emerald Creek.....	10,000
Coon Creek.....	2,000	Empire Creek.....	2,000
Grove Creek.....	2,000	Musgrove Lake.....	2,000
Hawxhurst Creek.....	2,000	Malta, Big Evans Creek.....	3,000
Kahnah Creek.....	14,000	Lake Creek.....	5,000
Lenox Creek.....	2,000	Minturn, Gore Creek.....	8,000
Leon Creek.....	2,000	Moffatt, North Crestone Creek.....	16,000
Mesa Creek.....	2,000	Rita Alta Creek.....	6,000
Mesa Lake.....	2,000	New Castle, Middle Elk Creek.....	8,000
Park Creek.....	2,000	Pando, Eagle River.....	14,000
Plateau Creek.....	3,000	Paonia, East Muddy Creek.....	14,000
Dillon, Beaver Ponds.....	2,000	Henderson Creek.....	6,000
Brush Creek.....	6,000	Terror Creek.....	10,000
Lost Lake.....	4,000	West Muddy Creek.....	8,000
Meadow Creek.....	4,000	Puzzler, Shadow Creek.....	1,000
Slate Creek.....	6,000	Ridgeway, Cimarron River.....	10,000
Slate Lake.....	4,000	Cow Creek.....	8,000
Straight Creek.....	4,000	Salida, Big Cottonwood Creek.....	4,500
Divide, Loshbaugh's pond.....	2,000	Sapinero, Pass Creek.....	8,000
Edwards, Lake Creek.....	12,000	Upper Taylor River.....	10,000
Empire, Clear Creek, North Fork.....	4,500	Victor, Skaguay Lake.....	8,000
Fairplay, South Platte River.....	8,000	Woodland Park, Carroll Lakes.....	12,000
Florence, Middle Creek.....	3,000	Northfield Lake.....	8,000
South Hardscrabble Creek.....	9,000	Idaho:	
Grant, Geneva Creek.....	8,000	Ashton, Black Pond.....	7,500
		Hauser, Hauser Lake.....	12,250

<sup>a</sup> Exclusive of 29,750 fingerlings lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BLACKSPOTTED TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Michigan: Detroit, Aquarium.....	*12,000	New Mexico—Continued.	
Montana:		East Las Vegas, Gallinas River.....	9,600
Alberton, Rancourt's pond.....	1,750	Rio de la Casa.....	2,400
Belgrade, East Gallatin River.....	14,000	Trout Springs Creek.....	1,200
West Gallatin River.....	16,000	Embudo, Agua Piedra River.....	8,000
Belton, Lake McDonald.....	32,000	Angustora River.....	8,000
Glacier Park, St. Marys River.....	105,000	Little Rio Grande.....	6,000
Two Medicine River.....	105,000	Rio Junta.....	6,000
Heron, Elk Creek.....	10,500	Rio Pueblo.....	14,000
Lewistown, War House Lake.....	20,000	Rio Santa Barbara.....	6,000
Libby, Fisher River.....	20,000	Glorietta, Bradleys Pond.....	7,200
Missoula, Bear Creek.....	8,000	Jacks Creek.....	4,800
Beaver Creek.....	6,000	Pecos River.....	21,600
Bitter Root River.....	8,000	Ortiz, Los Pinos River.....	8,000
Blanchard Creek.....	8,000	San Antonio River.....	8,000
Butler Creek.....	6,000	Raton, City Lake.....	4,800
Camas Creek.....	8,000	Sugarite Creek.....	2,400
Cottonwood Creek.....	6,000	Santa Fe, Nambe River.....	8,000
Deer Creek.....	4,000	Rio Capulin.....	8,000
Dick Creek.....	4,000	Rio Medio.....	8,000
Fish Creek.....	8,000	Santa Fe Creek.....	10,000
Gold Creek.....	6,000	Tesucque Creek.....	8,000
Grant Creek.....	8,000	Silver City, Dry Creek.....	6,000
Graves Creek.....	6,000	Taos, Latir Creek.....	6,000
Hayes Creek.....	4,000	Lucero Creek.....	6,000
Johnson Creek.....	6,000	Pot Creek.....	6,000
Kramer Creek.....	8,000	Rio Hondo.....	6,000
Marshall Creek.....	6,000	Taos Creek.....	6,000
Miller Creek.....	8,000	Ute Park, American Creek.....	2,400
Montour Creek.....	8,000	Bitter Creek.....	4,800
O'Keefe Creek.....	6,000	Cimarron River.....	3,600
Pattee Creek.....	6,000	Clear Creek.....	3,600
Raster Creek.....	6,000	Eagle Nest Creek.....	7,200
Rattlesnake Creek.....	8,000	East Cieneguilla Creek.....	1,200
Six Mile Creek.....	8,000	Goose Creek.....	2,400
Twin Creeks.....	6,000	Hewitt Creek.....	1,200
Warren Creek.....	4,000	Nine Mile Creek.....	3,600
Noxon, Pilgrim Creek.....	8,750	Red River.....	3,600
Piper, McDonald Creek.....	4,500	Tolby Creek.....	2,400
Saltese, Big Sunday Creek.....	7,000	West Agua Fria Creek.....	2,400
Brimstone Creek.....	8,750	Wooten, Fresnal Canon Creek, North Fork.....	2,400
Dominion Creek.....	8,750	Oregon:	
Packer Creek, West Fork.....	8,750	Bonneville, State fish commission.....	*121,000
Rainy Creek.....	8,750	Forest Grove, Dairy Creek.....	6,000
Randolph Creek.....	8,750	Gales Creek.....	6,000
Randolph Creek, East Fork.....	8,750	Patton Creek.....	6,000
Randolph Creek, North Fork.....	7,000	Scoggins Creek.....	6,000
St. Regis River.....	12,250	La Grande, Grand Ronde River, South Fork.....	6,000
St. Regis Slough Ponds.....	1,750	Oregon City, Molalla River and tributaries.....	10,000
Silver Creek.....	8,750	Trail, Rogue River.....	37,700
Silver Lake.....	8,750	South Dakota:	
Thompson Falls, Prospect Creek.....	8,750	Big Stone City, Big Stone Lake.....	15,000
Thompson River.....	14,000	Englewood, Hanna Creek.....	10,000
Three Forks, Madison River.....	20,000	Hanna Creek, East Fork.....	8,000
Trout Creek, Trout Creek.....	10,500	Landis Creek.....	10,000
Troy, O'Brien Creek.....	8,000	Spearfish Creek, South Branch.....	8,000
Warland, Five Mile Creek.....	10,000	Ward Creek.....	8,000
Whitefish, Haskill Creek.....	10,000	Hill City, Newtons Fork Creek.....	6,000
Stillwater River.....	20,000	Palmer Gulch Creek.....	6,000
Whitepine, Big Beaver Creek.....	12,250	Patterson Gulch Creek.....	6,000
White Sulphur Springs, Checker- board Creek.....	8,000	Spring Creek.....	12,000
Eagle Creek.....	8,000	Sunday Gulch Creek.....	6,000
Eight Mile Creek.....	6,000	Hot Springs, Beaver Creek.....	8,000
Four Mile Creek.....	8,000	Rapid City, Deer Creek.....	6,000
Little Birch Creek.....	8,000	Lockhart Pond.....	4,500
Willow Creek.....	6,000	Murphy Pond.....	8,000
Woods Gulch Creek.....	6,000	Rapid Creek.....	25,000
Nebraska: Andrews, White River.....	7,500	Rounds Pond.....	6,000
New Mexico:		Schambers Pond.....	6,000
Albuquerque, Jemez River.....	9,600	Siekler Pond.....	4,500
Buckman, Alamo Canyon Creek.....	6,000	Spring Creek.....	20,000
Chama, Canones Creek.....	14,000	Rochford, Gimlet Creek.....	6,000
Ensenada River.....	8,000	South Box Elder Creek, Branch of.....	6,000
Lower Chama River.....	8,000	Spearfish, Boneta Spring Branch.....	6,000
Tierra Amarilla Creek.....	8,000	Little Sand Creek.....	10,000
Cimarron, Ponil Creek.....	6,000		
Shuree Creek.....	7,200		

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

BLACKSPOTTED TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
South Dakota—Continued.		Wyoming—Continued.	
Spearfish, Sand Creek.....	4,000	Cody, Crow Creek.....	7,500
Silver Spring Branch.....	6,000	Hard Pan Creek.....	6,000
Tilford, Morris Creek.....	4,500	Jordan Creek.....	6,000
Utah:		Libby Creek.....	6,000
Springville, Spring Creek.....	213,550	Moss Creek.....	6,000
Strawberry Reservoir, Strawberry Reservoir.....	40,000	Post Creek.....	6,000
Washington:		Sage Creek.....	10,500
English, Cranberry Lake.....	10,000	Shoshone Lake.....	15,000
Lake Goodwin.....	14,600	Sweetwater Creek.....	7,500
Verett, Fleming Lake.....	12,000	Whit Creek.....	6,000
Lake Armstrong.....	10,000	Encampment, Encampment Creek.....	30,000
Lake Isabel.....	14,000	Encampment Creek, North Fork.....	20,000
Mud Lake.....	6,000	Little Snake River and Branches.....	30,000
Montesano, Cook Creek.....	4,000	Miner Creek and Branches.....	20,000
North Bend, Pratt Lake.....	6,000	Soldier Creek.....	20,000
Northport, Deep Creek.....	14,000	Laramie, Lewis Lake.....	30,000
Deep Creek Lake.....	18,000	Lookout Lake.....	35,000
Pepon Lake.....	14,000	Sand Lake.....	35,000
Satsop, Big Creek.....	4,000	Powell, Ishawooa Creek.....	10,500
Stevenson, Boles Creek.....	2,000	Marquette Creek.....	7,500
Duncan Creek.....	3,000	Murray Creek.....	4,500
Little White Salmon River.....	6,000	Saratoga, Cedar Creek.....	24,000
Rock Creek.....	10,000	Bow Creek.....	20,000
Washougal River.....	6,000	Jacks Creek.....	20,000
Washotgal River, North Fork.....	3,000	South Spring Creek.....	5,000
Wind River.....	6,000	Sundance, Miller Creek.....	4,000
Woodard Creek.....	4,000	Thumb, Clear Creek.....	† 35,000
Tacoma, Carney Lake.....	10,000	Columbine Creek.....	† 30,000
Crescent Lake.....	6,000	Cub Creek.....	† 45,000
Lake Lapps.....	14,000	Hatchery Creek.....	† 90,000
South Prairie Creek.....	12,000	Wamsutter, Battle Creek.....	20,000
Voight Creek.....	12,000	Big Sandstone Creek.....	20,000
Vancouver, Big Creek.....	10,000	Little Sandstone Creek.....	15,000
Cedar Creek.....	10,000	Little Snake River.....	25,000
Wyoming:			
Clearmont, Clear Creek.....	9,000	Total.....	* 133,000
Trigger Lake.....	3,000		† 200,000
			2,875,100

LOCH LEVEN TROUT.

Colorado: Parkdale, Arkansas River.....	60,000	South Dakota—Continued.	
South Dakota:		Rapid City, June Pond.....	1,000
Rapid City, Ash Creek.....	4,000	Lomond Pond.....	1,000
Barker Pond.....	1,000	Plum Creek.....	4,000
Burglar Pond.....	1,000	Total.....	73,000
Canyon Pond.....	1,000		

LAKE TROUT.

Colorado: Leadville, Twin Lakes.....	20,000	Michigan—Continued.	
Massachusetts: Woronoco, Big Pond.....	1,200	Isle Royale, Lake Superior.....	† 272,500
Michigan:		Long Point, Lake Superior.....	† 800,000
Alpena, Lake Huron.....	† 200,000	Marquette, Lake Superior.....	† 625,000
Beaver Harbor, Lake Michigan.....	† 1,136,640	Munising, Lake Superior.....	† 625,000
Beaver Head Reef, Lake Michigan.....	† 2,275,840	Nine Mile Point, Lake Michigan.....	† 2,288,640
Belle Isle, Aquarium.....	* 18,000	Norwood Reef, Lake Michigan.....	† 1,144,320
Big Rock Reef, Lake Michigan.....	† 1,144,320	Rock Harbor, Lake Superior.....	† 600,000
Charlevoix, Lake Michigan.....	† 4,577,280	St. Ignace, Lake Huron.....	† 100,000
Pine Lake.....	† 200,000	St. Joseph, Lake Michigan.....	† 200,000
State fish commission.....	* 1,000,000	Tobens Harbor, Lake Superior.....	† 600,000
Cheboygan, Hammond Bay.....	† 200,000	Washington Harbor, Lake Superior.....	† 200,000
Dahls Shoal, Lake Michigan.....	† 1,144,320	Wrights Island, Lake Superior.....	† 600,000
Escanaba, Lake Michigan.....	† 500,000	Minnesota:	
Fishermens Home, Lake Superior.....	† 600,000	Beaver Bay, Lake Superior.....	† 400,000
Fishermens Island, Lake Superior.....	† 400,000	Bovey, Watson Lake.....	6,000
Fishermens Reef, Lake Michigan.....	† 2,288,640	Chicago Bay, Lake Superior.....	† 300,000
Fish Island, Lake Superior.....	† 100,000	Deer River, Deer River.....	20,000
Frankfort, Lake Michigan.....	† 100,000	Duluth, Lake Superior.....	26,500
Harbor Beach, Lake Huron.....	† 200,000	French River, Lake Superior.....	† 400,000
Houghton, Lake Superior.....	† 625,000		80,000
Iron River, Pickereel Lake.....	10,000	Grand Marais, Lake Superior.....	† 600,000
Trout Lake.....	15,000		

## TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

## LAKE TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Minnesota—Continued.		Vermont—Continued.	
Grand Portage, Lake Superior.....	† 600,000	Newport, Echo Pond.....	660
Knife River, Lake Superior.....	† 480,000	Seymore Lake.....	1,406
St. Paul, State fish commission.....	100,000	Orleans, Long Pond.....	1,410
Spring Brook, Carver Lake.....	*250,000	Wloughby Lake.....	660
Sucker River, Lake Superior.....	10,000	Wisconsin:	
Susie Island, Lake Superior.....	† 400,000	Couderay, Devils Lake.....	10,000
New Hampshire:	80,000	Spring Lake.....	15,000
Lake Tarleton, Lake Tarleton.....	† 200,000	Windfall Lake.....	20,000
Newport, Long Pond.....	710	Donaldson, Black Oak Lake.....	20,000
New York:	3,000	Drummond, Lake of the Woods.....	3,000
Albany, State fish commission.....	*1,800,000	Laona, Rat Lake.....	15,000
Fuller Bay, Lake Ontario.....	† 182,250	Port Wing, Lake Superior.....	† 600,000
Gabriels, Lake Meacham.....	† 19,500	Wyoming:	
Grenadier Island, Lake Ontario.....	† 177,725	Lander, Brooks Lake.....	2,000
Lake Clear, Lake Placid.....	† 14,500	Bull Lake Creek.....	2,000
Port Henry, Clear Pond.....	† 24,000	Crowheart Lake.....	2,000
Port Jervis, Bauer Lake.....	† 15,000	Fry Lake.....	2,000
Watkins, Seneca Lake.....	† 35,000	Lake of the Woods.....	2,000
South Dakota: Fruitdale, Reclamation Reservoir.....	27,975	Lewis Lake.....	2,000
Vermont:		Silas Lake.....	2,000
Barton, Stone Pond.....	660	Total.....	† 23,495,475
Canaan, Big Averill Lake.....	1,000		765,180

## BROOK TROUT.

Alabama: Anniston, Jordan Brook.....	4,500	Colorado—Continued.	
Alaska: Juneau, applicant.....	*50,000	Lime Siding, Deep Creek.....	5,000
Colorado:		Loveland, Big Thompson River.....	60,000
Arkansas Junction, Turquoise Lake.....	113,500	Lyons, North St. Vrain Creek.....	18,000
Bilk Siding, Bilk Creek.....	10,000	South St. Vrain Creek.....	16,000
Boulder, Four Mile Creek.....	45,000	Maddox, South Platte River.....	40,000
Jim Creek.....	45,000	Malta, Empire Creek.....	8,000
Left Hand Creek.....	30,000	Mancoes, Echo Creek.....	5,000
Canon City, Beaver Creek.....	30,000	Monte Vista, Alamosa River.....	10,000
East Beaver Creek.....	20,000	Conejos River.....	10,000
Sells Lake.....	6,000	Rock Creek, South Fork.....	10,000
Colorado Springs, Erie Lake.....	5,000	Osier, Los Pinos River.....	15,000
Frantz Lake.....	60,000	Pagosa Springs, San Juan River,	
Hay Creek.....	9,000	West Fork.....	20,000
Mesa Lake.....	5,000	Taylor Canon Creek.....	10,000
Monument Creek Lake.....	9,000	Pando, Eagle River.....	50,000
Queens Canyon Creek.....	20,000	Placerville, Beaver Creek.....	20,000
Crested Butte, Slato River.....	10,000	Naturita Creek.....	20,000
Cripple Creek, Rule Creek Lake.....	4,000	Saltado Creek.....	20,000
Denver, Bear Creek.....	69,000	Puzzler, Yuki Lake.....	22,000
Clear Creek, North Fork.....	20,000	Radium, Sheephorn Creek.....	10,000
Cub Creek.....	20,000	Salida, Willow Dale Ponds.....	24,000
Dillon, Cataract Creek.....	12,000	Silverton, South Mineral Creek.....	10,000
Cataract Lake.....	69,000	South Fork, Bear Creek.....	10,000
Slate Creek.....	15,000	Dyers Creek.....	10,000
Divide, Copland Creek.....	4,000	Goose Creek.....	15,000
Dolores, Stoner Creek.....	10,000	Rio Grande, South Fork.....	10,000
West Dolores River.....	10,000	Steamboat Springs, Cody Lake.....	2,500
Eldora, Lake Eldora.....	6,000	Gold Creek Lake.....	10,000
Fairplay, High Creek.....	12,000	Tabernash, Cabin Creek.....	7,500
Fort Collins, Cache La Poudre River.....	60,000	Crooked Creek.....	10,000
Lone Pine Creek.....	15,000	Pole Creek.....	7,500
Glenwood Springs, Grizzly Creek.....	16,000	Thomasville, Englebrecht Lakes.....	30,000
Granby, Blainey Slough Pond.....	10,000	Timber Spur, West Dolores River.....	12,500
Buffalo Creek.....	5,000	Trinidad, Purgatory River.....	40,000
Spring Creek.....	5,000	Purgatory River, Middle Fork.....	40,000
Stillwater Creek.....	10,000	Troublesome, Rabbit Ear Creek.....	5,000
Supply Creek.....	7,500	Troublesome Creek, East Fork.....	10,000
Willow Creek.....	12,500	Troublesome Creek, West Fork.....	10,000
Hillside, Balman Lake.....	25,000	Vanadium, Big Bear Creek.....	10,000
Leadville, Arkansas River.....	30,000	Victor, Bison Creek.....	8,000
Half Moon Creek.....	12,500	Skaguay Lake.....	12,000
Lake Creek.....	25,000	Woods Lake.....	6,000
Lake Creek, South Fork.....	12,000	Yampa, Blue Lake.....	5,000
Tennessee Creek.....	24,000	Chatfield Lake.....	10,000
Timberline Lake.....	8,000		

<sup>a</sup> Exclusive of 2,204 fingerlings lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Colorado—Continued.		Maine—Continued.	
Yampa, Crosho Lake.....	5,000	Boundary, Boundary Pond.....	† 9,000
Heart Lake.....	10,000	Clear Pond.....	† 9,000
Hunt Creek.....	7,500	Mud Pond.....	† 9,000
Lily Lake.....	7,500	Unknown Pond.....	† 9,000
Middle Hunt Creek.....	7,500	Brownfield, Little Saco River.....	† 12,000
Moody Creek.....	5,000	Shepards River.....	† 12,000
North Hunt Creek.....	10,000	Bryant Pond, Christopher Lake.....	† 9,000
Rainbow Lake.....	10,000	Byron, Garland Pond.....	† 9,000
Round Lake.....	5,000	Corinna, Alder Brook.....	† 6,000
Simon's pond.....	2,500	Cornish, Berry Brook.....	† 6,000
South Hunt Creek.....	10,000	Mine Pond.....	† 9,000
Stillwater Lake.....	10,000	Stanley Ponds.....	† 9,000
Watson Creek.....	5,000	Trafton Pond.....	† 6,000
Connecticut:		Dennysville, Cathance Brook.....	† 12,000
Cheshire, Ten Mile River.....	6,000	Dennys River.....	† 15,000
East Haddam, Early Brook.....	3,500	Wilson Brook.....	† 9,000
Martin Brook.....	500	Dexter, Half Moon Pond.....	† 6,000
Selden Brook.....	3,000	Jimmie Brook.....	† 3,000
Forestville, Cold Brook.....	1,600	Pitts Brook.....	† 3,000
Hartford, Abbot Pond.....	500	Eagle Lake, Eagle Lake.....	12,000
Brook Brook.....	4,000	East Orland, Craig Pond.....	† 75,000
Salmon Brook.....	5,000	Gully Brook.....	† 10,000
Silver Brook.....	4,000	Harts Pond.....	† 12,500
Westbrook Creek.....	500	Patten Pond.....	6,200
Long Hill, Willow Brook.....	4,000	Ellsworth, Beech Hill Lake.....	† 24,000
Meriden, Albert Bacon Brook.....	3,000	Branch Pond.....	† 100,000
Honey Pot Brook.....	3,000	Patten Pond.....	† 75,000
Meeting House Brook.....	2,000	Franklin, Donnells Pond.....	† 12,000
Misery Brook.....	4,000	Frveburg, Buck Brook.....	† 6,000
Parker Brook.....	1,200	Clays Brook.....	† 6,000
Pipesdale Brook.....	2,000	Cold River.....	† 12,000
Sodam Brook.....	1,200	Little Cold River.....	† 9,000
Spruce Glen Brook.....	1,200	Little Saco River.....	† 6,000
Westfield Falls Brook.....	1,200	Wards Pond and Brooks.....	† 3,000
Willow Brook.....	1,500	Gilead, Wild River and tributaries.....	73,800
Norwalk, Wilson Brook.....	2,400	Grand Lake Stream, Grand Lake.....	† 48,480
Stepney, Pepper Street Brook.....	3,000	Green Lake, Mann Brook.....	† 50,000
Washington, Bee Brook.....	3,000	Greenville Junction, Wilson Pond.....	† 18,000
Chapel Brook.....	1,000	Harmony, Grant Brook.....	† 6,000
Mallory Brook.....	8,000	Holeb, Fish Pond.....	† 6,000
Sawmill Brook.....	2,000	Gulf Brook.....	† 6,000
Walker Brook.....	5,000	Holeb Lake.....	† 12,000
Wood Brook.....	6,000	Moose River.....	† 12,000
Waterbury, DeBishop Pond.....	500	Turner Pond.....	† 6,000
Mad River.....	500	Unknown Pond.....	† 6,000
Wauregan, Blackwell Brook.....	5,000	Island Falls, Mattawaumkeag Lake.....	† 8,700
Georgia:		Jackman, Attean Lake.....	† 15,000
Blue Ridge, Rock Creek.....	9,000	Bog Pond.....	† 6,000
Nacoochee, Bell Branch.....	5,400	Clearwater Pond.....	† 6,000
Simmons Branch.....	5,400	Cold Stream Pond.....	† 9,000
Idaho:		Crocker Pond.....	† 9,000
Fort Hail, Clear Creek.....	1,050	Enchanted Lake.....	† 15,000
Ross Fork Creek.....	3,500	Gander Brook.....	† 9,000
Spring Creek.....	1,400	Hatchery Brook.....	† 6,000
Franklin, Bear River.....	2,000	Horseshoe Pond.....	† 9,000
Payette, Shamberger's pond.....	1,500	Lake Parlin.....	† 9,000
Pocatello, Marsh Creek.....	8,500	Little Bid Wood Lake.....	† 9,000
Pebble Creek.....	1,250	Long Pond.....	† 6,000
Preston, Bear Lake.....	2,800	Moose River.....	† 9,000
Bear River.....	4,050	Sandy Brook.....	† 9,000
Indiana:		Slackers Pond.....	† 6,000
Michigan City, Palmer Brook.....	4,500	Kennebago, Kennebago Lake.....	† 12,000
Schurz's pond.....	3,000	Kinco, Carry Brook.....	† 2,000
Wolf Creek.....	3,000	Moose River.....	† 8,000
Iowa:		Socatean Creek.....	† 10,000
Calmar, Glenwood Creek.....	2,000	Lincoln Mills, Alder Brook.....	† 3,000
Manchester, Spring Branch.....	390	Livermore Falls, Tilton Pond.....	† 6,000
Kentucky:		Machias, Fulton Lake.....	† 9,000
Bowling Green, Jennings Creek.....	75	Mattawaumkeag, Wyman Brook.....	† 9,000
South Union, Clear Creek.....	75	Monmouth, Cochnewagan Lake.....	† 9,000
Maine:		Moodys Crossing, Weymouth Pond.....	† 9,000
Belfast, Kimball Brook.....	† 4,000	North Anson, Embden Pond.....	† 11,400
Bigelow, Spring Lake.....	11,000	North Belgrade, Messalonskee Lake.....	† 15,000
Bingham, Bean Pond.....	† 5,700	Oldtown, Birch Creek.....	† 15,000
Pleasant Pond.....	† 8,550	Titcomb Pond.....	† 12,500
Rowe Pond.....	† 8,550	Otis, Green Lake.....	† 193,200

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Maine—Continued.		Massachusetts—Continued.	
Pembroke, Boyden Lake.....	†15,000	Great Barrington, Egremont Brook.....	400
Portage, Portage Lake.....	†10,000	Goodale Brook.....	400
Portland, Beaver Brook.....	†6,000	Green River.....	13,800
Forest Lake.....	†9,000	Harmon Brook.....	11,400
Little River.....	†12,000	Konkapot River.....	24,400
Red Brook.....	†6,000	Lee Brook.....	400
Presque Isle, Presque Isle River.....	†14,500	Muddy Brook.....	3,400
Squan Lake.....	†11,600	Roaring Brook.....	400
Princeton, Huntley Brook.....	8,000	Seekonk River.....	8,000
Saco, Boothby Brook.....	†3,000	Spring Brook.....	1,000
Burham Brook.....	†3,000	Swann Brook.....	3,000
Carter Brook.....	†3,000	Umpachenee Brook.....	3,000
Deep Brook.....	†9,000	Williamsville River.....	5,800
Foss Brook.....	†3,000	Hinsdale, Fox Brook.....	300
Foxwell Brook.....	†9,000	Washington Pond Brook.....	400
Freshwater Brook.....	†9,000	Holyoke, Paddy Hill Brook.....	600
Goose Fare Brook.....	†9,000	Spruce Corner Brook.....	800
Harmon Brook.....	†6,000	Hoosac Tunnel, Cold River.....	4,000
Holmes Brook.....	†3,000	Paddleford Brook.....	2,800
Lilley Brook.....	†3,000	Lenox, Belden Brook.....	1,000
Meade Brook.....	†9,000	Yokum Brook.....	6,000
Ricker Brook.....	†3,000	Millbury, Cronin Brook.....	600
Sebago Lake, North Branch.....	†6,000	Monterey, Meadow Brook.....	1,250
Sherman, Davis Pond.....	4,000	Mountain Brook.....	1,250
Skinner, Barrett Pond.....	†6,000	Ransome Brook.....	8,000
Bog Brook.....	†6,000	North Dana, Silver Brook.....	2,400
Indian Pond.....	†9,000	Northampton, Walker Pond.....	5,000
Lowell Pond.....	†6,000	Orange, Stevens Pond.....	10,600
Twin Island Pond.....	†9,000	Whitney Pond.....	7,500
South Orrington, Douglas Pond.....	†15,000	Palmer, Burleigh Brook.....	4,800
South Paris, Abbot Pond.....	†6,000	Pittsfield, Clark Brook.....	2,000
Concord River.....	†9,000	Jacoby Brook.....	4,000
Shagg Pond.....	†9,000	Sackett Brook.....	8,500
Spear Creek.....	†9,000	School House Brook.....	5,000
Twenty Mile River.....	†15,000	Secum Brook.....	8,000
Washburn Pond.....	†3,000	Shaker Brook.....	2,000
Unity, Unity Pond.....	†6,000	Town Brook.....	9,500
Walker Siding, Squa Pan Creek.....	6,000	Yokum Brook.....	4,000
Whitneyville, Arna Meadow Brook.....	†6,000	Shelburne Falls, Baro River.....	6,000
Winthrop, Lake Maranacook.....	†12,000	South Lee, Bear Mountain Brook, East Branch.....	5,000
Woodland, Anderson Brook.....	6,000	Bear Mountain Brook, West Branch.....	5,000
Maryland:		Springfield, Allen Pond.....	400
Academy Junction, Towson Branch.....	4,000	Grassy Meadow Brook.....	3,000
Anne Arundel, Stoney Run.....	3,000	Stockbridge, Konkapot River.....	1,200
Carrollton, Greens Run.....	500	Tyngsboro, Carney's pond.....	2,000
Reeds Run.....	500	Wesfield, Big Powder Mill Brook.....	6,000
Cumberland, Dickerson Run.....	5,000	Blandford Brook.....	4,800
Everett Creek.....	2,200	Loomis Street Brook.....	7,200
Deer Park, Watson Lake.....	2,000	Manhan River.....	9,600
Frostburg, Bear Creek.....	6,000	Potash Brook.....	7,200
Big Laurel Run.....	4,000	Sandy Mill Brook.....	4,800
Puzzler Run.....	5,000	Michigan:	
School House Run.....	2,000	Alpena, Beaver River.....	7,500
Spiker Run.....	2,000	Comstock Creek.....	3,000
Two Mile Run.....	1,000	Little Wolf Creek.....	4,500
Hampstead, Indian Run.....	1,500	Baldwin, Baldwin Creek.....	9,375
Kitzmiller, Lost Land Run, East Prong.....	4,000	Baraga, Grandville Creek.....	†1,000
Lost Land Run, West Prong.....	2,000	Plumbago Creek.....	†2,000
Short Run.....	1,000	Neulah, Betsy River.....	2,500
Wolf Den Run.....	2,000	Branch, Weldon Creek.....	9,375
Lonaconing, Mud Lick Creek.....	2,000	Calumet, Agate River.....	†4,000
Mullikin, Eglinton Run.....	2,000	Beaver Creek.....	†3,000
Oakland, Cherry Creek.....	4,000	Beaver Dam Pond.....	†1,000
Muddy Run.....	8,000	Bufalo River.....	†3,000
Ruxton, Callendar House Pond.....	500	Eagle River.....	†4,000
Takoma Park, Sligo Creek.....	300	Garden City Pond.....	†1,000
Massachusetts:		Garden City River.....	†3,000
Athol, Thrower Brook.....	10,000	Gratiot River.....	†5,000
Barre, Gaston's pond.....	12,500	Hills Creek.....	†9,000
Clinton, Berlin Brook.....	15,000	Horseshoe Creek.....	†2,000
Clamshell Pond Brook.....	8,000	Horseshoe Lake.....	†4,000
Collins Brook.....	11,000	Little Gratiot River.....	†5,000
Sheehan Brook.....	8,000	Medora River.....	†2,000
Dalton, Cady Brook.....	400	Meadow Dam Pond.....	†1,500
Windsor River.....	1,000	Mineral River.....	†3,000
Great Barrington, Alford Brook.....	3,400	Montreal River.....	†14,000
Dalzell Brook.....	3,000		

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Michigan—Continued.		Minnesota—Continued.	
Calumet, Mosquito Creek.....	† 2,000	Dover, Logan Branch.....	500
North American River.....	† 5,000	Middle Branch.....	1,000
Old Cliff Meadow Pond.....	† 1,000	South Branch.....	1,500
One Mile Farm Creek.....	† 1,500	Trout Creek.....	500
Seward Creek.....	† 3,000	Duluth, Amity Creek, West Branch	† 2,000
Tobacco River.....	† 5,000	French River.....	† 1,500
White Birch Creek.....	† 3,000	Gooseberry River.....	† 2,500
Charlevoix, Horton Creek.....	† 15,000	Knife River.....	† 2,500
Inwood Creek.....	† 16,000	Little Cloquet River.....	† 2,500
Iron Ore Creek.....	2,000	Pine River.....	† 1,500
McGeagh Creek.....	† 29,000	Shadow Lake.....	† 3,000
Monroe Creek.....	† 10,000	Stewart River.....	† 2,000
Stover Creek.....	† 20,000	Sucker River.....	† 2,500
Cheboygan, Laperal River.....	† 21,000	Ely, Burnside River.....	† 2,000
Clare, Chard Creek.....	† 7,500	Lonstorf Creek.....	† 2,000
Five Lake Creek.....	† 6,000	Section Thirty Creek.....	† 1,000
Half-lead Creek.....	† 7,500	Mazeppa, Trout Creek.....	400
Lowry Creek.....	† 5,000	Preston, Camp Creek.....	1,000
McEwen Creek.....	† 6,000	St. Charles, Campbell Creek.....	500
Morrison Creek.....	† 5,000	Demouth Creek.....	500
Parrish Creek.....	† 6,000	Drakes Creek.....	500
Sanford Creek.....	† 6,000	Ferguson Creek.....	500
Crystal Falls, Briar Hill Creek.....	2,000	Hemmingway Creek.....	500
Chicagon Creek.....	2,500	Holms Creek.....	500
Clark Creek.....	2,000	Holts Creek.....	500
Peterson Creek.....	1,500	Logan Branch.....	500
Connors, Gilchrist Creek.....	20,000	Middle Branch.....	500
Dryden, Lees Pond.....	5,000	Nichols Creek.....	500
Eagle Mills, Morgan Creek.....	† 4,000	North Branch.....	500
East Tawas, Indian Creek.....	† 10,000	Pettie Creek.....	500
Lond Creek.....	† 10,000	Quincy Creek.....	500
Silver Creek.....	33,000	South Branch.....	500
Tawas Creek.....	4,500	Trout Creek.....	500
Vaughn Creek.....	† 10,000	Troy Creek.....	500
Emison, Net River.....	1,500	Whitewater River.....	500
Frankfort, Betsy River.....	2,500	Spring Grove, Bee Creek.....	1,000
Gaylord, Au Sable River.....	15,000	Biceland Creek.....	1,000
Hale, Smith Creek.....	† 10,000	Upper Bear Creek.....	1,000
Highland, Rock Creek.....	10,000	Twin Valley, Marsh Creek.....	† 3,000
Spring Creek.....	10,000	Two Harbors, Crow Creek.....	† 2,000
Ishpeming, Barnhart Creek.....	† 4,000	Encampment River.....	† 2,000
Dead River.....	† 1,000	Knife River and branches.....	† 9,000
Escanaba River and tributaries.....	† 18,000	Little Stewart River.....	† 1,500
Green Creek.....	† 1,000	Silver Creek.....	† 2,500
Spruce River.....	† 2,000	Splitrock Creek.....	† 3,000
Jackson, Crouches Creek.....	4,500	Splitrock Creek, North Branch.....	† 2,000
Lake Linden, Spring Creek.....	† 1,500	Stewart River.....	† 2,500
Lake Mine, Fire Steel Creek.....	† 6,000	Stone Creek.....	† 1,500
Little Lake, Connors Creek.....	† 2,000	Montana:	
Marietta, Slagel River.....	5,000	Ballantine, Arrow Creek.....	600
Mastodon, Mastodon Creek.....	1,000	Belgrade, Thompson Creek.....	1,750
Onaway, Rainy Lake.....	9,000	Belton, Conlons Bay.....	† 90,000
Tomahawk Creek.....	6,000	Kelley's Bay.....	† 10,000
Ontonagon, Cranberry River.....	† 3,000	Big Timber, Bologne Creek.....	2,400
Cunningham Creek.....	† 2,000	Cayuse Creek.....	4,800
Deer Creek.....	† 1,000	East Boulder River.....	12,000
Osoda, Pine River.....	† 10,000	Lower Deer Creek.....	9,000
Park Siding, Reservoir Creek.....	1,000	Mussellshell River, American Fork.....	7,200
Parma, Raymond Creek.....	3,000	Otter Creek.....	7,200
Pellston, Maple River.....	15,000	Swamp Creek.....	4,800
Petosky, Heber Creek.....	† 10,000	West Boulder Creek.....	9,000
Raco, Sullivan Creek.....	† 8,000	Billings, Sage Creek.....	12,000
Rockland, Rockland Creek.....	† 3,000	Bozeman, Angell Creek.....	9,600
Roscommon, Au Sable River, South		Baker Creek.....	10,000
Branch.....	† 2,000	Bamber Creek.....	2,000
Sidnaw, Sidnaw Creek.....	3,000	Barnhart Creek.....	900
Trimountain, Cushman Creek.....	† 4,000	Bostwick Creek.....	300
Wingleton, Baunan Creek.....	3,750	Cache Creek.....	600
Sweetwater Creek.....	15,000	Camp Creek.....	26,500
Yuma, Slagle Creek.....	12,000	Cherry Creek.....	600
Minnesota:		Cockerill Creek.....	1,000
Albion, Americana Pond.....	† 1,000	Cottonwood Creek.....	4,500
Brownsville, Driscoll's pond.....	500	Cowan Creek.....	1,800
Caledonia, Irish Creek.....	1,000	Curtiss Creek.....	11,500
Clearbrook, Clearbrook Creek.....	† 5,000	Dry Creek.....	8,250
Rully Creek.....	† 3,000	Fish Creek.....	4,500
Dover, Crown Creek.....	500	Gallatin River, Middle Fork.....	300
Drake Creek.....	500	Heeb Creek.....	4,500

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
<b>Montana—Continued.</b>		<b>Montana—Continued.</b>	
Bozeman, Jaekel Creek .....	3,000	Whitefish, Swift Creek .....	1,750
Kennedy Creek .....	2,700	Whitefish Lake .....	1,750
Lansing Creek .....	5,250	Winston, Vermont and Beaver Creeks .....	30,000
Martin Creek .....	2,000	Yellowstone, Cougar Creek .....	2,800
Meadow Creek .....	600	Gneiss Creek .....	2,100
Middle Creek .....	1,500	<b>Nebraska:</b>	
O'Dell Creek .....	600	Chadron, Dead Horse Creek .....	2,400
Pass Creek .....	6,300	Gordon, Antelope Creek .....	5,000
Reese Creek .....	3,450	Larabee Creek .....	5,000
Ross Creek .....	6,300	Snake Creek .....	10,000
Sales Creek .....	1,500	Spring Creek .....	5,000
Smith Creek .....	3,000	White Clay Creek .....	6,000
South Dry Creek .....	600	Wounded Knee Creek .....	6,000
Spring Hill Creek .....	9,000	<b>New Hampshire:</b>	
Story Creek .....	11,000	Baileys, Grandview Brook .....	† 1,000
Stuckey Creek .....	5,250	Ingerson Brook .....	† 1,000
Sun River, North Fork .....	12,500	Mason Brook .....	† 2,000
Thompson Creek .....	6,700	Moulton Brook .....	† 1,000
Tice Creek .....	3,000	Palmer Brook .....	† 1,000
Wild Rose Pond .....	1,500	Parker Brook .....	† 1,000
Brisbin, Brisbin Creek .....	800	Plaisted Brook .....	† 1,000
Chestnut, Goose Creek .....	1,600	Priscilla Brook .....	† 2,000
Columbus, Stillwater River .....	12,000	Roberts Brook .....	† 1,000
Darby, Bitter Root Creek .....	350	Bartlett, Bartlett Brook .....	† 7,500
Robinson's pond .....	1,050	Louisville Brook .....	† 17,500
Dell, Big Sheep Pond .....	4,200	Bethlehem Junction, Beaver Brook .....	† 25,000
Emigrant, Pine Creek .....	3,200	Gale River .....	† 10,000
Forest Grove, Bear Creek .....	1,750	Golf Link Brook .....	† 25,000
Tyler Creek .....	2,800	Little River brooks .....	† 20,000
Fort Benton, Shonkin Creek .....	12,000	State Road Brook .....	† 5,000
Gardiner, Upper Rock Creek .....	2,800	Two Horse Brook .....	† 10,000
Gilman, Sun River and tributaries .....	33,000	Bradford, Massasecum Lake .....	8,000
Glacier Park, park waters .....	† 250,000	Bristol, Brayley Brook .....	7,500
Harlowton, Big Elk Creek .....	21,600	Cass Mill Brook .....	5,250
Boyd Creek .....	350	Cockermouthy River .....	3,750
Bozeman Fork Creek .....	700	Danforth Brook .....	2,250
Little Spring Creek .....	14,400	Dickerman Brook .....	4,000
Warm Spring Creek .....	700	Dick Brown Brook .....	3,000
Homestake, Homestake Reservoir .....	1,200	Fowler River .....	3,750
Lame Deer, Lame Deer Creek .....	22,500	George Brook .....	2,250
Muddy Creek .....	7,500	Kimball Hill Brook .....	4,500
Lennep, Allabaugh Creek .....	10,500	Noyes Brook .....	5,250
Bozeman Fork Creek .....	5,250	Patton Brook .....	4,500
Comb Creek .....	3,500	Rowell Brook .....	5,250
Coyote Creek .....	3,500	Smith River .....	4,500
Musselshell River .....	8,750	Taylor Brook .....	3,000
Warm Spring Creek .....	3,500	Ten Mile Brook .....	4,500
Lewistown, Casino Creek .....	13,500	Welton Brook .....	2,250
Sage Creek .....	2,450	Canaan, Bicknell Brook .....	4,000
Libby, Granite Lake .....	1,400	Burnt Hill Brook .....	6,000
Howard Lake .....	1,400	Merrill Brook .....	3,000
Jackson Creek .....	1,400	Rogers Brook .....	3,000
Rainy Creek .....	1,050	Story Brook .....	2,000
Livingston, Blood Lake .....	300	Wendell Brook .....	2,000
Elbow Creek .....	450	Wright Brook .....	6,000
Fleshman Creek .....	600	Charlestown, Benware Brook .....	3,000
Mortimer Creek .....	300	Great Brook .....	6,000
Strickland Creek .....	450	Reservoir Brook .....	5,000
Summerland Creek .....	1,200	Cherry Mountain, Cherry Mountain Brook .....	† 20,000
Yellowstone River .....	1,500	Israel River .....	† 20,000
Lodge Grass, Lodge Grass Creek .....	12,000		† 47,200
Rotten Grass Creek .....	6,000	Christine, Lake Christine .....	8,389
Martinsdale, Richmond Creek .....	2,450	Concord, Bog Meeting House Brook .....	7,995
Missoula, Browns Lake .....	3,200	Canterbury Brook .....	7,995
Dusault Creek .....	700	Dolloff and Stumpfield Brooks .....	7,995
Kleinschmidt Lake .....	3,200	Crawfords, Saco Pond .....	† 1,000
Lo Lo Creek .....	1,050	Saco River .....	† 9,000
Opseta Lake .....	3,200	East Kingston, Winkley Brook .....	3,000
Norris, Madison Lake and tribu- taries .....	30,000	Enfield, Cole Pond .....	5,000
Piper, McDonald Creek .....	16,500	Hanover Brook .....	4,000
Red Lodge, Rock Creek and branches .....	18,000	Lovejoy Brook .....	3,000
Townsend, Dry Creek .....	1,200	Wells Brook .....	4,000
Greyson Creek .....	1,200	Glen, Back Brook .....	† 1,500
Ray Creek .....	1,200	Bog Brook .....	† 20,000
Two Medicine Lake, Two Medicine Lake .....	8,100	Elkins's pond .....	† 3,000
Whitefish, Lazy Creek .....	1,750	Fernald Farm Brook .....	† 5,000
		Goodrich Brook .....	† 1,500

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
New Hampshire—Continued.		New Hampshire—Continued.	
Glen, Rocky Branch.....	† 3,000	Newport, Blood Brook.....	4,000
Gorham, Barnes Brook.....	† 3,000	Cuts Brook.....	4,000
Barrett Brook.....	† 3,000	Shedd Brook.....	2,000
Bear Spring Brook.....	† 2,000	Walker Brook.....	2,000
Clay Brook.....	† 2,000	North Conway, Cedar Brook.....	† 1,000
Glen Cottage Brook.....	† 1,000	Kearsage Brook.....	† 3,000
Glen House Brook.....	† 1,000	Moat Brook.....	† 3,500
Jenny Lind Brook.....	† 2,000	North Woodstock, Ammonoosuc River.....	70,308
Josh Billings Brook.....	† 1,000	Eastman Brook.....	600
Lead Mine Brook.....	† 5,000	Jackson Branch.....	600
Madison Brook.....	† 3,000	Johnson Brook.....	12,810
Moose Brook.....	† 4,000	Lost River.....	600
Stony Brook.....	† 2,000	Pemigewasset River, Middle Branch.....	600
Greenville, Furnace Brook.....	4,000	Perry, Christine Lake.....	1,000
Hill, Bartlett Brook.....	2,000	Pittsburg, Connecticut Pond.....	† 5,000
Bennett Brook.....	2,000	Coon Brook.....	† 8,000
Colby Brook.....	2,000	East Inlet Brook.....	† 12,000
Favor Brook.....	3,000	Perry Brook.....	† 15,000
Flounder Brook.....	4,000	Second Connecticut Lake.....	† 5,000
Gile Meadow Brook.....	3,000	Plymouth, Yeaton Brook.....	900
Knox Brook.....	2,000	Potter Place, Cole Pond.....	7,000
Mountain Brook.....	5,000	Towtow River, Hume Brook.....	2,000
Intervale, Intervale Brook.....	† 7,500	Towle Brook.....	2,400
Lebanon, Bliss Brook.....	3,000	South Brookline, Rockwood's pond.....	3,000
Great Brook.....	6,000	Whitefield, Carroll Brook.....	† 4,000
Hardy Brook.....	3,000	Wilton, Blood Brook.....	6,000
Hibbard Brook.....	3,000	Hodgdon Brook.....	4,000
Rix Brook.....	2,000	Woodsville Wild Ammonoosuc River.....	900
Stony Brook.....	4,000	Woodstock, Eastman Branch.....	600
Londonderry, Solvent Spring Pond.....	500	New Jersey:	
Lyndeboro, Woodward Brook.....	2,000	Bernardsville, Hill Brook.....	1,000
Manchester, Baker Brook.....	3,000	Clementon, Cold Creek.....	1,500
Barnard Brook.....	1,000	Greenloch, Big Lebanon Creek.....	1,000
Bear Brook.....	7,995	Oak Ridge, Stony Brook Lake.....	1,500
Bowman Brook.....	7,000	Oxford Furnace, Pequest River.....	1,500
Cohas Brook.....	8,000	Ridgewood, Belmar Spring Pond.....	500
Gulf Brook.....	7,995	Whippany, Badgley Brook.....	500
Hodgdon Brook.....	5,000	Woodbury, Richey Run.....	1,000
Little Cohas Brook.....	7,995	New Mexico:	
Massabesic Lake.....	8,000	Carizosa, Rio Bonito, South Fork.....	5,000
Mill Brook.....	3,000	Cimarron, Ponil Creek.....	17,500
Patten Brook.....	3,000	Rayado River.....	15,000
Peters Brook.....	2,000	Urraca Lake.....	10,000
Prescott Brook.....	2,000	Cloudercroft, Bluewater Creek.....	10,000
Reid Brook.....	10,995	East Las Vegas, Calf Canyon Creek.....	5,000
Sweetwater Brook.....	3,000	Coyote River.....	15,000
Watts Brook.....	7,995	Gallinas River, South Fork.....	15,000
Whiting Brook.....	7,995	Gallinas River, Youngs Fork.....	7,500
Milford, New Boston Brook.....	6,000	Rio de la Casa.....	15,000
Osgood Brook.....	4,000	Winsor Creek.....	10,000
Nashua, Bartemus Brook.....	2,000	Three Rivers, Three Rivers, Branch of.....	7,500
Beaver Brook.....	6,460	Tularosa, Rio Ruidoso.....	15,000
Brick Yard Brook.....	4,920	Ute Park, Cimarron River.....	20,000
Budro Brook.....	2,000	New York:	
Chase Brook.....	2,000	Adams, Sandy Creek and branches.....	† 12,000
Crowell Brook.....	2,000	Albany, Emerich's ponds.....	† 15,000
Duval Brook.....	1,000	Ardley, Grassy Sprain Brook.....	2,000
Flint Brook.....	2,000	Arena, Mill Brook.....	† 5,000
Ford Brook.....	1,000	Babylon, Sumpwam Brook.....	4,000
Ford Corners Brook.....	1,230	Bangall, Cold Spring Brook.....	1,000
Glover Brook.....	3,000	Honey Meadow Brook.....	1,000
Greenleaf Brook.....	1,000	Warren Brook.....	1,200
Hardy Brook.....	3,000	Batavia, Mills Brook.....	† 2,000
Lyd Read Brook.....	2,000	Wolf Creek.....	† 3,000
Muddy Brook.....	2,000	Beaver River, Beaver River.....	† 10,000
Naticook Brook.....	3,000	Besemer, Eddie Pond.....	† 1,000
Norman Howe Brook.....	2,000	Big Moose, Silver Lake.....	† 4,000
Old Maids Brook.....	1,000	Twitchell Lake.....	† 6,000
Peacock Brook.....	3,000	Brinckerhoff, Wickopee Creek.....	1,600
Peg Leg Brook.....	3,000	Cambridge, Camden Brook.....	5,000
Pemigewasset River.....	4,000	Jackson Brook.....	1,000
Riverside Farm Brook.....	1,000	Lowrie Brook.....	2,000
Robinson Brook.....	2,920	Maynard Brook.....	2,000
Second Brook.....	3,000	Owl Kill Brook.....	5,000
Silver Spring Brook.....	3,000	Sherman Brook.....	3,000
Smalls Brook.....	3,000		
Witch Brook.....	6,000		
Newbury, Lake Sunapee.....	18,000		

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
New York—Continued.		New York—Continued.	
Carter, Bear Pond.....	44,000	North Hion, Steele Creek.....	47,000
Lake Kora.....	45,000	North Lansing, Glenn Smith Creek.....	43,000
Sagamore Lake.....	45,000	Gulf Creek.....	43,000
Catskill, Black Brook.....	41,750	Teeter Creek.....	43,000
Haines Brook.....	41,750	Northville, Buckhorn Pond.....	47,500
Kirkstown Creek.....	41,750	Oneida, Oneida Creek.....	48,000
Saxes Brook.....	41,750	Sconodoo Creek.....	47,000
Shinglekill Creek.....	43,500	Oneonta, Charlotte River.....	412,500
Sicely Brook.....	41,750	Oswego, Carpenter Creek.....	44,000
Voss Kill Creek.....	41,750	Pawling, Swamp River.....	6,400
Whippoorwill Brook.....	41,750	Pittsford, Lily Pond.....	42,000
Whitcomb Brook.....	41,750	Port Henry, Cheeney Pond.....	3,000
Cattaraugus, Finch Brook.....	42,000	Sand Pond.....	2,500
Wallace Brook.....	42,000	Trout Pond.....	2,500
Clayton, Frontenac Crystal Springs Pond.....	41,000	Port Jervis, Bushkill Brook.....	42,500
Cobleskill, Charlottevile Creek.....	45,000	Mongaup River.....	47,500
Cobleskill Creek.....	47,500	Shinglekill Brook.....	42,500
Cole Hollow Brook.....	45,000	Steinkill Creek.....	42,500
Dibble Hollow Brook.....	45,000	Potsdam, Clear Pond.....	45,000
East Worcester Creek.....	47,500	Preble, Troughnioga River.....	45,000
West Creek.....	45,000	Quaker Bridge, Creeks Run.....	43,000
West Fulton Creek.....	45,000	Hotchkiss Run.....	44,000
West Middleburg Creek.....	42,500	Pierce Run.....	43,000
Cranberry, Cranberry Creek.....	47,500	Quaker Run.....	45,000
Elmira, Baldwin Creek.....	44,000	Richland, Salmon River, North Branch.....	46,000
Banfield Creek.....	44,000	Rome, Fish Creek, East Branch.....	412,000
Beaver Brook.....	42,000	Salamanca, Morton Pond.....	2,000
Catherine Creek.....	45,000	Prosser Pond.....	43,000
Cornish Creek.....	44,000	Santa Clara, Deep Pond.....	43,000
Cranberry Creek.....	43,000	Deer Pond.....	42,000
Goldsmith Creek.....	43,000	Dimmick Brook.....	43,000
Horseshoe Canal.....	42,000	Goose Pond Brook.....	43,000
Jackson Creek.....	44,000	Guide Board Brook.....	42,000
Miller Brook.....	42,000	Spring Pond.....	41,000
Newtown Creek.....	47,000	Saugerties, Plattekill Creek.....	45,000
Seeley Creek.....	48,000	Reservoir Creek.....	45,000
Sing Sing Creek.....	46,000	Schenectady, Poentic Kill Creek.....	45,000
Smith Creek.....	43,000	Schenevus, Elk Creek.....	412,500
Texas Creek.....	43,000	South Lansing, Ernest Teeter Creek.....	42,000
Wynkoop Creek.....	44,000	Steinburg Creek.....	43,000
Forestport, Little Woodhull Creek.....	43,000	Stateline, Indian Brook.....	6,000
Gabriels, Buck Pond.....	44,000	Syracuse, Bear Creek.....	44,000
Clear Pond.....	45,000	Bear Trap Brook.....	43,000
Rice Brook.....	43,000	Bishop Brook.....	42,000
St. Regis River.....	47,000	Butternut Brook.....	44,000
Genoa, Fred Green Creek.....	42,000	Carpenter Pond Brook.....	43,000
Gamel Creek.....	43,000	Chittenango Creek.....	45,000
Pine Hollow Creek.....	43,000	Fabius Brook.....	44,000
Groton, Owasco Creek.....	45,000	Fellows Brook.....	42,000
Hopewell Junction, Wortlekill Creek.....	2,400	Geddes Brook.....	46,000
Hoosac Falls, Shingle Hollow Creek.....	3,000	LaFayette Creek.....	46,000
White Creek.....	2,000	Manlius Brook.....	42,000
Hunters, Batavia Kill Creek.....	47,500	Melvinc Pond.....	4500
Ithaca, Newfield Creek.....	44,000	Onondaga Creek, West Branch.....	42,000
South Danby Creek.....	45,000	Peck Brook.....	42,000
Stratton Creek.....	45,000	Pools Brook.....	48,000
Lacona, Deer Creek.....	45,000	Redhead Brook.....	42,000
La Fargeville, Cold Creek.....	42,000	South Hollow Brook.....	46,000
Lake Clear, Chub River.....	44,000	Spofford Brook.....	48,000
Lake Plains, AuSable River.....	410,000	Stony Brook.....	47,000
Liberty, Neversink River.....	42,500	Swamp Brook.....	44,000
Neversink River, East Branch.....	42,500	Van Bergen Brook.....	42,000
White Sulphur Creek.....	42,500	Tappan, Palsades Creek.....	41,600
Long Lake West, Bear Pond.....	44,000	Utica, Homer City Brook.....	43,000
Charley Pond.....	42,000	Voorheesville, Cold Springs Creek.....	45,000
Loon Pond.....	48,000	New Scotland Creek.....	410,000
Lyons, Glenmart Creek.....	44,000	Walton, Beers Brook.....	42,500
Mudge Creek.....	44,000	Bramley Brook.....	42,500
Malone, Deer River.....	45,000	Chase Brook.....	42,500
Hatch Creek.....	45,000	Dryden Brook.....	42,500
Trout River.....	46,000	East Brook.....	42,500
Millbrook, Bubbs Hollow Run.....	2,400	Hinman Hollow Brook.....	42,500
Howards Pond.....	1,600	Kerrs Creek.....	42,500
Montour Falls, Glen Creek.....	42,000	Mallory Brook.....	42,500
Spring Brook.....	43,000	Sullivan Glen Brook.....	41,000
Sullivan Glen Brook.....	41,000	Oxbow Hollow Brook.....	42,500
New York, Aquarium.....	*5,000		

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
New York—Continued.		Pennsylvania—Continued.	
Walton, Pines Brook.....	†2,500	Coudersport, Baker Creek.....	800
Third Brook.....	†2,500	Clark Creek.....	400
Trout Brook.....	†12,500	Dingman Run and branches.....	1,600
Wakeman Brook.....	†2,500	Dry Run.....	400
Whitehall, Castle Creek.....	2,000	Dwight Creek.....	400
Cold Brook.....	2,000	Earl Run.....	400
Pike Brook.....	2,500	Ellison Run.....	400
Woods, Cranberry Pond.....	†3,000	Elm Run.....	800
Razor Back Pond.....	†4,000	Fee Run.....	400
Woods Lake.....	†3,000	Gordon Run.....	400
North Carolina:		Graves Run.....	400
Asheville, Mineral Creek.....	10,500	Howland Run.....	400
Canton, Crawford Creek.....	6,000	Kent Run.....	400
Danics Creek.....	6,000	Kline Run.....	400
Dillard, Big Creek.....	5,400	Knowlton Run.....	400
Mill Creek.....	3,600	Lehman Run.....	400
Satulah Creek.....	3,600	Leet Run.....	400
Shoal Creek.....	3,600	Lent Run.....	400
Slab Camp Branch.....	3,600	Lewis Run.....	400
Wildcat Lake.....	3,600	Mill Creek and branches.....	2,000
Ela, Cooper Creek.....	3,000	Mitchell Creek.....	400
Little Creek.....	3,000	Mosier Run.....	400
Etowah, Willow Creek, South Prong.....	4,500	Nelson Run.....	800
Foscoe, Dixon Creek.....	6,000	Niles Run.....	400
Horseshoe, North Mills River and branches.....	17,500	Potter Run.....	400
Lake Toxaway, Bear Wallow Creek.....	11,400	Prosser Run.....	400
French Broad River, East Fork.....	7,200	Reed Run.....	800
Indian Creek.....	4,500	Reese Run.....	400
Shoal Creek.....	4,500	Rock Run (A).....	400
Lenoir, Anthony Creek.....	10,500	Rock Run (B).....	400
Lost Cove Creek.....	3,000	Sherwood Run.....	400
Linville, Big Grassy Creek.....	5,000	Steer Run.....	400
Grandmother Creek.....	6,000	Thompson Run.....	400
Kawana Lake.....	3,000	Trout Run.....	800
Linville River.....	10,000	Veley Run.....	800
Linville River, West Fork.....	5,000	Wadsworth Run.....	400
Little Grassy Creek.....	5,000	White Run.....	400
Micaville, South Toe River.....	8,000	Curry, Three Spring Run.....	3,000
Newland, Squirrel Creek.....	6,000	Downingtown, Broad Run.....	3,000
Pisgah Forest, Davidson River and branches.....	26,000	Easton, Browns Creek.....	500
South Mills River.....	26,500	Bushkill Creek.....	1,500
Poplar, Pigeon Roost Creek.....	7,500	Durham Creek.....	500
Samarand, Drowning Creek, Middle Branch.....	5,400	East Petersburg, Erbs Run.....	1,000
Tuxedo, Grassy Creek.....	5,400	Grosh Run.....	3,000
Grassy Creek, Briar Fork.....	5,400	Hostetter Run.....	3,000
Jims Creek.....	5,400	Snipe Creek.....	3,000
Rock Creek.....	5,400	Ebensburg, Barker Run.....	2,000
Ohio:		Blacklick Run.....	3,000
Canton, Nimisillen Creek.....	2,500	Little Conemaugh Creek.....	3,000
Mansfield, Coles Brook.....	2,000	Roaring Run.....	5,000
Urbana, Cedar Creek.....	3,000	Shady Creek.....	2,000
Oregon: Clackamas, Clackamas River.....	50,400	Stewart Run.....	2,000
Pennsylvania:		Tudor Run.....	2,000
Austin, Big Moores Run.....	1,000	Emporium, Big Run.....	400
Freeman Run.....	1,000	Bobby Run.....	400
Little Moores Run.....	1,000	Canoe Run.....	400
Nelson Run.....	1,000	Chop Run.....	400
Prouty Run.....	1,000	Clear Creek.....	800
South Fork Run.....	1,000	Cook Run.....	800
Blairs Mills, Horse Valley Run.....	5,000	Driftwood Run.....	1,600
Boiling Springs, Broad Run.....	6,000	East Cowley Creek.....	400
Old Town Run.....	6,000	Finley Run.....	800
Burrows, Pine Creek, West Branch.....	1,500	Five Mile Run.....	400
Cairnbrook, Beaver Run.....	5,000	Four Mile Run.....	400
Carbondale, Lyon Creek.....	1,800	Half Mile Run.....	800
Coburn, Fishing Creek.....	3,000	Hunts Run.....	800
Hornor House Run.....	2,000	Hunts Run, McKennon Branch.....	400
Phillips Creek.....	3,000	Lewis Run.....	800
Pine Creek.....	2,000	Little Hunts Run.....	800
Poe Creek.....	2,000	Nickays Run.....	400
Sinking Creek.....	2,000	North Creek.....	800
Spring Bank Run.....	2,000	Parker Run.....	800
Synagogue Creek.....	2,000	Portage Creek.....	800
Turpentine Run.....	2,000	Robinson Run.....	400
Winklebleak Run.....	2,000	Rock Run.....	800
		Sterling Run.....	800
		Waldy Run.....	800
		West Creek.....	1,200

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Pennsylvania—Continued.		Pennsylvania—Continued.	
Emporium, West Cowley Creek	800	Philipsburg, Little Beaver Run	1,000
Farrandville, Lick Run	3,000	Moravian Run	2,000
Garret, Brush Creek	8,000	Shields Run	1,000
Wares Run	2,000	Six Mile Run	2,000
Glen Mawr, Kettle Creek	2,000	Smays Run	1,000
Ogdonia Creek	2,000	Stanton Run	2,000
Rock Run	1,500	Star Run	2,000
Glen Union, Baker Run	3,000	Tomahawk Run	3,000
Mill Run	3,000	Tom Tit Run	1,000
Scootac Creek, North Fork	3,000	Trout Run (A)	1,000
Scootac Creek, South Fork	3,000	Trout Run (B)	1,000
Glynden, Britton Run	800	Phoenixville, Mashalmac Creek	1,000
Green Point, Trout Run, Northwest Branch	3,000	Reading, Willow Creek	3,000
Indiana, Ray Run	5,000	Renovo, Halls Run	1,600
Stake Run	4,000	Two Mile Run	1,600
Lemont, Branch Creek	3,000	Young Womans Creek	1,600
Center Furnace Branch	2,000	Rockport, Indian Run	2,000
Collier Run	2,000	Seranton, Lake Sheridan Creek	500
Fair Run	2,000	Somerfield, Beaver Creek	4,000
Rock Spring Creek	5,000	Tub Run	1,600
Shingletown Creek	2,000	Sonestown, Eagles Mere Creek	1,000
Sinking Creek	4,000	Trout Run, Dougherty Run	1,000
Slab Cabin Creek	3,000	Wolf Run	1,000
Spring Creek	3,000	Troy, Bullard Creek	500
Stone Creek	4,000	Bullard Creek, North Branch	500
Lewistown, Knepps Run	3,000	Covert Run	500
Mountain Spring Run	1,000	Dry Run	500
Listonburg, Whites Creek	2,800	Factory Run	500
Manns Choice, Breastwork Run	5,000	Griffin Creek	500
Fyan Run	5,000	Kiff Run	500
Laurel Run	5,000	Leona Creek	500
Marietta, Charles Run	4,000	Little Falls Creek	500
Collins Creek	4,000	Lye Run	500
Donegal Creek	4,000	Morgan Creek	500
Gladfelter Run	2,000	Morgan Creek, North Branch	500
Mifflin, Solouff Run	2,000	Porter Creek	500
Mill Hall, Cedar Run	6,000	Sugar Creek, North Branch	500
Cherry Run	3,000	Tioga River	1,500
Fishing Creek	15,000	Uniontown, Chaney Run	800
Fox Hollow Run	2,000	Laurel Run	800
Plum Run	4,000	Mill Run	1,200
Little Bear Creek	1,500	Rock Run	800
Montoursville, Odonice Run	2,000	Walnutport, Wild Creek	5,000
Wallis Run	2,500	Waterville, Canoe Bottom Run	1,200
Mount Union, Long Hollow Run	5,000	Pine Bottom	1,800
Muncie, Turkey Run	1,000	Waynesboro, Cress Creek	2,000
Oil City, Norway Run	1,000	Whiteland, Lionville Run	3,000
Orviston, Big Run	2,000	Whiteland Run	7,000
Eddy Lick Run	2,000	Williamsport, Big Bear Creek	1,500
Hays Run	2,000	Dry Run	1,000
Paddy Mountain, Penns Creek	4,000	Hoagland Run	1,500
Pen Argyl, Bushkill Creek	5,000	Hoagland Run, Sandy Branch	1,500
Cherry Valley Creek	500	Learys Creek, Spooners Branch	1,000
Green Walk Creek	500	Wolf Run	1,500
Reynolds Creek	500	Windber, Berkebyle Run	3,000
Ross Common Creek	500	Biscuit Spring Run	2,000
Ross Valley Creek	500	Clear Shade Creek	7,000
Spruce Run	500	Cub Run	1,000
Penn Haven Junction, Drakes Creek	3,000	Manger Run	2,000
Philipsburg, Alder Run	2,000	Mickel Run	3,000
Ardel Run	1,000	Mill Creek	1,000
Barker Run	1,000	Miller Run	3,000
Bark Shed Run	1,000	Muncie Creek	1,000
Beaver Meadow Run	1,000	Ober Run	3,000
Bemer Run	1,000	One Mile Run	1,000
Benners Run	2,000	Piney Run	6,000
Bigelow Run	1,000	Roaring Fork Run	5,000
Bilger Run	1,000	Seese Run	3,000
Black Bear Run	2,000	Shingle Run	2,000
Black Moshanon Creek	3,000	Tub Run	4,000
Cold Creek	2,000	Whitaker Run	2,000
Dayton Run	1,000	York, Conewago Creek	8,000
Forge Run	3,000	Youngdale, McElhattan Run	1,500
Four Mile Run	2,000	Rhode Island:	
Hutton Run	1,000	Greene, Bear Brook	6,000
Huzzard Run	1,000	Bullock Brook	6,000
Little Barker Run	1,000	Cottrell Brook	6,000
		Fall River Brook	6,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Rhode Island—Continued.		South Dakota—Continued.	
Greene, Muddy Brook.....	6,000	Spearfish, Creamery Pond.....	1,000
Providence, Cork Brook.....	4,800	Cress Creek.....	2,000
Roaring Brook.....	6,000	Dedrock Spring Branch.....	1,500
Spruce Brook.....	4,800	Driskill Creek.....	2,000
Tomaquog Brook, East Branch.....	3,600	Ernest Branch.....	2,000
Tomaquog Brook, West Branch.....	4,800	Farmer Jones Creek.....	2,400
South Carolina: Pickens, Surveyors		Higgins Gulch Creek.....	5,000
Camp Creek.....	7,200	Henwood Branch.....	4,500
South Dakota:		Lindley Spring Branch.....	4,800
Custer, French Creek.....	8,000	McGreager Creek.....	7,250
Deadwood, Trucanos Pond.....	1,500	McVeys Creek.....	5,000
Elmore, Hanna Creek.....	3,000	Meadow Creek.....	800
Spearfish Creek.....	6,000	Mill Creek.....	2,000
Englewood, California Gulch Creek.....	1,200	Mordau Creek.....	7,750
Little Spearfish Creek.....	6,000	Oak Spring Creek.....	750
Peak Creek.....	10,000	Oak Spring Pond.....	3,750
Spearfish Creek, South Branch.....	1,200	Owens Creek.....	1,500
Wildcat Gulch Creek.....	3,000	Park Creek.....	2,000
Fairburn, French Creek.....	6,000	Pettigrew Creek.....	2,000
Galena Creek.....	4,000	Red Water Creek.....	18,000
Squaw Creek.....	6,000	Riverview Branch.....	5,000
Hermosa, Iron Creek.....	6,000	Schmidt Creek.....	2,000
Hill City, Battle Creek.....	10,000	Spearfish Creek.....	20,000
Newtons Fork Creek.....	8,000	Stucco Creek.....	3,000
Palmer Gulch Creek.....	6,000	Summers's Pond.....	2,000
Patterson Gulch Creek.....	5,000	Toomey Creek.....	1,000
Spring Creek.....	20,000	Town Creek.....	6,000
Sunday Gulch Creek.....	5,000	Willow Creek.....	4,000
Ice Box Canyon, Spearfish Creek.....	7,200	Sturgis, Bear Butte Creek.....	24,000
Keystone, Battle Creek.....	3,000	Deadman Creek.....	4,000
Nahant, Little Rapid Creek.....	16,000	Tillford, Morris Creek.....	3,500
Tilson Creek.....	7,000	Vetal, Cedar Creek.....	5,000
Nemo, Box Elder Creek.....	30,000	Little White River.....	15,000
Este Creek.....	3,000	Tennessee: Elkmont, Jakes Creek.....	6,750
McCall Creek.....	1,000	Utah:	
Pine Ridge, Porcupine Creek.....	13,500	Burrville, Small Creek.....	2,500
White Clay Creek.....	4,500	Fish Lake, Fish Lake.....	18,500
Wolf Creek.....	2,500	Payson, Payson Creek.....	2,500
Pringle, Beaver Creek.....	29,000	Spring Lake.....	2,500
Rapid City, Antlers Creek.....	1,000	Provo, Provo River.....	26,800
Box Elder Creek.....	6,000	Richfield, Fish Lake.....	13,500
Cedar Creek.....	500	Springville, Hobbie Creek.....	12,000
Cottonwood Creek.....	1,000	Thistle, Thistle Creek.....	2,000
Deer Creek.....	3,000	Vermont:	
Electric Light Pond.....	2,000	Barre, Martin Brook.....	† 2,000
Fairground Lake.....	1,000	Barton, May Pond.....	† 3,000
Indian School Lake.....	1,000	Bennington, Basin Brook.....	† 7,445
Jim Creek.....	3,000	Bates Brook.....	† 6,445
Lime Creek.....	2,000	Battenkill River.....	† 4,000
Lockhart Pond.....	1,000	Bickford Hollow Brook.....	† 7,450
Murray Pond.....	1,000	Burgess Brook.....	† 5,450
Nugget Creek.....	3,000	Bushnell Brook.....	† 5,445
Prairie Creek.....	3,000	Chase Brook.....	† 4,450
Rapid Creek and branches.....	41,650	Dewey Brook.....	† 1,000
Rounds Pond.....	1,000	Duck Pond Brook.....	† 5,450
Schambers Creek.....	1,000	Dunville Brook.....	† 5,445
Schambers Pond.....	1,000	Evans Brook.....	† 4,450
Scotts Pond.....	1,000	Fumace Lake Brook.....	† 5,445
Sickler Pond.....	1,000	Glastenbury Brook.....	† 8,445
Slate Creek.....	4,000	Hatchery Brook.....	† 2,000
Spring Creek.....	6,000	Little Hell Hollow Brook.....	† 6,450
Victoria Creek.....	4,000	North Bennington Pond Brook.....	† 3,000
Rochford, Castle Creek.....	6,000	Perry Thompson Brook.....	† 6,445
Jim Creek.....	3,000	Rake Branch.....	† 3,000
Peterson Pond.....	500	Rider Brook.....	† 7,450
Riley Pond.....	1,000	Rockwood Brook.....	† 5,445
Webber Pond.....	1,500	School Brook.....	† 5,445
Savoy, Little Spearfish Creek.....	4,000	Stratton Brook.....	† 6,450
Nursery Pond.....	19,000	Warm Brook.....	† 8,445
Spearfish, Bill Cook Creek.....	4,000	Webb Brook.....	† 7,450
Bridal Veil Creek.....	8,000	Brattleboro, South Pond.....	1,000
Camp Three Branch.....	2,000	Burlington, applicant.....	* 2,000
Castle Rock Creek.....	5,000	Canaan, Averill Brook.....	† 7,000
Chicken Creek.....	5,000	Big Averill Lake.....	† 4,000
City Creek.....	6,200	Black Brook.....	† 6,000
Coxes Lake.....	3,000	Cole Brook.....	† 8,000
Coxes Lake Creek.....	4,000	East Brook.....	† 9,000
Crago Branch.....	1,500		

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Vermont—Continued.		Vermont—Continued.	
Canaan, Forest Brook.....	†6,500	Morrisville, Darling Brook.....	†2,000
Forest Lake.....	†3,000	Green River.....	†5,000
Lewis Lake.....	†2,000	Hatch Brook.....	†1,500
Little Averill Brook.....	200	Hazen Brook.....	†2,000
Little Averill Lake.....	†6,000	McNall Brook.....	†4,000
Morrill Brook.....	†3,000	Potash Brook.....	†2,000
Norton Lake.....	1,000	Shippy Brook.....	†1,500
Nulhegan River.....	†10,000	Smith Brook.....	†2,000
Number Six Brook.....	†8,000	Terrell Brook.....	†4,000
Roaring Brook.....	†6,500	Newport, Buck Brook (A).....	†2,000
Second Black Brook.....	†5,000	Buck Brook (B).....	†2,000
Swanson Brook.....	†9,000	Center Brook.....	†3,000
Yellow Brook.....	†7,000	Day Brook.....	†2,000
Danville, Joes Brook.....	†5,000	Holton Brook.....	†2,000
Edgewater, Niggerhead Ledge Brook	†2,000	Jud Brook.....	†2,000
Ely, Bannock Brook.....	200	Kidder Brook.....	†2,000
Groton, Darling Pond.....	†50,000	Lang Brook.....	†1,000
Hardwick, Abutment Brook.....	17,426	Larabee Brook.....	†2,000
Bailey Brook.....	†1,000	Orcutt Brook.....	†2,000
Bell Brook.....	†2,000	Papenaw Brook.....	†2,000
Bunker Brook.....	†1,000	Tice Brook.....	†2,000
Collier Brook.....	†2,000	Turtle Pond.....	†2,000
Cold Spring Brook.....	†1,000	Ware Brook.....	†2,000
Cooper Brook.....	†2,000	Watson Brook.....	†2,000
Currier Brook.....	†1,000	Norwich, Lake Mitchell.....	†80,000
Foss Brook.....	†3,000	Orleans, Donaldson Brook.....	†2,000
High Trestle Brook.....	†2,000	Dunham Brook.....	†2,000
Keeler Brook.....	†2,000	Dutton Brook.....	†2,000
Lake Wapanacki.....	†1,000	Gallup Brook.....	†3,000
Lake Wapanacki Brook.....	†1,000	Hannat Brook.....	†2,000
Laundry Brook.....	†1,000	Hog Trough Brook.....	†2,000
Norris Brook.....	†1,000	Irasburg Brook.....	†2,000
Paine Brook.....	†2,000	Joslyn Brook.....	†2,000
Pierce Brook.....	†1,000	Long Pond.....	†6,000
Porter Brook.....	†3,000	Matthews Brook.....	†2,000
Tucker Brook.....	†2,000	Nigger Pond.....	†3,000
Warren Brook.....	†1,000	Parlin Brook.....	†2,000
Holden, Bassett Brook.....	†2,000	Wiggins Brook.....	†2,000
Beaver Brook.....	1,000	Willoughby River.....	†6,000
Billings Brook.....	1,000	Wyman Brook.....	†2,000
Clover Vale Brook.....	†4,000	Pittsford, Johnsons Pond.....	500
Coal Kiln Brook.....	†5,000	Plainfield, Carr Brook.....	†1,000
Coburn Brook.....	†2,500	Kingsbury Brook.....	†2,000
Fitzgerald Brook.....	700	Peacham Pond.....	†5,000
Furnace Brook and branches.....	†22,000	Randolph, Adams Brook.....	†2,000
Horton Brook.....	1,000	Annis Brook.....	†1,500
Ore Bed Brook.....	†2,000	Ayers Brook.....	†3,500
Osgood Brook.....	1,000	Bass Brook.....	300
Randall Brook.....	†2,500	Bear Hill Brook.....	†1,000
Ripley Brook.....	1,000	Beedles Pond.....	†1,300
Sand Spring Brook.....	†3,000	Blanchard Brook.....	†1,000
School House Brook.....	1,000	Bowman Brook.....	†1,500
Spring Lake.....	525	Chandler Brook.....	†2,000
Sugar Hollow Brook.....	†3,000	Clough Brook.....	†2,000
Valley View Brook.....	†2,000	Fishers Brook.....	†1,500
Wardwell Brook.....	1,000	Guild Brook.....	†1,500
Willow Brook.....	†2,000	Gulf Brook.....	†500
Hyde Park, Hyde Pond.....	†1,000	Holman Brook.....	†1,500
Lunenburg, Baker Brook.....	†1,000	Howard Hill Brook.....	†2,000
Mallet Brook.....	†1,000	Mann Brook.....	†1,000
Mink Brook.....	†4,000	Meadow Brook.....	†2,500
Lyndonville, Pond Brook.....	†5,000	Morse Brook.....	†1,000
Manchester, Battenkill River, West		Mud Pond.....	†3,000
Branch.....	†5,000	Pelt Brook.....	†2,000
Manchester Depot, Battenkill River.	†8,000	Poverty Lane Brook.....	†2,000
Boom Pond.....	†5,000	Riford Brook.....	†3,000
Marshfield, Beaver Pond.....	†2,000	Roaring Brook.....	†1,500
Middlesex, Great Brook.....	†3,000	Roods Brook.....	†1,000
Panhandle Brook.....	†2,000	Roxbury Brook.....	†2,000
Morrisville, Billings Brook.....	†5,000	Soper Brook.....	†1,500
Bugbee Brook.....	†2,000	Spears Brook.....	†3,000
Copper Brook.....	†2,000	Taber Brook.....	†1,000
		Roxbury, East Warren Brook.....	1,500
		Mad River.....	2,500
		Stetson Brook.....	1,000
		Rutland, Phalen Brook.....	†2,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Vermont—Continued.		Virginia—Continued.	
Rutland, Wheeler Brook.....	†3,000	Stokesville, Briery Branch.....	3,000
Williams Brook.....	†3,000	Little River.....	3,500
St. Johnsbury, Baron Brook.....	†4,000	North River.....	3,875
Carpenter East Brook.....	†2,000	Sugar Grove, Panther Creek.....	3,000
Carpenter West Brook.....	†2,000	Vienna, Little Difficult Run.....	6,000
Cold Brook.....	†4,000	Troutdale, Big Fox Creek.....	3,000
Gage Brook.....	†6,000	Little Laurel Creek.....	2,000
Hasting Brook.....	†5,000	Mill Creek.....	5,000
Hawkins Brook.....	†7,000	Ripshino Creek.....	1,000
Joes Brook.....	†15,000	Woodstock, Little Stony Creek.....	2,000
Meadow Brook.....	†1,000	Washington:	
Moose River.....	†18,000	Boys, Sherwood Creek.....	350
Parker Pond.....	†3,000	Everett, Martha Lake.....	7,000
Pierce Brook.....	†3,000	Oakville, Cedar Creek.....	7,000
Roberts Brook.....	†3,000	Stevenson, applicant.....	*50,000
Sleepers River.....	†3,000	West Virginia:	
Spaulding Brook.....	†4,000	Alexander, Buchanan River, Left	
Walter Andrick Brook.....	†14,000	Fork.....	15,000
Wright Brook.....	†3,000	Beverly, Files Creek.....	400
St. Johnsbury Center, Richards		Davis, Blackwater Creek.....	11,000
Brook.....	†4,000	Elkins, Cross Run.....	300
King Brook.....	†5,000	Isner Run Laurel Branch.....	300
Sharon, Standing Pond.....	300	Grafton, Wells's Pond.....	800
Sheldon Junction, Adams Pond.....	1,000	Hambleton, Elk Lick Creek.....	3,000
Bakersfield Brook.....	2,000	Otter Creek.....	4,000
Cold Hollow Brook.....	2,000	Roaring Run.....	2,000
County Brook.....	1,000	Hendricks, Otter Creek.....	600
Ladd Trout Brook.....	1,000	Holcomb, Holcomb Run.....	4,000
Mineral Spring Brook.....	1,000	Horton, Gandy Creek.....	8,000
Pat Brady Brook.....	2,000	Lumber, Spruce Run.....	200
St. Johns Brook.....	1,000	Wolf Run.....	200
Stoneville Brook.....	1,000	Marlington, Elk River.....	12,000
South Royalton, Alco Pond.....	†3,000	Midvale, Tygarts River, Middle Fork	125,000
South Ryegate, Balcys Pond.....	†500	Mill Creek, Tygarts Valley River.....	55,400
Long Pond.....	†1,000	Moorefield, Turn Mill Run.....	4,000
Muddy Pond.....	†2,500	Morgantown, Quarry Run.....	9,000
Scott Brook.....	†4,000	Newlon, Buchanan River, tributary	
Wallingford, Maxhams Brook.....	†2,000	of.....	15,000
Roaring Brook.....	†3,000	Parsons, Mill Run.....	300
Wells River, Wells River.....	†10,000	Reedsville, Fields Creek.....	2,000
West Hartford, Meadow Brook.....	†2,000	Richwood, Big Rocky River.....	7,000
Rockland Brook.....	†2,000	Cherry River, North Fork.....	15,000
Williamstown, White River, branch		Cherry River, South Fork.....	15,000
of.....	†2,000	Cold Knob Fork Creek.....	7,000
Woodstock, Beaver Meadow Brook.....	†2,000	Hunters Run.....	7,000
Gallup Brook.....	†2,000	Improvement Run.....	5,000
Kedron Brook.....	†3,000	Little Laurel Creek.....	10,000
North Bridgewater Brook.....	†1,000	Panther Creek.....	15,000
Ottauguechee River.....	†6,000	Sitlington, Sitlington Creek.....	8,000
South Barnard Brook.....	†3,000	Stony Bottom, Woods Run.....	300
South Pomfret Brook.....	†3,000	Terra Alta, Eelseys Run.....	4,000
Virginia:		Thomas, Blackwater River.....	600
Barbours Creek, Barbours Creek.....	1,500	Blackwater River, North Fork.....	3,000
Buena Vista, Chalk Mine Run.....	2,000	Laurel Run.....	1,000
Indian Gap Run.....	1,000	North Branch.....	600
Lowerys Run.....	3,000	Wildell, Greenbrier River.....	7,800
Robinson Branch.....	2,000	Winterburn, Greenbrier River.....	5,000
Buffalo Forge, Belle Cove Creek.....	2,000	Little River.....	5,000
Bylesby, Chestnut Creek.....	3,000	Wisconsin:	
Charlottesville, Buck Mountain		Adams, Duck Creek.....	1,000
Creek.....	6,300	Jackson Creek.....	2,000
East Falls Church, Four Mile Run.....	150	Schoonover Creek.....	1,000
Holmes Run.....	150	Algoma, Black Ash Creek.....	2,000
Elkton, Green Meadow Pond.....	1,000	Alma, Beef Valley Creek.....	2,000
Fairwood, Wilson Creek.....	4,000	Cream Creek.....	2,000
Galax, Goodson Creek.....	3,000	Eagle Creek.....	2,000
Laurel Branch.....	2,000	Johns Creek.....	2,000
Harrisonburg, Dry River.....	3,000	Johns Valley Creek.....	2,000
Hunters, Rocky Run.....	200	Little Waumandee Creek.....	2,000
Lorton, Charles Run.....	400	Norwegian Valley Creek.....	1,000
Mount Solon, Briery Branch.....	625	Waumandee Creek.....	1,000
Natural Bridge, Elk Creek.....	6,000	Wolf Creek.....	1,000
Hell Gate Creek.....	3,000	Antigo, Kennedy Creek.....	1,000
Pearisburg, Sugar Run.....	1,000	Schmitz Creek.....	1,000
Purcelle, Reed Creek.....	6,000	Arcadia, American Valley Creek.....	1,000
Riverside, Stony Creek.....	2,000	Bulls Valley Creek.....	1,000
Snowden, Cashaw Creek.....	2,000	Eagle Valley Creek.....	1,000
Staunton, Ramseys Run.....	7,000	Eagle Valley Creek, North Branch.....	1,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Wisconsin—Continued.		Wisconsin—Continued.	
Arcadia, English Creek.....	1,000	Cumberland, Sand Creek.....	‡3,000
Gilmore Valley Creek.....	1,000	Dodgeville, Brewery Branch.....	800
Haines Creek.....	1,000	Conley Creek.....	800
North Creek.....	3,000	Dodge Branch.....	1,600
Riley Creek.....	1,000	Edmunds Branch.....	1,600
Rohn Valley Creek.....	2,000	Jones Branch.....	800
Spring Creek.....	1,000	Meudt Creek.....	1,600
Spring Valley Creek.....	1,000	Smith Bros. Branch.....	2,400
Thomas Valley Creek.....	1,000	Trehorville Branch.....	3,200
Travis Valley Creek.....	1,000	Yeagers Creek.....	800
Trout Creek.....	1,000	Donaldson, Spring Creek.....	2,500
Wichon Valley Creek.....	1,000	Tamarac Creek.....	3,000
Augusta, Bear Grass Creek.....	580	Eau Claire, Bessie Creek.....	290
Beef River and branches.....	2,900	Clara Creek.....	290
Bridge Creek.....	580	Grace Creek.....	580
Browns Creek.....	290	Sand Creek.....	290
Coon Gut Creek.....	290	Shady Creek.....	580
Hathaway Creek.....	290	Willow Creek.....	290
Hay Creek.....	290	Edmund, Furnace Hollow Creek.....	1,600
Sand Creek.....	290	Spring Valley Creek.....	2,400
Whippoorwill Creek.....	290	Eleva, Adams Creek.....	1,000
Barneveld, Jones Creek.....	2,400	Anderson Creek.....	1,000
Smith Branch.....	2,400	Bemet Valley Creek.....	2,000
Trout Creek.....	3,200	Big Creek.....	2,000
Walnut Hollow Creek.....	4,000	Bollinger Creek.....	1,000
Black River Falls, Douglas Creek.....	1,000	Crystal Creek.....	1,000
Kenyon Creek.....	1,000	Hawkinson Valley Creek.....	1,000
Perry Creek.....	2,000	Haze Valley Creek.....	1,000
Roaring Creek.....	2,000	Hoven Creek.....	1,000
Sand Creek.....	2,000	Lindsay Creek.....	1,000
Slosser Creek.....	1,000	Rosman Creek.....	2,000
Snow Creek.....	1,000	Tollefson Creek.....	1,000
Squaw Creek.....	1,000	Trout Creek.....	1,000
Town Creek.....	1,000	Elk Mound, Beaver Dam Creek.....	290
Trout Creek.....	1,000	Fond du Lac, Dotyville Creek.....	2,000
Blair, Lake Coulee Creek.....	2,000	Eden Creek.....	2,000
Peterson Creek.....	1,000	Gans Creek.....	2,000
Trump Coulee Creek.....	2,000	Hinn Creek.....	1,000
Bloomer, Duncan Creek.....	290	Hobbs Creek.....	1,000
Hay Creek.....	290	Mulvey Creek.....	2,000
McCann Creek.....	290	Rock Creek.....	1,000
Sand Creek.....	290	Stroup Creek.....	1,000
Stevens Creek.....	290	Fountain City, Bohris Valley Creek.....	1,000
Trout Creek, North Fork.....	580	Eagot Valley Creek.....	1,000
Blue Mounds, Austin Creek.....	800	Freid Valley Creek.....	1,000
Camp Creek.....	800	Huber Creek.....	1,000
Garfoot Creek.....	800	Pipers Valley Creek.....	1,000
Walnut Hollow Creek.....	800	Schaffner Valley Creek.....	1,000
Boscobel, Coon Branch.....	1,600	Grand Marsh, White Creek.....	3,000
Brandon, Rock River, tributary of.....	2,000	Grand Rapids, Drainage Creek.....	3,000
Bruce, Alder Creek.....	1,160	Five Mile Creek.....	2,000
Brule, Little Brule River.....	3,000	Harvey Creek.....	2,000
Cashton, Berens Creek.....	1,000	Lynn Creek.....	1,000
Bohemian Creek.....	1,000	Seven Mile Creek.....	2,000
Brush Creek.....	1,000	Spring Branch.....	2,000
Cannon Valley Creek.....	1,000	Two Mile Creek.....	2,000
Coles Valley Creek.....	1,000	Wakely Creek.....	2,000
Hagen Creek.....	1,000	Hatfield, Visnow Creek.....	2,000
Halls Valley Creek.....	1,000	Hawkins, Manning Creek.....	870
Hay Hollow Creek.....	1,000	Skinner Creek, North Fork.....	870
Heiser Creek.....	1,000	Skinner Creek, South Fork.....	870
Houser Creek.....	1,000	Hayward, Mincola Creek.....	‡4,500
Korn Spring Creek.....	1,000	Hazelhurst, Kitty Creek.....	500
Mansky Valley Creek.....	1,000	Rocky Creek.....	2,000
Mashak Creek.....	1,000	Hillsboro, Billings Creek.....	1,000
Morrison Creek.....	1,000	Hortonville, McNutt Creek.....	1,000
Oium Valley Creek.....	1,000	Mill Pond.....	2,000
Panlson Creek.....	1,000	Nordman Creek.....	1,000
Pleasant Valley Creek.....	1,000	Independence, Borst Creek.....	2,000
Russell Valley Creek.....	1,000	Bruce Creek.....	1,000
Timber Valley Creek.....	1,000	Bryn Creek.....	1,000
Twenty Four Mile Creek.....	1,000	Elk Creek.....	2,000
Chippewa Falls, Duncan Creek.....	870	Olson Creek.....	1,000
Paint Creek.....	870	Plumb Creek.....	1,000
Conderay, King Creek.....	1,000	Moskos Creek.....	1,000
Poer Creek.....	1,000	Kilbourn, Gilmore Creek.....	2,000
Weirgor Creek.....	2,000	La Crosse, Burns Valley Creek.....	3,000
Windfall Creek.....	1,000	Mormon Coulee Creek.....	‡36,470

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Wisconsin—Continued.		Wisconsin—Continued.	
Iadysmith, Radger Creek.....	290	Menomonie, Torgerson Creek.....	1,000
Beaver Creek.....	230	Trout Creek.....	1,000
Lone Pine Creek.....	580	Valley View Creek.....	1,000
Spring Creek.....	580	Vance Creek.....	1,000
Laona, Rat River and tributaries.....	3,900	Varney Creek.....	1,000
Mattoon, Wise Creek.....	3,000	Washburn Creek.....	1,000
Menomonie, Adams Creek.....	1,000	Watterson Creek.....	1,000
Anderson Creek.....	1,000	Wilson Creek and tributaries.....	2,000
Annis Creek.....	1,000	Wolf Creek.....	1,000
Asylum Creek.....	1,000	Merrill, Averill Creek.....	2,000
Big Beaver Creek.....	1,000	Barnes Creek.....	2,000
Big Elk Creek.....	1,000	Big Hay Meadow Creek.....	2,000
Big Meadow Creek.....	1,000	Devils Creek.....	2,000
Big Missouri Creek.....	1,000	French Ridge Creek.....	2,000
Big Otter Creek.....	1,000	Johnson Creek.....	2,000
Biss Creek.....	1,000	Little Hay Meadow Creek.....	2,000
Blair Creek.....	1,000	Pat Smith Creek.....	2,000
Bolin Creek.....	1,000	Pine River and tributaries.....	6,000
Bubbling Springs Creek.....	1,000	Prairie Creek.....	2,000
Cady Creek.....	1,000	Millston, Covey Creek.....	1,000
Campbell Creek.....	1,000	Glen Creek.....	1,000
Clacks Creek.....	1,000	Jacobs Creek.....	1,000
Connors Creek.....	1,000	Lambert Creek.....	1,000
Coon Creek.....	1,000	LaPoint Creek.....	1,000
Cranberry Creek.....	1,000	Larkin Creek.....	1,000
Crosby Creek.....	1,000	Mile Creek.....	1,000
Dahl Creek.....	1,000	Patterson Creek.....	1,000
Drowley Creek.....	1,000	Pigeon Creek.....	1,000
Dushane Creek.....	1,000	Pongratz Creek.....	1,000
Eau Galle River.....	1,000	Pump House Creek.....	2,000
Eddy Creek.....	1,000	Robinson Creek.....	2,000
Eighteen Mile Creek.....	1,000	Rocky Creek.....	1,000
Enems Creek.....	2,000	Second Creek.....	1,000
Galloway Creek.....	1,000	Stanton Creek.....	1,000
Gilbert Creek.....	2,000	Wyman Creek.....	2,000
Hall Creek.....	1,000	Minocqua, Davidson Creek.....	500
Hay Creek and tributaries.....	4,000	Howard Creek.....	1,500
Hobbs Creek.....	1,000	Kitty Creek.....	1,500
Honey Creek.....	1,000	Little Tomahawk Creek.....	1,500
Iron Creek.....	1,000	Pine Creek.....	1,500
Irving Creek.....	1,000	Scotchman Creek.....	1,000
Jesse Creek.....	1,000	Shampine Creek.....	1,000
Johns Creek.....	1,000	Three Mile Creek.....	1,000
Johnson Creek.....	2,000	Mount Horeb, Aavang Creek.....	800
King Creek.....	1,000	Bohn Creek.....	3,200
Knights Creek.....	1,000	Dolhantry Creek.....	2,400
Lambs Creek.....	1,000	East Blue Mounds Creek.....	800
Lindsay Creek.....	1,000	East Branch.....	800
Little Beaver Creek.....	1,000	Haakeness Creek.....	2,400
Little Elk Creek.....	1,000	Klevenville Creek.....	1,600
Little Missouri Creek.....	1,000	Lubmann Creek.....	1,600
Little Otter Creek.....	1,000	Mount Horeb Branch.....	1,600
Little Sand Creek.....	1,000	Noon Creek.....	800
Losbys Creek.....	1,000	Springdale Creek.....	2,400
Lynch Creek.....	1,000	Vermont Creek.....	2,400
McCarthy Creek.....	1,000	Muscoda, Byrds Creek.....	1,600
Mares Creek.....	1,000	Coon Creek.....	2,400
Miller Creek.....	1,000	Fox Hollow Creek.....	800
Mud Creek and tributaries.....	3,000	Gault Hollow Creek.....	1,600
Owen Creek.....	1,000	Hoosier Creek.....	2,400
Palmer Creek.....	1,000	Indian Creek.....	800
Parker Creek.....	1,000	Jurgerson Branch.....	800
Pine Creek.....	2,000	Kinsing Creek.....	1,600
Popple Creek.....	1,000	Ludwig Creek.....	2,400
Propper Creek.....	1,000	Sand Creek.....	800
Quader Creek.....	1,000	Shemake Creek.....	800
Quilling Creek.....	1,000	Six Mile Creek.....	2,400
Rock Creek.....	1,000	Studnicka Branch.....	800
Rush Creek.....	1,000	Neenah, Herziger's pond.....	1,000
Sand Creek.....	1,000	New Lisbon, Brewer Creek.....	500
Shaffer Creek.....	1,000	Diller Creek.....	2,000
Simonson Creek.....	2,000	Fountain Creek.....	500
Smith Creek.....	1,000	Little Lemonweir River.....	1,500
Spring Creek.....	1,000	Macomber Creek.....	1,000
Stoner Creek.....	1,000	Meads Creek.....	500
Styer Creek.....	1,000	Richard Creek.....	2,000
Thums Creek.....	1,000	Webster Creek.....	2,000
Tiffany Creek.....	1,000	Norwalk, Roy Creek.....	5,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Wisconsin—Continued.		Wisconsin—Continued.	
Pembiné, Boulder Creek.....	1,500	Tunnel City, Stillwell Creek.....	1,000
Pemeno Creek.....	2,500	Unalaska, Sandy Cooley Creek.....	†76,000
Silver Creek.....	1,500	Warrens, Beltz Creek.....	1,000
Phelps, Muskrat Creek.....	2,000	Castle Rock Creek.....	1,000
Twin Creek.....	1,500	Domply Creek.....	1,000
Plainfield, Ten Mile Creek.....	3,000	Fish Creek.....	2,000
Portage, Prentice Creek.....	4,800	Lowery Creek.....	1,000
Wintergreen Creek.....	4,000	Mill Creek.....	2,000
Prentice, Erick Nelson Creek.....	580	Reed Creek.....	1,000
Hanson Creek.....	580	Sand Creek.....	1,000
Hunziker Creek.....	290	Second Creek.....	1,000
Jump River.....	580	Whiskey Creek.....	1,000
Maulden Creek.....	870	Wyman Creek.....	2,000
Nyeberg Creek.....	580	Wascott, Wascott Creek.....	†3,800
Sandeen Creek.....	580	Waukesha, Capt. Lawrence Creek.....	800
Welch Creek.....	290	Garrett Creek.....	800
Rice Lake, Cobb Creek.....	1,600	Genessee Creek.....	800
Ridgeway, Strutt Creek.....	1,600	Kulitz Creek.....	800
Williams Creek.....	1,600	Memphis Creek.....	800
River Falls, Kinnickinnick River, South Fork.....	580	Pazik Creek.....	800
Sheboygan, Krueger Creek.....	1,000	Rice Creek.....	2,400
Pigeon River and tributaries.....	4,000	Smith Creek.....	800
Sheboygan Falls, Mullet River.....	2,000	Wagner Creek.....	800
Solon Springs, Buckety Creek.....	†1,000	Wright Creek.....	800
Sparta, Ash Creek.....	1,000	Waupaca, Dopp Creek.....	4,000
Farr Creek.....	1,000	Emmons Creek.....	2,000
Ranch Creek.....	1,000	McLean Creek.....	2,000
Squaw Creek.....	2,000	Nicolls Creek.....	1,000
Spring Brook, Godfrey Creek, West Fork.....	†1,000	Pearl Creek.....	2,000
Spring Brook Branch.....	†1,000	Pest House Creek.....	1,000
Superior, Big Balsam Creek.....	†3,000	Radley Creek.....	3,000
Empire Creek.....	†3,000	Robinson Creek.....	1,000
Tigerton, Tiger Creek.....	2,000	Wausau, Black Creek.....	2,000
Tomah, Allen Creek.....	1,000	Four Mile Creek.....	2,000
Ash Creek.....	1,000	Freeman Creek.....	3,000
Bear Creek.....	1,000	Gin Moore Creek.....	2,000
Brandy Creek.....	1,000	Little Rib River.....	2,000
Brush Creek.....	1,000	Little Trap River.....	2,000
Clifton Creek.....	1,000	Pine River.....	3,000
Cole Creek.....	1,000	Pine River, North Branch.....	2,000
Council Creek.....	1,000	Plover River.....	11,000
Council Creek, South Branch.....	1,000	Spring Lake.....	4,000
Deer Creek.....	1,000	Trapp River.....	5,000
Dixon Creek.....	1,000	Westby, Carlson Creek.....	1,000
Jennings Creek.....	1,000	Dickson Creek.....	1,000
La Crosse River.....	1,000	Eggen Creek.....	1,000
La Fleur Creek.....	1,000	Hanson Creek.....	1,000
Mill Creek, North Branch.....	1,000	Holte Creek.....	1,000
Mud Creek.....	1,000	Nelson Creek.....	1,000
Prairie Creek.....	1,000	Peterson Creek.....	1,000
Prairie Farm Creek.....	1,000	Whitehall, Adams Creek.....	1,000
Sand Creek.....	1,000	Breed Creek.....	1,000
Silver Creek.....	1,000	Caswell Creek.....	1,000
Sparta Creek.....	1,000	Cook Creek.....	1,000
Squaw Creek.....	1,000	Couran Creek.....	1,000
Stony Creek.....	1,000	Curran Creek.....	1,000
Swamp Creek.....	1,000	Farr Creek.....	1,000
Tar Creek.....	1,000	Freeman Creek.....	1,000
Tomahawk, Beery Creek.....	500	Harlem Creek.....	1,000
Big Pine Creek and branch.....	2,500	Harnden Creek.....	1,000
Hay Creek.....	1,000	Hensel Creek.....	1,000
Little Pine Creek.....	1,500	Iduna Creek.....	1,000
Meadow Creek.....	1,000	Kidder Creek.....	1,000
Spring Creek.....	500	Lake Creek.....	1,000
Squaw Creek.....	1,000	Libakken Creek.....	1,000
Trout Creek.....	1,500	McKenzie Creek.....	1,000
Trempealeau, Fox Cooley Creek.....	1,000	Pike Creek, East Fork.....	1,000
French Creek.....	1,000	Solsrud Creek.....	1,000
Holcomb Cooley Creek.....	1,000	Taylor Creek.....	1,000
Norway Cooley Creek.....	1,000	Torgerson Creek.....	1,000
Pine Creek.....	1,000	Vold Creek.....	1,000
Tamarac Creek.....	1,000	Webb Creek.....	1,000
Tunnel City, Hackett Creek.....	1,000	Wells Creek.....	1,000
Riches Creek.....	1,000	Wood Creek.....	1,000
Sparta Creek, East Branch.....	1,000	Wilton, Dorset Creek.....	1,000
Spring Bank Creek.....	3,000	Gerkes Creek.....	1,000
		McCanns Creek.....	1,000
		Noths Creek.....	1,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Wisconsin—Continued.		Wyoming—Continued.	
Wilton, Sleighton Creek.....	1,000	Lander, Bear Creek.....	900
Winnepoujou, Bass Lake.....	†1,500	Bull Lake.....	1,800
Brule River.....	†5,000	Crook Creek.....	900
Cedar Island Lake.....	†1,500	Deep Creek.....	900
Cutler Creek.....	†2,000	Dick Creek.....	900
Harts Lake.....	†1,000	Dry Creek.....	900
Long Lake.....	†2,000	Dry Creek Lakes.....	1,800
Loon Lake.....	†1,500	Dunoir Creek.....	900
Lucius Lake.....	†1,500	Farlow Creek.....	900
Nebagamon River.....	†2,500	Horse Creek.....	900
Pierce Lake.....	†1,500	Jakies Fork Creek.....	1,800
Winter, Casey Creek.....	†1,000	Johnson Creek.....	900
Knapp Stout Creek.....	†2,000	Little Warm Spring Creek.....	900
McDonald Creek.....	†1,000	Little Wind River, forks of.....	1,800
Thelan Creek.....	†1,000	Long Creek.....	900
Spring Creek.....	†2,000	Lost Lake.....	900
Wyoming:		McKenney Creek.....	900
Beulah, Davis Pond.....	1,500	Meadow Creek.....	900
Sand Creek.....	5,400	Rock Creek.....	900
South Redwater Creek.....	1,500	Sheep Creek.....	900
Bonneville, Bonneville Lake.....	1,800	Sheridan Creek.....	900
Canyon, Brush Creek.....	20,000	Simpson Lake.....	900
Little Rock Creek.....	20,000	Spring Creek.....	900
Clearmont, Crazy Woman Creek,		Tory Creek.....	900
North Fork.....	750	Tory Lake.....	900
Magdalena Lake.....	750	Willow Creek.....	900
Cody, Aldrich Creek.....	400	Laramie, Brooklyn Lake.....	20,000
Bear Creek.....	600	Deep Lake.....	20,000
Cabin Creek.....	1,050	North Gap Lake.....	17,500
Cambfield Creek.....	700	Towner Lake.....	17,500
Clearwater Creek.....	1,750	Lysite, Railroad Lake.....	600
Deer Creek.....	1,050	Manderson, Medicine Lodge Lake.....	200
Diamond Creek.....	1,050	Paint Rock Creek, North Fork.....	400
Eachle Creek.....	1,750	Solitude Lake.....	600
Goff Creek.....	1,050	Newcastle, Cold Creek.....	4,400
Gooseberry Creek.....	1,750	Powell, Blackwater Creek.....	1,000
Gunbarrel Creek.....	1,050	Bull Creek.....	600
Holly Creek.....	350	Ranchester, Prune Creek.....	450
Houlihan Creek.....	350	Wolf Creek.....	6,000
Jones Creek.....	600	Rock Creek, Rock Creek.....	300
Little Rocky Creek.....	1,050	Sand Creek, Sand Creek.....	2,700
Mormon Creek.....	700	Saratoga, Calf Creek.....	10,000
Newton Creek.....	700	Cedar Creek.....	25,000
Paint Creek.....	700	Continental Creek.....	4,000
Pat O'Hara Creek.....	1,000	Cottonwood Creek.....	25,000
Rattlesnake Creek.....	600	Jack Creek.....	51,000
Rattlesnake Lake.....	1,000	Lake Creek.....	31,000
Red Creek.....	400	Loco Creek.....	25,000
Snyder Creek.....	350	North Platte River.....	72,000
Trail Creek.....	400	Pass Creek.....	57,000
Trout Creek.....	400	Rainbow Creek.....	12,000
Twin Creek.....	400	Sage Creek.....	20,000
Wood River.....	1,000	Spring Creek, forks of.....	56,000
Yellow Creek.....	400	Sheridan, Kemp Creek.....	450
Encampment, Beaver Creek.....	25,000	Shoshoni, Gross Creek.....	900
Big Creek.....	25,000	Sundance, Miller Creek.....	10,000
Cow Creek.....	35,000	Yellowstone, Blacktail Creek.....	10,500
Encampment River.....	30,000	Glen Creek.....	10,500
Salmon Creek.....	50,000	Lava Creek.....	9,000
Spring Fork Creek.....	25,000		
Grey Bull, Shell Creek.....	4,900		
Lander, Atlantic Creek.....	900		
Baldwin Creek.....	1,800		
		Total a.....	* 107,000 † 4,153,050 7,638,615

GRAYLING.

Montana: Meadow Creek, Madison River.....	† 275,000		
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a Exclusive of 13,800 fry and 11,142 fingerlings lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## SMELT.

Disposition.		Number.	Disposition.		Number.
Maine:			New York: Tuxedo, applicant.....		* 3,000,000
Holeb, Unknown Pond.....		† 4,000,000	Total.....		{ * 3,000,000
Otis, Green Lake.....		† 2,437,000			{ † 6,437,000

## PIKE AND PICKEREL.

Arkansas: Black Rock, Black River.....		a 215	Minnesota:		
Illinois:			Homer, Mississippi River.....		a 327,250
Galena, Mississippi River.....		a 115	Red Wing, Mississippi River.....		a 85
Sand Prairie, Mississippi River.....		a 267	Wisconsin:		
Iowa:			Clayton, Mississippi River.....		a 8,700
Bellevue, Mississippi River.....		a 417	La Crosse, Mississippi River.....		a 30,700
Fairport, Mississippi River.....		a 230	Total.....		375,935
North McGregor, Mississippi River.....		a 3,100			
Pleasant Creek, Mississippi River.....		a 148			
Yellow River, Mississippi River.....		a 4,700			

## FRESH-WATER DRUM.

Iowa: Bellevue, Mississippi River.....		a 477
Minnesota: Homer, Mississippi River.....		a 18,500
Total.....		18,975

## CRAPPIE.

Alabama:			Illinois—Continued.		
Alton, Queenstown Lake.....		60	Coulterville, Adams's Pond.....		80
Courtland, Big Nance Creek.....		50	Dallas City, Lake Cooper.....		a 10,775
Arizona: Globe, Roosevelt Lake.....		900	Freeport, Pecatonica River.....		2,550
Arkansas: Alma, Big Clear Creek.....		50	Galena, Mississippi River.....		a 2,173,000
White River, West Fork.....		50	Marshall, Spring Lake.....		200
Arkadelphia, Arnold's Pond.....		22	Meredosia, Illinois River.....		a 33,000
Arnold, Little Red River.....		400	Naperville, Boecker & von Oven Pond.....		200
Lost Creek.....		400	Natural Products Lake.....		500
Meadow Creek.....		400	New Boston, Mississippi River.....		a 48,335
Black Rock, Black River.....		a 8,580	Nora, Fevre River.....		750
Edgemont, Caney Creek.....		300	Orangeville, Richland Creek.....		1,050
Red River, Devales Fork.....		300	Yellow Creek.....		1,125
Red River, North Fork.....		400	Quincy, Spring Lake.....		375
Elba, Hurricane Creek.....		200	Salem, Salem Pond.....		80
Linn Creek.....		300	Sand Prairie, Mississippi River.....		a 1,373,000
Moon Creek.....		200	Scales Mound, Apple River.....		1,500
Red River.....		200	Warren, Apple River.....		1,500
Everton, Anderson Pond.....		100	Winslow, Pecatonica River.....		1,050
Partain, Little Red River.....		600	Indiana:		
Pine Bluff, Hillcrest Lake.....		36	Eddy, Long Lake.....		150
St. Joe, Cave Creek.....		100	Indianapolis, Sugar Creek.....		300
Texarkana, Hogane Lake.....		40	Sellersburg, Belknap Lake.....		300
Zack, Bear Creek.....		300	Warsaw, Little Tippecanoe Lake.....		450
Brush Creek.....		200	Iowa:		
Colorado:			Earlville, Plum Creek.....		400
Pueblo, Club Lakes.....		600	Fairport, Mississippi River.....		a 23,825
Lake Minnequa.....		200	Lime Springs, Upper Iowa River.....		900
Connecticut: Hartford, State fish commission.....		3,600	McDolons Dam, Mississippi River.....		a 40,000
Delaware: Wilmington, Bellvue Pond.....		1,250	Manchester, Maquoketa River.....		13,060
Florida: Lake Wales, Starr Lake.....		330	Mud Hen, Mississippi River.....		a 16,000
Georgia:			North McGregor, Mississippi River.....		a 831,300
Americus, McMath's Pond.....		21	Pleasant Creek, Mississippi River.....		a 316,250
Muckalee Creek.....		42	Smiths Ferry, Mississippi River.....		a 467,000
Crawfordville, Cox Lake.....		3	Waukon, Mississippi River.....		a 8,000
Illinois:			Kansas:		
Anna, Duck Pond.....		20	Edmond, Gresh's Pond.....		200
Apple River, Fevre River.....		750	Edwardsville, Cement Lake.....		300
Aquaunka, Mississippi River.....		a 3,785	Forest Lake.....		500
Blanding, Mississippi River.....		a 180,000	Holtan, Rafter's Pond.....		400
Cairo, Mississippi River.....		a 159,000	Lenora, Spring Pond.....		200
Carrollton, Lake of the Woods.....		60	Parsons, Club Ponds.....		25
			Pittsburg, Country Club Lake.....		100

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## CRAPPIE—Continued.

Disposition.	Number.	Disposition.	Number.
<b>Kentucky:</b>		<b>New Jersey:</b>	
East Cairo, Ohio River.....	a 109,500	Butler, Glen Wild Lake.....	375
Haags Spur, Clear Lake.....	a 25,000	Towaco, Surprise Lake.....	750
Prairie Lake.....	a 6,000	New Mexico: Carlsbad, Tansill Lake..	100
Louisville, Lake Lansdowne.....	375	<b>New York:</b>	
<b>Louisiana:</b>		Albany, State fish commission.....	100
Homer, Shaw's pond.....	40	Clemons, Long Pond.....	150
New Iberia, Iberia Lagoon.....	12	Fishkill, Bennywater Pond.....	300
<b>Maryland:</b>		Brinkerhoff Pond.....	300
Baltimore, Gwynn Oak Lake.....	200	Lockport, Red Creek.....	150
Bethesda, Quarry Pond.....	375	Newburgh, Orange Lake.....	300
College Park, Pasture Pond.....	250	Salisbury Mills Pond.....	300
<b>Massachusetts:</b>		Wurtsboro, Masten Lake.....	150
Berkshire, Sandisfield Lake.....	1,050	<b>North Carolina:</b>	
Concord, Punkatasset Pond.....	150	Angier, Spring Branch.....	200
Lowell, Ames's pond.....	450	Battleboro, Davis's pond.....	200
<b>Michigan:</b>		Bryson City, Tuckaseige River.....	400
Allenville, Brevort Lake.....	300	Burlington, South Piedmont Pond..	200
Channing, Sawyer Lake.....	266	Franklinton, Seven Springs Pond.....	200
Clyde, Round Lake.....	300	Greensboro, Cool Spring Pond.....	300
Crystal Falls, Anderson Lake.....	100	Cunningham Mill Pond.....	300
Fortune Lake.....	100	Hickory, Cliffs Lake.....	200
Railroad Lake.....	33	High Point, Furlough Lake.....	500
Runkle Lake.....	33	Kinston, Jericho Pond.....	400
Stager Lake.....	34	Littleton, Warren Pond.....	500
Upper Holmes Lake.....	100	Marshville, Fairview Pond.....	100
Houghton, Fales Lake.....	100	Pendleton, Stephenson-Skye Mill Pond.....	400
Weber Lake.....	200	Raleigh, Lakewood Pond.....	400
<b>Iron River, Sunset Lake.....</b>	<b>100</b>	Neuseoco Club Lake.....	600
Jackson, Grass Lake.....	590	Rosindale, Clark Mill Pond.....	300
Marquette, Mud Lake.....	34	<b>Oklahoma:</b>	
Northville, Cooley Lake.....	300	Alsama, Grooshart Pond.....	100
Twin Lake, Mid Lake.....	300	Antlers, Locke Lake.....	500
North Lake.....	600	Ardmore, Lake Marie.....	200
<b>Minnesota:</b>		Macks Lake.....	100
Clearbrook, Lindberg Lake.....	142	Primrose Lake.....	400
Duluth, Lake Antoinette.....	160	Carnegie, Stinking Creek.....	600
Fairmont, Amber Lake.....	300	McAlester, M. K. & T. Lake.....	400
Budd Lake.....	300	Madill, City Lake.....	300
George Lake.....	390	Frisco Lake.....	200
Hall Lake.....	300	Lake Pettijohn.....	200
Sisseton Lake.....	300	Marietta, Harvey Brothers Pond.....	100
Homer, Mississippi River.....	a 8,007,225	Marietta Club Lake.....	300
Mankato, Lake Francis.....	200	Peak Pond.....	100
Lake Washington.....	200	Mill Creek, Blue River.....	1,000
Norwood, Eagle Lake.....	400	Pawhuska, Chapman Lake.....	100
Hyde Lake.....	400	Hatt Lake.....	100
Red Wing, Mississippi River.....	a 10,730	Perry, Woodruff Lake.....	400
Sherburn, Fox Lake.....	400	Rock Island, James Lake.....	100
<b>Mississippi:</b>		Spiro, Bowman's pond.....	100
Ashwood, Thompson's pond.....	25	Stillwater, Lowery's pond.....	300
Canton, Lake Kirkwood.....	100	Tulsa, Tribes Lake.....	400
Corinth, Kemper Lake.....	375	Wewoka, George Cooper Pond.....	300
Lake Solitaire.....	40	Wister, Clear Lake.....	300
Friar Point, Mississippi River.....	a 23,069	<b>Pennsylvania:</b>	
Grenada, Riverdale Pond.....	50	Canton, Towanda Creek.....	225
Oxford, Tarver's pond.....	150	Moscow, Foundry Pond.....	150
Woodville, Buckridge Pond.....	50	Krotser Pond.....	150
Lake Clement.....	20	Mud Pond.....	150
Lewis's pond.....	20	<b>South Carolina:</b>	
McGehee's pond.....	20	Batesburg, Strother Pond.....	400
Sessions's pond.....	25	Greenville, Southern Power Pond.....	400
Whitstone's pond.....	50	Leesville, Shealy Pond.....	300
<b>Missouri:</b>		Orangeburg, Edisto River.....	300
Aurora, Flat Creek.....	600	Seneca, Miller's pond.....	100
Carthage, Coolbrook Lake.....	25	<b>South Dakota:</b>	
Diamond, Cedar Lake.....	100	Milbank, Big Stone Lake.....	500
Jonesburg, Ammann Lakes.....	375	Tyndale, Merkel Lake.....	800
Merwin, Corbin Lakes.....	350	<b>Tennessee:</b>	
Monroe City, Hardy's pond.....	125	Covington, Sheltondale Pond.....	250
Pleasant Hill, Schader's pond.....	150	Franklin, West Harpeth River, Murphy Fork.....	45
Sparta, Finley Creek.....	200	Memphis, Stephenson Pond.....	20
West Plains, Lake View.....	400	Nashville, Lake Kewalco.....	261
<b>Montana:</b>		<b>Texas:</b>	
Glendive, Yellowstone River.....	750	Belcherville, Belcherville Lake.....	1,300
Miles City, Yellowstone River.....	750		
<b>Nebraska: Rushville, Big Bend Pond.....</b>	<b>100</b>		

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## CRAPPIE—Continued.

Disposition.	Number.	Disposition.	Number.
Texas—Continued.		Wisconsin—Continued.	
Brenham, Club Lake.....	140	Lake Millicent, Lost Lake.....	71
Lake Henry.....	70	Rocky Lake.....	71
Burton, Watson's pond.....	70	Lavalle, Cazenovia Mill Pond.....	400
Virginia:		Lynxville, Mississippi River.....	a 8,000
Beaver Dam, Beaver Dam Pond.....	200	Manson, Manson Lake.....	160
Cohoke, Mill Creek Pond.....	300	Mason, Bass Lake.....	250
Crewe, Crystal Lake.....	300	Mercer, Trude Lake.....	1,000
Disputanta, Disputanta Pond.....	400	New Auburn, Axe Handle Lake.....	359
Emporia, Jones Pond.....	400	Silver Lake.....	500
Gretna, Fitzgerald's mill pond.....	250	New Richmond, Cedar Lake.....	200
Hanover, Lake Aylett.....	400	Little Round Lake.....	200
Hewlett, Mount Ida Pond.....	100	Lower Pine Lake.....	200
Ivanhoe, Mill Creek.....	625	Middle Pine Lake.....	200
Painter Creek.....	625	Upper Pine Lake.....	200
Kinsale Wharf, School Pond.....	100	Norrie, Kelleys Pond.....	200
Richmond, Jollys Mill Pond.....	200	Lake Go To It.....	200
Lakeside Lake.....	300	Lake Wausau.....	200
Suburban Lake.....	300	Lone Rice Lake.....	200
Stony Creek, Sapponey Creek.....	400	Mayflower Lake.....	200
Suffolk, Lake Savage.....	400	Mud Lake.....	200
Sweet Hall, Custis Lake.....	100	Flowman Lake.....	200
Wytheville, Reed Creek, North Fork.....	500	Road Lake.....	200
Zuni, Darden Lake.....	400	Smith Lake.....	200
Niblett Mill Pond.....	400	Stony Lake.....	200
Wisconsin:		Osseo, Osseo Mill Pond.....	500
Athens, Black Creek.....	300	Prairie du Chien, Mississippi River.....	a 199,300
Blair, Trempealeau River.....	1,000	Reedsburg, Bay View Pond.....	300
Trempealeau River Pond.....	2,000	Gray Pond.....	500
Boyd, Pike Lake.....	300	Lawton's pond.....	500
Yellow River.....	260	Osborne's pond.....	400
Centuria, Deer Lake.....	500	Richfield, Fries Lake.....	200
Chippewa Falls, Glenn Loche Pond.....	300	Solon Springs, Beauregard Lake.....	80
Walters Pond.....	300	Somerset, Bass Lake.....	300
Clayton, Mississippi River.....	a 126,000	Superior, Amnic Lake.....	160
Frenchtown, Mississippi River.....	a 8,000	Lyman Lake.....	80
Gordon, Snider Lake.....	80	Tomah, Water Mill Pond.....	300
Hayward, Calhoun Lake.....	200	Tomahawk, Beaver Lake.....	150
Charlie Lake.....	200	Lake Mabel.....	150
Hallie Lake.....	200	Lily Lake.....	150
Harriett Lake.....	200	Mirror Lake.....	150
Horse Lake.....	200	Somo Lake.....	150
Rice Lake.....	200	Twin Lakes.....	150
La Crosse, Mississippi River.....	a 1,507,800	Eyalusing, Mississippi River.....	a 10,000
Lake Millicent, Five Island Lake.....	71	Mexico: Nacozari, Huacal Dam.....	5,000
Lake Millicent.....	71		
		Total b.....	15,837,865

## LARGEMOUTH BLACK BASS.

Alabama:		Alabama—Continued.	
Alexander City, Foshee Mill Pond Creek.....	† 2,600	Florence, Little Cypress Creek.....	† 6,000
Hillabee Creek.....	† 4,000	Sweetwater Creek.....	† 3,000
Sunny Love's Creek.....	† 2,000	Gantt, Huckaba's pond.....	3,000
Tallahpoosa River.....	† 3,000	Gantt's Junction, Gantt's Quarry Lake.....	† 3,000
Anniston, Blue Pond.....	† 2,000	Geiger, Liars Club Lake.....	{ † 3,000
Hughes Mill Pond.....	† 2,000	Gordo, Kirk's pond.....	450
Rock Creek.....	† 3,000	Grand Bay, Jackson Creek.....	200
Ashland, Jefferson Lake.....	† 2,000	Greensboro, Millwood Pond.....	† 4,500
Atmore, Hurricane Pond.....	250	Greenville, Sirron's pond.....	900
Bayou la Batre, Bayou la Batre.....	{ † 9,000	Grimes, Edwards's pond.....	† 2,000
Carl Creek.....	1,950	Haleyville, Foreshoe Lake.....	† 1,000
Brierfield, Mahan Creek.....	† 2,000	Wilson Lake.....	630
Calvert, Tombigbee River.....	† 6,000	Hartselle, Big Spring Lake.....	200
Decatur, Beaver Lake.....	1,225	Hough Creek Pond.....	† 3,000
Delchamps, East Fowl River, branches of.....	2,090	Heflin, Snake Creek.....	† 3,000
Epes, Maniecc Lake.....	† 13,500	Huntsville, Braham Spring Pond.....	† 2,000
Monette Pond.....	1,000	Kushla, Chickasawogue Creek.....	225
Fayetteville, Cedar Creek.....	1,500	Kushla, Smith's lake.....	† 11,000
Pennywinkle Creek.....	4,000	Loxley, Fish River.....	1,000
Floralia, Lake Jackson.....	3,000	McElderry, Cheaha Creek.....	† 6,000
Miller Pond.....	2,100	Madison, Bradley Pond.....	† 3,000
	700	Bronaugh Pond.....	† 4,500

a Rescued from overflowed lands and restored to original waters.

b Exclusive of 2,462 fingerlings lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Alabama—Continued.		Arkansas—Continued.	
Madison, Burnam Lake .....	† 6,000	El Dorado, Dumas Pond.....	600
Clay Pond .....	† 7,500	Sloan's Lake .....	1,500
Gum Pond .....	† 3,000	Fayetteville, Davidson Lake .....	100
Lanier's pond .....	† 7,500	Gurdon, Rawl's pond .....	300
Willow Pond .....	† 4,500	Hardy, Spring River .....	400
Maide Marion, Moore's lake .....	675	Harrison, Huzzah Creek.....	1,200
Mobile, Bayou Sara .....	† 3,000	Hermitage, Ferguson's pond .....	400
Big Creek .....	2,050	Hope, Allen's pond .....	300
Crichton Pond .....	1,000	Colley Lake .....	900
Deer River.....	† 3,000	Little Rock, Spring Lake .....	600
Hall Mill Creek .....	1,050	Luna, Lake Chicot .....	1,000
Hall Mill Creek .....	† 4,000	Mammoth Spring, Tracey Creek.....	200
Little Creek .....	2,000	Monticello, Wood's lake .....	800
Miller Creek .....	† 4,000	Morrilton, Morrilton Lake .....	400
Nigger Lake .....	1,900	Oil Mill Pond .....	300
Shelt Bayou .....	1,050	Nashville, Orchard View Pond.....	1,500
Montgomery, Cain's pond .....	† 2,000	Paragould, Hill Lake .....	600
Crescent Lake .....	4,000	Readland, Grand Lake .....	2,000
Jordan's pond .....	2,000	Rosboro, Lumber Company Pond .....	600
Mountain Creek, Faulkner Pond .....	2,000	Russellville, Big Piney River .....	600
Taber Pond .....	3,000	Illinois River .....	600
Mount Vernon, Cedar Creek .....	1,500	Illinois River, North Fork .....	600
Mill Creek .....	1,500	Springdale, Lower White River .....	300
Oneonta, Warrior River and branches.....	3,375	South Osage River .....	300
Perdido Station, Johnson's pond .....	100	Walker Lake .....	200
Pine Hill, Sheffield's ponds .....	800	West Brush Creek .....	200
Pleasant Gap, Hurricane Creek .....	† 3,000	Warren, Lucas's pond .....	400
Ramer, Bermuda Lake .....	† 2,000	Salina River .....	500
Riderwood, Lake Choctahana .....	150	Womble, Ouachita River, South Fork .....	600
Russellville, Lake Galeys .....	† 2,000	Colorado:	
Sellers, Findley's pond .....	† 2,000	Colorado Springs, Douglas Lakes.....	500
Sheffield, Lake Wilson .....	1,500	Craig, Yumpa River .....	500
Speigner, Speigner Lake .....	4,000	Greley, Timnath Lake .....	500
Sterrett, Bear Creek .....	2,000	Paonia, Winter's pond .....	120
Kelley Creek .....	4,000	Pueblo, Club Lakes .....	2,100
Sulligent, Northington's pond .....	240	Tabernash, Thompson's pond .....	400
Talladega, Cheaha Creek .....	2,000	Connecticut:	
Choccolocco Creek .....	4,000	Jewett City, Ashland Pond .....	400
Pope Creek .....	1,000	Rockville, Crystal Lake .....	300
Roberson Mill Pond .....	2,000	Snipsie Lake .....	300
Rock Spring Lake .....	3,000	Wallingford, Quonnapaug Lake .....	400
Silver Lake .....	3,000	Delaware:	
Town Creek, Town Creek .....	1,125	Delaware City, St. Georges Creek .....	225
Dinkins's pond .....	3,000	Felton, McCauley Mill Pond .....	150
Northcutt's pond .....	1,350	Frankford, Derickson Creek .....	200
Silver Lake .....	3,350	Laurel, Trussom Pond .....	100
Tyler, Quarles's pond .....	1,000	Wilmington, Hockessin Pond .....	150
Wagar, McClure Mill Pond .....	2,000	Florida:	
Walker Springs, Mason Mill Pond .....	1,650	Defuniak Springs, Buffalo Lake .....	1,400
Winfield, Indian Creek .....	200	Chipley Park Lake .....	7,400
Yellow Pine, Dog River .....	1,500	Lily Pad Lake .....	1,750
Arizona:		Ehren, Lily Pond .....	700
Flagstaff, Mormon Lake .....	240	Fruitland Park, Crystal Lake .....	700
Oak Creek .....	240	Lake Myrtle .....	700
Globe, Pinal Creek .....	200	Gainesville, Cashalton Lake .....	700
Roosevelt Lake .....	5,600	Hague, Layne's pond .....	350
Holbrook, Becker Lake .....	80	Kissimmee, Lake Tohopekaliga .....	2,100
Humboldt, Hooker Lake .....	160	Lady Lake, Lake Dream .....	700
Lukachukai, Lukachukai Lake .....	80	Lake Hermosa .....	700
Tempe, Tempe Drainage Canal .....	200	Park Lake .....	700
Williams, Cataract Ponds .....	320	Sunset Lake .....	350
Winkelman, Meyer's pond .....	100	Mohawk, Mohawk Lake .....	1,070
Arkansas:		Olive, Olive Pond .....	700
Alpena, Long Creek .....	1,600	Pomona, Lake Broward .....	1,750
Arkadelphia, Caddo Creek .....	1,200	Quincy, Dixie Pond .....	700
Atkins, Illinois Bayou .....	600	St. Petersburg, Lake Maggorie .....	1,400
Batesville, Blue Creek .....	600	Stella, Turner's pond .....	1,050
Ruddell Lake .....	600	Walden Spring Branch .....	700
Berryville, Kings River .....	1,600	Tallahassee, Wards Mill Pond .....	1,400
Black Rock, Black River .....	† 725	Tampa, Manro Lake .....	1,400
Canway, Golds Lake .....	400	Windemere, Lake Butler .....	1,400
Owen Lake .....	1,000	Lake Tobet .....	1,400
Corning, Black River .....	800	Georgia:	
Corning Lake .....	800	Albany, Kinchafonnee Creek .....	† 5,000
Cotter, White River.....	† 2,000	Muckalee Creek .....	† 5,000
	800	Americus, Muckaloochee Creek .....	† 5,000
		Ashburn, Tharpe's pond.....	350

† Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Georgia—Continued.		Illinois—Continued.	
Atlanta, East Lake.....	6,000	Nora, Fevre River.....	200
Augusta, Carmichael Pond.....	4,000	Sand Prairie, Mississippi River.....	a 20,200
Old Brad Merry Mill Pond.....	3,000	Sciota, Yellow Creek.....	160
Bainbridge, Lake Carlford.....	700	Shawneetown, Wimbo Lake.....	200
Lake Douglas.....	1,050	Warren, Fevre River.....	600
Boston, McRao Lake.....	700	Indiana:	
Bowman, Campbell Mill Pond.....	2,000	Albion, Neuffer's pond.....	225
Box Springs, Lake Mohigniac.....	† 3,000	Angola, Crooked Lake.....	375
Byron, Crawford Lake.....	3,000	Bluffton, Old Erie Stone Quarry	
Canton, Johnson's pond.....	1,000	Pond.....	200
Cartersville, Euharlee Creek.....	1,250	Wabash River.....	500
Chula, Cypress Pond.....	1,400	Bremen, Lake of the Woods.....	375
Clarkston, Sam's pond.....	1,000	Corydon, Elm Lake.....	80
Comer, Gholston's pond.....	2,000	Corydon Junction, Buck Creek.....	240
Crawfordsville, Little River, North		Hartman's pond.....	80
Prong.....	2,000	Quebbeman Lake.....	80
Douglas, Vickers's pond.....	1,050	Culver, Lake Maxinkuckee.....	1,200
Fairfax, Satilla River.....	1,400	Eddy, Atwood Lake.....	300
Griffin, Lake Rushton.....	† 2,000	Hackenberg Lake.....	300
Kibbee, Black Pond.....	3,000	Meesic Lake.....	300
Kite, Meeks's pond.....	1,000	Whitmer Lake.....	400
La Grange, Lazylands Lake.....	3,000	Elkhart, Boston Lake.....	500
Leary, Daniel's pond.....	700	Hillsboro, Coal Creek.....	60
Lithonia, Watson's pond.....	2,000	Hobbs, Carr's pond.....	70
Lumpkin, Deason Lake.....	† 2,000	Huntingburg, Ferdinand Lake.....	120
Geeslin Pond.....	† 2,000	Indianapolis, Little Eagle Creek.....	125
Ray Pond.....	† 2,000	White River.....	175
Macon, Haleyon Lake.....	† 4,000	Kendallville, Long Lake.....	400
Nelson Mill Pond.....	† 3,000	Logansport, Binns's pond.....	
Riggins Mill Pond.....	† 3,000	Brandt's pond.....	90
Willow Lake.....	† 3,000	Pipe Creek.....	150
Marietta, Goli Club Lake.....	1,500	Lynn, Clark's pond.....	200
Marshallville, Haslam's pond.....	4,000	Michigan City, Tec Lake.....	450
Millen, Buckhead Creek.....	3,000	Mill Creek, Fish Lake.....	575
Millhaven, Brier Creek.....	4,900	Muncie, South Lagoon.....	300
Montezuma, Lewis Mill Pond.....	4,000	New Albany, Indian Creek.....	240
Mount Vernon, Palmer's pond.....	3,000	Oak Knoll Pond.....	80
Newman, Wynn's pond.....	† 3,000	Paoli, Lick Creek.....	150
Nunez, Ohoopoe River.....	6,000	Log Creek.....	60
Oglethorpe, English Pond.....	3,000	Pierceton, Webster Lake.....	160
Poulan, Chapman's pond.....	350	Pittsboro, White Lick Creek, Middle	
Clements's pond.....	700	Fork.....	80
Raymond, Raymond Lake.....	† 4,000	Ramsey, Crystal Pond.....	80
Rome, Dykes Creek.....	1,500	Rochester, Dudgeon's pond.....	400
Dykes Creek, West Fork.....	1,500	Shelbyville, Flat Rock River.....	240
Sharpsburg, Pitman's pond.....	† 1,000	Terro Haute, Greenfield Bayou.....	180
Soperton, Henry's pond.....	2,000	Valparaiso, Wahob Lake.....	220
Stillmore, Durden's pond.....	2,000	Veedersburg, Coal Creek.....	100
The Rock, Stafford's pond.....	† 3,000	Warsaw, Tippecanoe Lake.....	200
Valdosta, Lake Spurlin.....	700	White Pigeon, Stone Lake.....	300
Woodland, Flint River.....	4,000	Wilkinson, Perry Lake.....	40
Illinois:		Iowa:	
Alpha, Crescent Lake.....	210	Bellevue, Mississippi River.....	a 715
Antioch, Huntley Lake.....	160	Creston, Summit Lake.....	420
Apple River, Fevre River.....	200	Earlville, Plum Creek.....	150
Aquaka, Mississippi River.....	a 195	Fairport, Mississippi River.....	a 5,516
Blanding, Mississippi River.....	a 2,300	Harpers Ferry, Mississippi River.....	a 2,625
Brighton, Stubblefield's pond.....	100	Le Mars, Dalton Pond.....	100
Carrollton, Walnut Lake.....	250	Lime Springs, Upper Iowa River.....	5,400
Colfax, Gillam's pond.....	50	Manchester, Maquoketa River.....	400
Coulterville, Illinois Central Lake.....	250	Mason City, Lime Creek.....	150
Council Hill, Fevre River.....	200	North McGregor, Mississippi River.....	a 1,300
Dallas City, Lake Cooper.....	a 820	Ottumwa, Loch Burns Pond.....	270
Deatur, Club Lake.....	575	Pleasant Creek, Mississippi River.....	a 2,350
Freeport, Richland Creek.....	80	Smiths Ferry, Mississippi River.....	a 950
Galena, Mississippi River.....	a 7,297	Kansas:	
Grayslake, Huntley Lake.....	160	Caney, Havanna Country Club Lake.....	400
Hudgens, Hudgens Lake.....	250	Chanute, Shadow Lawn Pond.....	300
McCormell, Pecatonica River.....	40	Kincaid, Grindstone Lake.....	225
Meredosia, Illinois River.....	a 6,000	Silver Spring Lake.....	225
Moline, Lake Ivo.....	90	Olathe, Twin Lakes.....	300
Naperville, Du Page River.....	220	Parsons, Club Ponds.....	25
Natural Products Lake.....	150	Pittsburg, Country Club Lake.....	400
New Boston, Mississippi River.....	a 2,660	Quinter, Saline River.....	500

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
<b>Kentucky:</b>		<b>Massachusetts:</b>	
Baskett, Baskett Lake.....	150	Edgartown, Edgartown Great Pond.....	500
Bowling Green, Morris's pond.....	90	Lowell, Concord River.....	65
Bristow, Gott's pond.....	160	Flushing Pond.....	130
Hays's pond.....	240	Hart Pond.....	130
Campbellsville, Pitman Creek.....	320	Merrimac River.....	130
Cave City, Ford's pond.....	160	Nabasset Pond.....	130
Covington, Michels Pond.....	160	Newfield Pond.....	130
Crab Orchard, Clearwater Lake.....	70	Tyngs Pond.....	130
Daniel Boone, Boone Lake.....	60	<b>Michigan:</b>	
East Cairo, Ohio River.....	a 100	Baraga, Springwater Lake.....	200
Edgote, Ingleside Lake.....	250	Bergland, Lake Gogebic.....	300
Eminence, Sanford's pond.....	70	Brighton, Woodruff Lake.....	225
Eubank, Caney Creek.....	160	Bruce Crossing, Spring Lake.....	200
Fulton, Fall's pond.....	150	Calumet, Rice Lake.....	200
Guthrie, Meadow Grove Pond.....	150	Caspian, Chicagoan Lake.....	150
Spring Creek.....	150	Champion, Fish Lake.....	200
Herndon, Smith's pond.....	200	Lake Michigamme.....	300
Hodgenville, Beams's pond.....	80	Comins, Pond Lake.....	300
Nolin River, South Fork.....	240	Crystal Falls, Fortune Lake.....	100
Horse Cave, Taylor's pond.....	80	Holmes Lake.....	100
Vanceve's pond.....	80	Lower Holmes Lake.....	100
Louisville, Douglas Park Lake.....	105	Paint River.....	100
Lake Lansdowne.....	70	Railroad Lake.....	100
Morganfield, Robertson Pond.....	60	Silver Lake.....	100
Mt. Sterling, Karrick's pond.....	80	Swan Lake.....	100
Munfordville, Wood's pond.....	450	Tobin Lake.....	100
Petroleum, Big Trammell Creek.....	300	Dunham, Lake Celeste.....	200
Richmond, Lake Reba.....	240	East Tawas, Sand Lake.....	375
Shelbyville, Bullsken Creek.....	105	Gwinn, Bass Lake.....	100
Clear Creek.....	105	Houghton, Elm River Lake.....	200
Somerseset, Meece's pond.....	80	Lake Eva.....	300
South Park, South Park Lake.....	700	Lake Gerald.....	200
Trenton, Chiles Pond.....	200	Snake River.....	200
Crutchfield's pond.....	200	Iron Mountain, Powder Lake.....	200
Mc Elwain's pond.....	200	Iron River, Iron Lake.....	150
Maplewood Pond.....	200	Morrison Lake.....	75
Riley's pond.....	200	Round Lake.....	150
Wright's pond.....	200	Keweenaw Bay, Mud Lake.....	200
Pine Grove, Weymeth Lake.....	120	Lake Rowland, Lake Rowland.....	200
<b>Louisiana:</b>		Little Lake, Little Lake.....	300
Ashland, Drigger's pond.....	12,000	Low Moor, Forbs Lake.....	100
Abbeville, Vermillion River.....	1,250	Horseshoe Lake.....	200
Eunice, Gourney Lake.....	17,000	Klippells Lake.....	100
Goldoma, Harlan's pond.....	13,000	Lake Lowery.....	200
Iota, Hayes Lake.....	15,000	Palmer Lake.....	100
Lejeune Pond.....	1,250	Wolf Lake.....	100
LaFayette, Francez's pond.....	1,800	Marquette, Lake Van Iderstine.....	500
Lake Charles, Perkins's pond.....	1,250	Mass, Courtney Lake.....	200
Mansfield, Wemple's pond.....	21	Michiganame, Gibson Lake.....	200
Peason, Peavy Wilson Lake.....	13,000	Lake Michigamme.....	300
Urania, Lake Urania.....	14,000	Munising, Annie River.....	800
Wisner, Pennebaker's pond.....	140	Negaunee, Horseshoe Lake.....	100
<b>Maryland:</b>		Perch Lake.....	100
Antietam, Potomac River.....	400	Teal Lake.....	100
Baltimore, Gwynn Oak Lake.....	60	Painesdale, Stonington Lake.....	200
Lake Kukhills.....	120	Pentoga, Chicagoan Lake.....	200
Cambridge, Blackwater River.....	150	Indian Lake.....	300
Chicacoquic River.....	150	Republic, Allens Lake.....	100
Transquaking River.....	150	K. C. Lake.....	100
Catoctin, Potomac River.....	100	Laxstrom Lake.....	100
Cumberland, Potomac River.....	490	Michigamme River.....	100
Potomac River, North Branch.....	650	Porterfield Lake.....	200
East New Market, Smith's pond.....	150	Spruce Creek.....	100
Geiges, Youghiogheny River.....	400	Romeo, Cusic Lake.....	450
Glendale, Folly Run.....	400	Rose Center, Munger Lake.....	150
Hyattsville, School House Pond.....	180	Rose City, Wagner Lake.....	300
Lansdowne, Lugenbeel's pond.....	200	Sand River, Lake Lillie.....	200
Linkwood, Higgins Mill Pond.....	150	South Range, Otter Lake.....	200
Popes Creek, Power House Pond.....	400	Stager, Little Tobin Lake.....	200
Queen Anne, Moores Mill Pond.....	200	Round Lake.....	100
Robinson, Magothy River.....	300	Stager Lake.....	200
Taneytown, Big Pipe Creek.....	200	State Line, Moon Lake.....	100
Timonium, Spring Run.....	400	Toivala, Lake Eva.....	200
Trappe, Wrights Mill Pond.....	200	Trout Lake, Carp Lake.....	200
Worton, Montabello Lake.....	200	Watersmeet, Lake Cisco.....	1,100

a Rescued from over flowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Michigan—Continued.		Mississippi—Continued.	
Wellsburg, Avery Lake	200	Columbus, Byler Lake	†3,000
Soldiers Lake	200	Harvey Lake	†3,000
Minnesota:		Corinth, East Lake	450
Barnesville, Nyeng Lake	300	Hinton Lake	†4,500
Solum Lake	400	Lamberth's pond	†3,000
Bernum, Big Lake	100	Cotton Plant, Guyton's pond	†2,000
Hanging Horn Lake	100	Crystal Springs, Goodwin's pond	675
Biwabik, Bass Lake	400	D <sup>o</sup> Lo, Finkbine Log Pond	375
Carlton, Chub Lake	100	Fayette, Carother's pond	250
Chatfield, Root River, North Branch	750	Friar Point, Mississippi River	<sup>a</sup> 22,005
Chaska, Pierson Lake	115	Moon Lake	500
Chisholm, Dewey Lake	400	Fulcher, Snow's pond	200
Perch Lake	300	Guntown, Gum Pond	†3,000
Sturgeon Lake	300	Hattiesburg, Ogden Mill Pond	600
Clearbrook, Johnson Lake	80	Hazlehurst, Lake Hazle	625
Cokato, Skipstrom Lake	500	Helm, Helm's pond	250
Cologne, Miller Lake	390	High Point, Dempsey's pond	†2,000
Cottonwood, Cottonwood Lake	140	Hillsdale, Batson's pond	1,950
Duluth, Deep Water Lake	80	Holly Springs, Dunlap-Williams Ponds	1,500
Little Beaver Creek, branch of Pike Lake	100 80	Jackson, Croom Pond	250
Fairmont, Amber Lake	300	Gary's pond	450
Budd Lake	300	Hall's pond	900
Clear Lake	300	Ratliff's pond	200
George Lake	300	Kosciusko, Bailey Lake	705
Hall Lake	300	Eastman-Gardiner Pond	†4,000
Sisseton Lake	300	Long Pond	470
Wilmert Lake	300	Louisville, Fulton Pond	400
Fergus Falls, Forfoot Lake	400	Louisville Club Lake	800
Wenstrom Lake	300	McCool, Smith Spring Pond	705
Gilbert, Cedar Island Lake	300	Macon, Club Lake	†7,000
Hackensack, Little Whitefish Lake	902	Curler's pond	†1,600
Herman, Bernice Lake	300	Thompson's pond	†3,000
Holdingford, Lake Marie	120	Magnolia, Minnehaha Creek	†3,000
Home, Mississippi River	<sup>a</sup> 92, 120	Tangipahoa River	†7,500
Knife River, Harriet Lake	150	Meridian, Waterworks Lake	450
Tettegouche Lake	150	Mobile, Franklin Creek	†4,000
Le Roy, Upper Iowa River	150	Natchez, Sligo Pond	400
Lindstrom, Little Lake	500	Springfield Pond	200
Mankato, Lake Francis	750	New Albany, Bias's pond	1,000
Lake Washington	750	Branyan's pond	500
Mazepa, Mazepa Power Lake	535	File's pond	†2,000
Rochester Power Lake	535	Hall's pond	600
Zumbro River	625	Parker's pond	115
Zumbro River, North Branch	535	Potts Pond	†2,000
Miroc, Riley Lake	500	Robbins's pond (A)	400
Morris, Crooked Lake	225	Robbins's pond (B)	600
Pine River, Crooked Lake	125	Robbins's pond (C)	800
Red Wing, Mississippi River	<sup>a</sup> 430	Pachuta, Ohalti Lake	†9,000
Rochester, Zumbro Lake	440	Pecan, Franklin Creek	†3,000
Zumbro River	440	Goode Mill Lake	†3,000
Rosemount, Lake George	313	Pelahatchee, Clear Branch Pond	†1,600
Rutledge, Long Lake	100	Pheba, Bridges Mill Pond	1,000
St. Cloud, Block Lake	125	Lee's pond	500
St. Paul, Mississippi River	400	Loyd Pond	400
State fish commission	6,500	Old Rife Pond	1,000
Sherburn, Fox Lake	300	Picayune, East Hobolochitto Creek	†6,000
Tamarack, Round Lake	80	Tate's lake	†2,000
Trail, Halverson Lake	120	Plantersville, Park Lake	†2,100
Victoria, Auburn Lake	120	Red Oak Lake	450
Winona, Lake Winona	22	Pontotoc, Ferguson's pond	675
Wright, Ox Eye Lake	80	Highland Pond	200
Mississippi:		Mable Lake	450
Abcdeen, Burk Gallop Pond	675	Moss Pond	†2,000
Jones Lake	†3,000	Orchard Lake	675
Jones's pond	†3,000	Ridgeway Lake	†2,000
Smith's lake	†3,000	Port Gibson, Gage Pond	450
Armory, Gallop's pond	450	Woodburn Lake	400
Bay Springs, Yelverton's pond	†1,000	Richton, Smith's pond	†2,000
Blue Springs, Hall's pond	500	Saucier, Hester Creek	1,200
Canton, Big Lake	705	Scoba, Trammell's pond	200
Blackton's pond	†6,000	Scott, Lake Bolivar	450
Carbado's pond	†6,000	Starkville, Pearsons Caldwell Pond	200
Cedar Bluff, Cottonwood Pond	600	Stephenson, Foster Creek Mill Pond	625
Chunky, Moore's pond	450	Sturgis, Daniel Lake	†3,000
Collins, Beauty Pond	†3,000	Parker Slough	†7,500
McQueene's pond	†3,000		

<sup>a</sup> Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Mississippi—Continued.		New Mexico—Continued.	
Sumner, Stephen's pond.....	750	Onava, Five Lakes.....	160
Tibbee Station, Scuppermong Farm Pond.....	800	Raton, Barilla Mesa Lake.....	80
Utica, Oak Grove Lake.....	400	Brannan Lake.....	40
Wortham, Lee's pond.....	200	Davis Lake.....	40
Missouri:		Eagle Nest Lake.....	40
Brashear, Quinn's pond.....	90	Roswell, Penasco River.....	200
Cabool, Arthur Creek.....	90	Round Lake.....	200
Big Creek.....	90	Santa Rosa, Storage Lake.....	300
Brushy Creek.....	90	Springer, Reservoir No. 2.....	320
Elk Creek.....	90	New York:	
Little Indian Creek.....	175	Albany, Nassau Lake.....	600
Little Piney Creek.....	39	Binghamton, Susquehanna River.....	500
Carthage, Coolbrook Lake.....	25	Cattaraugus, Clear Pond.....	100
Cedar Gap, Cedar Gap Lake.....	120	Corinth, Efner Lake.....	150
Deepwater, Club Lake.....	300	Cornwall, Popolo Lake.....	300
Houston, Big Piney River.....	200	Davenport Center, Sherman Lake.....	200
Indian Creek.....	50	Elmira, Chemung River.....	500
Joplin, Arrowhead Lake.....	2,000	Hamilton, Woodman Pond.....	400
Moore's pond.....	25	Lyons, Canandaigua Creek.....	300
Thomas Lakes.....	100	Canargua Creek.....	300
Kansas City, Fairmont Lake.....	500	Montour Falls, Catherine Creek.....	300
Lebanon, Ballinger Pond.....	400	Mount Kisco, Wood's pond.....	200
Liberty, Urban Lake.....	400	Mount Vision, Gregory's pond.....	100
Little Blue, Dicrks Lake.....	300	Newark, Canandaigua Creek.....	300
Merwin, Corbin Lake.....	600	Coffey Lake.....	300
Neosho, Hickory Creek.....	112	North Carolina:	
Nevada, Radio Springs Lakes.....	500	Aberdeen, Marie Pond.....	2,000
Oasis, Fish Lake.....	150	Sand Hill Lake.....	3,000
Phillips, McMenus's pond.....	100	Ashboro, City Pond.....	400
Pleasant Hill, Baldwin Lake.....	200	Bayboro, Bay River.....	†400
Rolla, Little Piney River.....	300	Bostic, Rocky Broad River.....	450
Saginaw, Walker Lake.....	50	Burlington, Dickey's pond.....	1,500
Springfield, Kunzman's pond.....	50	Sartin Mill Pond.....	1,500
West Plains, Lake View.....	50	Old Willow Brook Pond.....	1,500
Montana:		Silver Lake.....	1,500
Glendive, Yellowstone River.....	245	Stinking Quarter Pond.....	1,400
Miles City, Yellowstone River.....	455	Walkers Pond.....	1,400
Nebraska:		Calypso, Sutton's pond.....	200
Glan, Meadow Brook Lake.....	300	Cary, Holleman's pond.....	200
Rushville, Davis's pond.....	200	Charlotte, Catawba River.....	1,750
Nevada: Fallon, Cottonwood Canon Run.....	150	Clinton, Great Coharie Creek.....	120
New Hampshire:		Six Runs.....	120
Newport, Crystal Lake.....	150	Corinth, Yarborough's pond.....	†400
Ledge Pond.....	150	Dunn, Jernigan's pond.....	400
Rockybound Pond.....	150	Smith Mill Pond.....	600
New Jersey:		Durham, Angier Pond.....	300
Asbury Park, Kisner Mill Pond.....	200	Caroenter Pond.....	275
Butler, Butler Lake.....	80	Wilbon Pond.....	300
Cold Spring Lake.....	80	Elkin, Carter Falls Pond.....	200
Echo Lake.....	80	Elkin River.....	225
Kampfe Lake.....	150	Ellerbe, Howell's pond.....	2,000
Mud Pond.....	80	Quick's pond.....	2,000
Wittack Lake.....	80	Fayetteville, Morrison's pond.....	400
Cedar Crest, Cedar Crest Lake.....	200	Flat Rock, King's pond.....	2,000
Chatsworth, Cranberry Lake.....	200	Ottaray Lake.....	3,000
Elberon, Poplar Brook Lake.....	200	Smythe's pond.....	†4,000
Gibbstown, Repaupa Creek.....	225	Graham, Pine Hill Pond.....	600
Towaco, Surprise Lake.....	500	Thompson Pond.....	100
New Mexico:		Greensboro, Revolution Pond.....	3,300
Aztec, Animas River.....	120	Seminole Pond.....	4,100
Carlsbad, Black River.....	200	Havelock, East Creek.....	1,350
Pecos River.....	200	Hendersonville, Bane's pond.....	100
Tansill Lake.....	200	Few's pond.....	300
Colmar, Valdez Lake.....	80	Hayne's pond.....	500
Cutter, Elephant Butte Lake.....	210	Maybank's pond.....	300
Lake B. M. Hall.....	210	Scheppergrell's pond.....	300
Gallup, Ramah Lake.....	160	Vincent's ponds.....	300
Las Vegas, Horse Lake.....	16	Hickory, Catawba River, Henrys Fork.....	100
Laguna Secunda.....	60	Catawba River, Jacobs Fork.....	100
LaQuesa Grande Lake.....	16	High Point, Walnut Branch Pond.....	600
Little Lake.....	16	Kinston, Jericho Pond.....	400
Organ Lake.....	160	Knightdale, Mill Pond.....	400
Pecos Bridge Lake.....	80	Lenoir, Buffalo Creek.....	100
Round Lake.....	16	Marble, Hyatts Creek.....	3,000
Magdalena, V. T. Lake.....	100	Valley River.....	3,000
Monero, Horse Lake.....	300	Marion, Big Buck Creek.....	100
Nara, Curio Lake.....	100	Brown Mill Pond.....	100
		Catawba River.....	100

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
North Carolina—Continued.		Ohio—Continued.	
Marion, Little Buck Creek.....	100	Fostoria, Lake Adams.....	300
Loftie Mill Pond.....	100	Galion, Sandusky River.....	625
Morgan's pond.....	100	Geneva, Grand River.....	225
Marshville, Austin's pond.....	700	Greenfield, Buckskin Creek.....	300
Lanes Creek.....	450	Paint Creek.....	1,300
Simpson's pond.....	1,400	Rattlesnake Creek.....	600
Mount Airy, Minnick's pond.....	3,400	Rocky Fork Creek.....	700
New Bern, Brices Creek.....	900	Leontonia, Independent Eagle Lake.....	375
Neuse River.....	1,100	Lemoyne, Quarry Pond.....	200
Trent River.....	1,100	Rockland Pond.....	200
Newport, Lake Oxley.....	† 200	Luke Chute, Muskingum River.....	1,000
Newton, Pinchut Creek Pond.....	200	Lyndon, Buckskin Creek.....	375
Norlina, Watson's pond.....	200	Malta, Muskingum River.....	1,000
Princeton, Holt's pond.....	600	Mansfield, Walker Lake.....	300
Rae ford, Beaverdam Pond.....	400	Marietta, Duck Creek.....	1,250
Raleigh, Boone's pond.....	400	Mentor, Ice Pond.....	75
Doctors Lake (A).....	400	Millersburg, Douty Creek.....	150
Doctors Lake (B).....	400	Killbuck River.....	225
Neusocco Club Lake.....	600	Paint Creek.....	150
Randleman, Bullrun Pond.....	200	Nelsonville, Hocking River.....	625
Richfield, Morgan's pond.....	100	New Concord, Muskingum River.....	1,000
Salisbury, Graf's pond.....	100	Oakwood, Auglaize River.....	400
Samarcand, Drowning Creek.....	4,000	St. Marys, Auglaize River.....	300
Lake Tamarlane.....	2,000	Holls Pond.....	300
Shulls Mills, Watauga River.....	1,700	Lake St. Marys.....	500
Smithfield, Holts Lake.....	1,300	St. Marys River.....	300
Stokesdale, Enoch's pond.....	300	Salem, Pigeon Pond.....	150
Sylvia, Cullowhee Creek.....	2,000	Sebring, Westville Lake.....	375
Scott Creek.....	2,000	Sidney, Tawana Creek.....	400
Tuckaseegee River.....	5,000	Turtle Creek.....	300
Tuckaseegee River, Left Fork.....	3,000	Warsaw Junction, Walhonding River.....	400
Tuckaseegee River, Right Fork.....	3,000	Wellington, Waterworks Pond.....	375
Tarboro, Fishing Creek.....	400	West Milton, Stillwater River.....	875
Lake Parks.....	400	Woodfield, Waterworks Pond.....	1,000
Tar River.....	400	Xenia, Anderson Fork Creek.....	400
Warren Plains, Dillard's pond.....	† 200	Caesars Creek.....	400
Tharrington's pond.....	† 200	Little Miami River.....	400
Washington, Broad Creek.....	600	Oklahoma:	
Chocowinity Bay.....	600	Alauma, Grooshart Lake.....	40
Chocowinity Creek.....	600	Antlers, Locke Lake.....	40
Respass Mill Pond.....	600	Ardmore, Lake Marie.....	25
Upper Broad Creek.....	600	Macks Lake.....	25
Winston-Salem, Ariston Pond.....	2,800	Enid, Clear Creek.....	375
Woodside, Lake Lilly.....	† 200	Erick, Gillum's pond.....	300
Youngsville, Moores Pond.....	† 400	Haddock's pond.....	300
North Dakota:		Guthrie, Fairview Pond.....	200
Dazey, Ensign Lake.....	120	Helena, Indian Pond.....	150
Douglas, Nelson-Darson Lake.....	160	Unruh's pond.....	225
Tangedahl Lake.....	120	Ketchum, Duck Creek.....	2,000
Forman, Lake Tjor.....	160	Kingfisher, Uncle Johns Creek.....	375
Lake Williams, Lake Williams.....	160	McAlester, M., K. & T. Lake.....	115
Mercer, Brush Lake.....	240	Madill, City Lake.....	40
Petrol, City Lake.....	72	Frisco Lake.....	40
Spring Lake.....	90	Lake Pettijohn.....	40
Valley City, Moon Lake.....	240	Mangum, Cave Creek.....	500
Winner, Dog Ear Lake.....	125	Marietta, Club Lake.....	25
Ohio:		Harvey Brothers Pond.....	25
Akron, East Lake.....	150	Peak Pond.....	25
Long Lake.....	150	Mexhoma, East Water Hole Pond.....	160
Nesmith Lake.....	150	Mill Creek, Blue River.....	75
Rex Lake.....	150	Newkirk, Country Club Lake.....	375
West Lake.....	150	Oklahoma City, Players Lake.....	200
Alliance, Westville Lake.....	375	State fish commission.....	3,600
Antwerp, Maumee River.....	500	Pauls Valley, Liberty Lake.....	400
Bedford, Tinkers Creek.....	150	Pawhuska, Chapman Lake.....	25
Berea, Diamond Lake.....	500	Hatt Lake.....	25
Lake Abram.....	500	Perry, Woodruff Lake.....	225
Riddle's pond.....	625	Prague, Smith's pond.....	300
Ruky Lake.....	625	Quay, Vogler's pond.....	200
Berlin Center, Spring Lake.....	1,500	Seminole, Townsend's pond.....	225
Blanchard, Gardner Quarry Pond.....	200	Shawnee, Maud Lake.....	450
Cambridge, Brush Fork Creek.....	625	Snyder, Clear Lake.....	400
Chillicothe, Lake Rowena.....	250	Spiro, Bowman's pond.....	150
Paint Creek.....	875	Tulsa, Tribes Creek.....	25
Cleveland, Shaker Heights Lake.....	225	Wister, Clear Lake.....	75
Columbus, Rocky Fork Creek.....	625	Pennsylvania:	
Crestline, Sandusky River.....	300	Aldham, Knickerbocker Pond.....	200
Walker Lake.....	225	Pickering Creek.....	200
East Monroe, Lees Creek.....	300	Altoona, Juniata River.....	1,600

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Pennsylvania—Continued.		Pennsylvania—Continued.	
Arcola, Perkiomen Creek.....	300	Schwenksville, Branch Creek.....	150
Skippack Creek.....	100	Perkiomen Creek.....	150
Avondale, White Clay Creek.....	300	West Swamp Creek.....	75
Collegetown, Perkiomen Creek.....	200	Selinsgrove, Middle Creek.....	500
Skippack Creek.....	100	Sellersville, Perkiomen Creek, North-	
Columbia, Chickies Creek.....	200	east Branch.....	200
Strickler Run.....	400	Slatington, Bowman Creek.....	100
Susquehanna River.....	400	Empire Pond (A).....	100
Denver, Kings Pond.....	200	Empire Pond (B).....	100
Leeds Run.....	200	Trout Creek Pond.....	200
Downingtown, Brandywine Creek.....	200	Somerfield, Little Sandy Creek.....	300
Quarry Pond.....	100	Spartansburg, Clear Lake.....	200
Ephrata, Cocalico Creek.....	200	Spring Mount, Branch Creek.....	150
Conestoga Creek.....	200	Perkiomen Creek.....	150
Muddy Creek.....	200	Susquehanna, Susquehanna River.....	500
Everett, Juniata River, Raystown		Troy, Sugar Creek.....	200
Branch.....	300	Uniontown, Corley Lake.....	300
Foster, Ely Lake.....	200	Valley Forge, Schuylkill River.....	100
Frazer, Hershey Mill Pond.....	200	Valley Creek Pond.....	100
Gaines Junction, Pine Creek.....	200	Warren, Alleghany River.....	300
Goldsboro, Susquehanna River.....	800	Conowago Creek.....	400
Gratersford, Branch Creek.....	150	Wind Ridge, South Wheeling Creek.....	100
Perkiomen Creek.....	450	Wheeling Creek.....	100
Green Lane, Perkiomen Creek.....	125	Wrightsville, Susquehanna River.....	1,000
Huntingdon, Juniata River.....	100	Yerkes, Perkiomen Creek.....	200
Juniata River, Raystown Branch.		Skippack Creek.....	100
Standing Stone Creek.....	200	Zeligersville, Perkiomen Creek.....	150
Lancaster, Conestoga Creek.....	600	South Carolina:	
Mill Creek.....	150	Aiken, Bauskett Pond.....	5,000
Landisville, Chickies Creek.....	200	Franklin's pond.....	3,000
Lewisburg, Buffalo Creek.....	600	Staub's pond.....	3,000
Bull Run.....	200	Tarrant's pond.....	3,000
Chillisquaque Creek.....	600	Bennettsville, Egypt Mill Pond.....	4,000
Penns Creek.....	200	McCall's pond.....	8,000
Spruce Creek.....	200	Camden, Jordan's pond.....	2,000
Susquehanna River.....	200	Swift Creek.....	3,000
Lititz, Hammer Creek.....	300	Columbia, Crystal Lake.....	3,000
Media, Crum Creek.....	300	Goodwill Pond.....	9,000
Hilley Creek.....	150	Holman's pond.....	2,000
Montoursville, Loyalsock Creek.....	500	Porter's pond.....	1,900
Montrose, Elk Lake.....	300	Sylvan's pond.....	225
Ely Lake.....	200	Creston, Boggy Gully Pond.....	3,000
Heart Lake.....	200	Darlington, Lowder Lake.....	750
Lake Montrose.....	500	Denmark, Pearson's pond.....	375
Norris Lake.....	300	Eastover, Jumping Run Pond.....	2,800
New Castle, Little Neshannock		Edgefield, Mountain Creek.....	500
Creek.....	400	Ehrhardt, Clearwater Lake.....	6,000
Neshannock Creek.....	120	Fort Mill, Carbert Lake.....	1,000
Slippery Rock Creek.....	400	Gary, Single Mill Pond.....	2,100
Newton, Neshaminy Creek.....	150	Gaston, Sandy Run Pond.....	3,000
Northampton, Crystal Pond.....	100	Great Falls, Catawba Lake.....	3,500
Oaks, Perkiomen Creek.....	100	Greer, Mill Pond.....	2,800
Schuylkill River.....	100	Hartsville, Black Creek Pond.....	7,000
Orbisonia, Aughwick Creek.....	300	Prestwood Lake.....	2,000
Black Log Creek.....	200	Jefferson, Big Rocky Creek Pond.....	2,000
Shade Gap Creek.....	100	Landrum, Hosiery Mill Pond.....	150
Spring Creek.....	100	Langley, Aiken Manufacturing	
Peach Bottom, Susquehanna River.		Company Pond.....	625
Pen Argyl, Broadhead Lake.....	40	Langley Mills Pond.....	625
Lake Pauponoming.....	40	Lexington, Barre Pond, Lower.....	300
Lesizys Pond.....	40	Barre Pond, Upper.....	600
Snydersville Creek.....	40	Dreher Mill Pond.....	600
Pequa, Otter Creek.....	150	Factory Pond.....	2,100
Susquehanna River.....	225	Twelve Mile Pond.....	2,100
Perkiomenville, Perkiomen Creek.....	150	Lowndesville, Rocky River.....	7,000
Philadelphia, Willow Grove Lake.....	650	Marion, Little Pee Dee River.....	4,000
Phoenixville, Pickering Creek.....	500	Monetta, Jordan's pond.....	2,400
Quarryville, Conowingo Creek.....	225	Yonce's pond.....	3,000
Hopkins Lake.....	225	Neeses, Pearson's pond.....	300
Octorara Creek.....	225	Orangeburg, Davis's pond.....	2,000
Rahn Station, Perkiomen Creek.....	150	Edisto River.....	1,200
Riddlesburg, Juniata River, Rays-		Fishery Branch.....	1,100
town Branch.....	200	Fraliek's pond.....	1,500
Riddlesburg Pond.....	200	Pearson's pond.....	2,400
Roaring Spring, Plum Creek.....	300	Pretty Pond.....	2,400
Yellow Creek.....	300	River Branch.....	1,500
Rohersstown, Little Conestoga Creek.		Ridge Springs, Raughman's pond.....	1,500
St. Clair, Kaufman Pond.....	300	Boatwright's pond.....	5,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
South Carolina—Continued.		Texas—Continued.	
Ruby, Spring Pond.....	200	Birome, Birome Pond.....	200
St. Matthews, Wannamaker's pond.....	1,200	Blooming Grove, Oil Mill Pond.....	580
Seneca, Price's pond (A).....	75	Blossom, Tomerlin's pond.....	385
Price's pond (B).....	75	Bonham, Bonham Club Lake.....	600
Springfield, Phillips Mill Pond.....	4,000	Boyd Club Lake.....	300
Steedman, Mill Branch Pond.....	3,000	City Lake.....	1,125
Summerville, Smith Pond.....	2,100	Meadow Lake.....	300
Wallhalla, Taylor's pond.....	75	Russell's pond.....	300
Woodside, Lake Ida.....	200	Brenham, Club Lake.....	765
York, Crystal Pond.....	175	Schroeder's Lake.....	28
South Dakota:		Brookston, McBat's pond.....	300
Fort Pierre, Meers Pond.....	400	Swan Lake.....	300
Hot Springs, Ice Pond.....	300	Brownsville, Resaca de la Guerra Lake.....	16
Lemmon, Flat Creek.....	72	Brownwood, Brooke Smith Lake.....	800
Merriman, Round Lake.....	400	Club Lake.....	1,600
Milbank, Big Stone Lake.....	88	Lake Richardson.....	800
Rapid City, Spruce Pond.....	600	Burnet, Hamilton Creek.....	400
Spearfish, Johnson's pond.....	300	Spring Creek.....	400
Nelson's pond.....	400	Cara, Ross's pond.....	200
Spring Creek Pond.....	400	Carrizo Springs, Ehler's pond.....	200
Webster, Allen Lake.....	176	Center, Runnell's pond.....	12
Long Lake.....	176	Wood Park Lake.....	12
Wessington, Tofflemire Lake.....	600	Chapel Hill, Jackson Creek.....	17
Tennessee:		Jackson Lake.....	17
Athens, Goodfield Creek.....	100	Old River Lake.....	17
Ten Mile Creek.....	100	Childress, Lake Keeler.....	125
Bristol, City Lake.....	†2,200	Chireno, Highland Pond.....	250
Chapel Hill, Dozier Pond.....	†3,000	Teutsch Lake.....	250
Clarksville, Columbia River.....	†1,000	Clawson, Clawson Club.....	550
Cleveland, Wildwood Lake.....	†4,000	Cleburne, Country Club Pond.....	400
Columbia, Duck River.....	†21,000	Clifton, Brandes Lake.....	200
Fountain Creek.....	900	Clute, Lake Caro.....	196
Rutherford Creek.....	900	Lake Jackson.....	196
Cumberland City, Lick Creek.....	1,500	Colorado, Lono Wolf Creek.....	100
Erin, Wells Creek.....	1,000	Columbus, Byars's pond.....	300
Franklin, Harpeth River.....	†6,000	Cooper, City Lake.....	300
Gibson, Persimmon Pond.....	250	Corsicana, Burke Pond.....	200
Kerrville, Lone Pine Lake.....	250	Orphan Home Lake.....	80
Knoxville, Lake Mahan.....	400	Refinery Reservoirs.....	800
La Vergne, Buchanan's pond.....	†2,000	Waterworks Pond.....	200
McKenzie, Clear Lake.....	1,500	Cotulla, Nueces River.....	80
Mayland, Sells Lake.....	800	Crockett, Bobbitt Lake.....	400
Nashville, Lake Kewalco.....	24	Eleaney Lake.....	400
Pinson, Matthews's pond.....	420	Cuero, Cuero Creek.....	125
Rockwood, Rockwood Pond.....	75	Guadalupe River.....	125
Rogersville, Limestone Creek.....	†5,000	McCoy Creek.....	125
Shelbyville, Duck River.....	†10,500	Daingerfield, Donald Dell Pond.....	100
Springfield, Armstrong Lake.....	†2,000	Willow Lake.....	100
Old Deerlick Pond.....	250	Dalhart, Rita Blanca Creek.....	225
Trenton, Holmes's pond.....	420	De Kalb, Jones's pond.....	770
Tullahoma, Hurricane Creek.....	100	May's pond.....	385
Lynchburg Mill Pond.....	200	Meneck's pond.....	770
Mulberry Creek.....	200	Russell's pond.....	770
Wilder, Hollow Pond.....	80	Denton, Bayless's pond.....	70
Texas:		Wilkerson's pond.....	40
Albany, Lake Diller.....	400	Detroit, Moss Bank Pond.....	385
Valleyview Pond.....	400	Price's pond.....	385
Alto, Hoover's pond.....	580	Diboll, Conn's pond.....	500
Amarillo, Amarillo Creek, Middle Prong.....	300	Dublin, Rucker's pond.....	400
Annaona, Denison Ranch Lake.....	385	Electra, City Lake.....	125
Grooms Lake.....	385	Meadow Lake.....	125
Porter Pond.....	385	Elgin, Burke's pond.....	25
Archer City, City Lake.....	1,140	Carlson's pond.....	25
Carver Lake.....	250	Fisheris Lake.....	35
Dugan Pond.....	250	Fromme's pond.....	25
Arcola Junction, Clear Lake.....	197	Sandahl's pond.....	25
Austin, Insane Asylum Lake.....	100	Engle, Veselka's pond.....	250
Ballinger, Coyote Creek.....	50	Ennis, Gatewood's pond.....	200
Fuzzy Creek.....	50	Herring Lake.....	200
Mustang Creek.....	50	Sand Lake.....	200
Pony Creek.....	50	Falfurrias, Montan's pond.....	180
Winters Lake.....	125	Ferris, Malone's pond.....	350
Beaumont, Holdebrand Bayou.....	300	Wester's pond.....	350
Big Wells, Claybank Pond.....	200	Flatonia, Vyojala Lake.....	300
Minnehaha Lake.....	200	Wheeler Lake.....	300
Thomson's pond.....	200	Fletcher, Village Creek.....	12

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Texas—Continued.		Texas—Continued.	
Floresville, Galea's pond .....	12	Leroy, Hay Barn Pond .....	200
Fort Worth, Fosdick Lake .....	600	Schroeder's pond .....	200
Lake Louise .....	30	Lindale, Lindale Lake .....	373
Lake Worth .....	1,512	Tom Lake .....	373
Franklin, Garner's pond .....	200	Linden, Fant Lake .....	75
Freeport, Sulphur Lake .....	196	Llano, Stribling's pond .....	400
Frisco, Henson's pond .....	300	Longview, Martin's pond .....	620
Garrison, Fern Lake .....	250	Lott, City Lake .....	420
Garrison Lake .....	750	Lueders, Brazos River, Clear Fork .....	800
Parrot's pond .....	500	Little Fish Creek .....	800
Gaston, Round Lake .....	125	Layford, Ritama Lake .....	12
Gatesville, Coryell Creek .....	464	McCoy, McGhee's pond .....	200
Cow House Creek .....	928	Mabank, Croft's pond .....	200
Plum Creek .....	464	Madisonville, Robinson's pond .....	24
Table Rock Creek .....	464	Manor, Chamberlain's pond .....	75
Giddings, Albers Home Lake .....	420	Marlin, Fortune Lake .....	200
Clear Knot Pond .....	35	Johnson Lake .....	200
Holman Lake .....	15	Reed's pond .....	200
Menzel's pond .....	17	Shields Lake .....	200
Moerbe's pond .....	420	Mart, Willow Lake .....	400
Pin Oak Lake .....	17	Menard, Celery Creek .....	75
Saenger's pond .....	35	Cogin Creek .....	75
Schatte's pond .....	420	Llano River, forks of .....	75
Gilmer, Club Pond .....	200	San Saba River .....	75
Mud Lake .....	300	Walliek Lake .....	75
Oaks Lake .....	200	Meridian, Bosque River .....	200
Goldthwaite, Lake Hull .....	250	Mertens, Myrick's pond .....	200
Gonzales, Willard's pond .....	420	Mesquite, Dallas Mesquite Lake .....	220
Grand Saline, Big B Lake .....	500	Jobson Lake .....	220
Carrington Lake .....	250	Lawrence Lake .....	220
Clark's lake .....	300	Mexia, Jones's pond .....	125
Germany Pond .....	300	Morgan's pond .....	125
Goode's pond .....	300	Midland, Bryam Place Pond .....	100
Luce's pond .....	300	Mincola, Club Lake (A) .....	374
Thomas Lake .....	250	Club Lake (B) .....	374
Westwood Lake .....	250	Club Lake (C) .....	374
Grapeland, Baker Lake .....	400	Goldsmith's pond (A) .....	373
Bowman's pond .....	400	Goldsmith's pond (B) .....	373
Spring Lake .....	400	Hart Pond .....	373
Grapevine, Chamblee's pond .....	300	Reed's pond .....	374
Greenbrier, Crow Lake .....	773	Sarber Club Lake .....	373
Indian Lake .....	774	Wells Lake .....	373
Mountain Lake .....	773	Willow Lake .....	374
Greenville, Ward Club Lake .....	115	Millett, Eclipse Pond .....	100
Groesbeck, Groesbeck Pond .....	350	Mineral Wells, Country Club Lake .....	500
Hallsburg, Hall Twin Lake .....	200	Elm Creek .....	400
Harriss Valley, Harriss Pond .....	200	Holt's pond .....	400
Hearne Sandy Creek .....	650	Hubbard's lake .....	400
Henderson, Bennett's pond (A) .....	115	Moody, Acree's pond .....	200
Bennett's pond (B) .....	115	Stam pede Lake .....	130
Deason Lake .....	115	Mount Calm, Clark Lake .....	580
Dorsey's pond .....	115	Tank Lake .....	580
Honey Island, Cochran's pond .....	12	Wolfe Creek Lake .....	580
House, Saw Mill Pond .....	197	Mount Pleasant, Ellis-Kelly Club .....	300
Thompson Lake .....	197	Lake .....	300
Hubbard, Cedar Pond .....	580	Mount Vernon, Blakey's pond .....	300
Huntington, Carter-Kelly Pond .....	200	Mullen, Leisure Land Lake .....	400
Huntsville, Felder's pond .....	400	Naples, Sullivan Sanford Pond .....	1,600
Irene, Irene Lake .....	200	Navasotta, Zulch Lake .....	100
White's pond .....	200	Newcastle, Terrell's pond .....	300
Jacksonville, Crysups's lake .....	63	Newsome, Elwood Lake .....	200
Haberlie's lake .....	63	Newton, Big Cow Creek Pond .....	225
Jasper, Sandy Creek .....	12	Caney Creek .....	225
Jayton, Hackberry Lake .....	200	Eligoh Lake .....	225
Sand Rock Lake .....	200	Gunter's pond .....	225
Kemp, Fogleman's pond .....	200	New Willard, Lumber Company .....	580
Huston Lake .....	200	Pond .....	580
Spence's pond .....	200	Nordheim, Butler Creek .....	125
Willow Lake .....	200	Normangee, Ellison Pond .....	125
Kerrville, Blue Bell Lake .....	1,600	Northrup, Falkes Pond .....	420
Kingsville, Santa Gertrudis Creek .....	24	North Zulch, H. & T. C. pond .....	125
Kountze, Cypress Creek .....	200	South Zulch Pond .....	125
Lampasas, Burleson Creek .....	400	Olney, Adam's pond .....	† 700
McCrea's pond .....	400	Paige, Fox Pond .....	18
School Creek .....	400	Rohde's pond .....	17
Sulphur Creek .....	800	South End Pond .....	17
Laredo, Willow Lake .....	80	Paint Rock, Ames Lake .....	125
Laure, Lambright's pond .....	200	Palestine, Elkhart Lake .....	400

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Texas—Continued.		Texas—Continued.	
Paris, Conrady Lake	400	Waco, Cooper's pond	50
Frazier Lake	400	Elm Lake	464
Jenkins's pond	400	Escondida Lake	464
Jones's pond	400	Everman Lake	50
Loraine Lake	400	Goodman Valley Lake	464
Scott Pond	400	Hickory Creek	464
Passadena, Sanders's pond	70	Mann Lakes	464
Phelps, Cline's mill pond	400	Maupin Lake	464
Pittsburg, Cotter-Willes Pond	100	Meadors Lake	464
Lily Pond	300	Oak Lake	514
Port Arthur, Number Seven Lake	300	Slone Lake	464
Quanah, Groesbeck Creek	225	Smith's pond	50
Randolph, Cat Tail Lake	300	Spring Lake	50
Rhome, Railroad Pond	600	Teal Lake	50
Richmond, Smithers Lake	300	Waco Club Pond	100
Riviera, Pataluma Pond	12	White Rock Farm Pond	50
Rochelle, Sellman Lake	100	Wildwood Lake	464
Rock Island, Moore's pond	125	Waelder, Hopkins Lake	300
Rosebud, Caddo Club Lake	420	Walnut Springs, Katy Lake	400
City reservoirs	840	Webster, Rice Canal Pond	196
Ellison's pond	420	Wellfare, Joshua Creek	400
Round Rock, Brushy Creek	300	Wichita Falls, Hodge Lake	250
San Angelo, Concho River	125	Wichita Valley Pond	200
Kiowa Creek	125	Winnboro, Lake Eric	100
San Antonio, Breckenridge Park Lake	270	Wills Point, Lake Crystal	220
Harrigan Lake	300	Owens's pond	220
Mellvaine's pond	75	Thorn Lake	220
Pipe Creek Lake	600	Utah:	
Zoological Park Pond	90	Marysville, Panguitch Lake	500
San Augustine, Ballard's pond	12	Price, Kilpack's pond	300
San Benito, Novotney Lake	12	Vermont:	
Sanger, Duck Creek	300	Barton, Parker Pond	300
Sarita, Santa Rosa Lake	12	Brattleboro, Lily Pond	75
Seguin, Geronimo Creek	300	Virginia:	
Guadalupe River	300	Abingdon, McBroom Mill Pond	300
Sherman, Chapman Lake	40	Alta Vista, Stanton River	200
Cottonwood Lake	1,600	Amherst, Campbell's pond	100
Lakewood Pond	24	Piney Creek	300
Rogers's pond	15	Arratt, Johnson Creek Pond	100
Seven Mile Pond	15	Basic, Shemandoah River, South Fork	880
Spur, J. 2 Pond	200	Beaver Dam, Beaverdam Pond	40
Stafford, Lester Lake	300	Blacksburg, Sinking Creek	165
Stanford, City Lake	675	Blackstone, Dobson's pond	120
Fish Creek	800	Blaine, Blackwater River	400
Harrell's pond	200	Bon Air, Cedar Crest Creek Pond	1,700
Sterling City, North Concho River	125	Boydton, Snyder Old Mill Pond	110
Strawn, Burton Lake	150	Burkeville, Ellett's pond	80
Lyra Lake	150	Charlottesville, Willow Spring Pond	300
No. 3 Lake	200	Clifton, Morris's pond	200
Streetman, Sims's pond	125	Crimora, South River	80
Sugar Land, Biltmore Lake	300	Danville, Lanier Pond	300
Sulphur Springs, McLaughlin's pond	100	Dry Fork, Harper's pond	200
Sweetwater, Santa Fe Lake	400	Edinburg, Forest Service	300
Taylor, Burns Lake	400	Emporia, Jones Pond	200
Temple, Lake Polk	250	Taylor's pond	50
Tenaha, Columbus Lake	24	Fredericksburg, Harris Pond	600
Terrell, Cate Ranch Lake	510	Miller Lake	600
Cottonwood Lake	220	Rappahannock River	2,200
Texarkana, Chub Lake	385	Hanover, Lake Aylett	160
Moore's Lake	1,600	Harrison, South River	80
Temple Lake	600	Henry, Smith River	700
Thomdale, Ellison's pond	400	Jefferson, Sandy Creek	500
Graves's pond	400	Kinsale, Schools Pond	200
Timpson, Porterfield's pond	325	Lee Hall, Small Stream	200
Witcher's pond	500	Lexington, Kerrs Creek	300
Trinity, Payton's pond	400	Maple Mill Pond	200
Troup, City Waterworks Pond	620	Louisa, Williams Mill Pond	400
Tyler, Chinquapin Lake	373	Lynchburg, Lee's pond	156
Country Club Lake	373	Maiden, Hening's pond	300
Lakewood Lake	373	Martinsville, Brown's pond	200
Park Club Lake	200	Massaponax, Massaponax Pond	400
Starr Lake	300	Meadow, Eberhard's mill pond	200
Valley Mills, Lake Elmo	200	Meadow Pond	300
Vernon, Anderson Lake	125	Minshull's pond	200
Voth, Pine Island Creek	12	Middletown, Cedar Creek	300
Waco, Armstrong Lake	50	Milford, White's pond	40
Axtell Lake	50	Moccasin Gap, Holston River, North Fork	400
Bosque Home Lake	464	New Castle, Craigs Creek	400

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Virginia—Continued.		Wisconsin—Continued.	
New Castle, Johns Creek.....	200	Bloomer, Island Lake.....	125
Orange, Mt. Sharon Pond.....	200	Jim Lake.....	125
Robertson River.....	300	Lake Como.....	125
Palmyra, Rivanna River.....	300	Little Beaver Lake.....	125
Pamplin, Baker's pond.....	200	Long Lake.....	125
Parksley, Mason's pond.....	100	Marsh Miller Pond.....	125
Pemberton, Flannigan Mill Pond.....	400	Mud Lake.....	125
Trenholm Pond.....	400	Pickeral Lake.....	125
Petersburg, Asher Creek.....	400	Pike Lake.....	125
Philpot, Smith River.....	400	Rice Lake.....	125
Port Republic, Shenandoah River,		Rock Lake.....	125
South Fork.....	120	Round Lake.....	125
Richmond, Jollys Mill Pond.....	160	Salisbury Lake.....	125
King William Mills Pond.....	120	Shattuck Lake.....	125
Rocky Mount, Giles Mill Pond.....	400	Town Line Lake.....	125
Power Pond.....	400	Bowler, Heaberlein Lake.....	40
Snofolk, Lake Savage.....	400	Centuria, Deer Lake.....	125
Sweet Hall, Custis Lake.....	120	Chippewa Falls, City Pond.....	700
Swords Creek, Clinch River, Maiden		Davis Lake.....	700
Spring Fork.....	400	Lake Wissota.....	700
Vickers, New River.....	160	Oneils Creek.....	700
Wakefield, Airfield Lake.....	400	Yellow River.....	450
Walker Ford, James River.....	400	Clayton, Mississippi River.....	a 1,700
Waverly, Shingleton Pond.....	400	Coloma, Carter Lake.....	450
West Point, Goddus Pond.....	450	Pleasant Lake.....	450
Wilson, Hobbs's pond.....	80	Comstock, Pipe Lake.....	400
Woodstock, Shenandoah River,		Cumberland, Beaver Dam Lake.....	500
North Fork.....	400	Sand Lake.....	400
West Virginia:		Devils Lake, Devils Lake.....	600
Arden, Laurel Creek.....	300	Donaldson, Big Portage Lake.....	100
Berkley Springs, Sleepy Creek.....	300	Dollar Lake.....	100
Central, Arnold Creek.....	240	Landing Lake.....	100
Charles Town, Evetts Run.....	200	Little Portage Lake.....	100
Shenandoah River.....	1,400	Pink Eye Lake.....	100
Clarksburg, Davisson Run.....	540	Eau Claire, Dell Pond.....	375
Orla Lake.....	800	Elcho, Otter Lake.....	100
Dundon, Big Buffalo Creek.....	300	Fine Lake.....	200
Elm Grove, Big Wheeling Creek.....	700	Elmwood, Eau Galle Mill Pond.....	200
Martinsburg, Patterson's pond.....	500	Fisher Lake, Fisher Lake.....	300
Paw Paw, Cacapon River.....	375	Fond du Lac, Long Lake.....	300
Philippi, Sugar Creek.....	200	Moon Lake.....	200
Romney, Potomac River, South		Mullet Lake.....	200
Branch.....	2,250	Round Lake.....	200
Walkersville, Monongahela River,		Twin Lake.....	300
North Branch.....	200	Wolf Lake.....	300
Weston, Monongahela River, West		Fox Lake, Fox Lake.....	750
Fork.....	800	Fredonia, Milwaukee River.....	625
Wisconsin:		Galesville, Lake Marinuka.....	500
Alma, State fish commission.....	3,600	Gordon, Big Eau Claire Lake.....	100
Baraboo, Dell Creek Pond.....	150	Bony Lake.....	100
Ellendale Springs Pond.....	150	Ox Lake.....	100
Fern Dell Pond.....	150	Pickeral Lake.....	100
Gray Slough Pond.....	150	Robinson Lake.....	100
Loch Mirror Bay.....	150	Sherman Lake.....	100
Mirror Lake.....	450	Hartford, Collins Lake.....	375
Narrows Creek.....	150	Mud Lake.....	375
Osborne Point Pond.....	150	Murphy-Maloy Lake.....	500
Pickeral Slough Pond.....	150	Hatfield, Lake Arbutus.....	120
Ringling Landing Pond.....	150	Hawthorne, Lake Minnesung.....	100
Smiths Slough Pond.....	150	Lake Nebagammon.....	100
South Bay Pond.....	150	Hayward, Andrew Lake.....	100
Spring Brook.....	150	Anthony Lake.....	100
Timmes Mill Pond.....	150	Arrow Pond.....	100
Twin Slough Pond.....	150	Ayers Lake.....	100
Bayfield, Siskiwit Lake.....	280	Balsam Lake.....	100
Beaver Dam, Beaver Dam Lake.....	1,200	Barney Lake.....	100
Birchwood, Birch Lake.....	70	Bean Lake.....	100
Black River Falls, Black River.....	300	Big Lake.....	100
Douglas Lake.....	300	Blue Lake.....	100
Morrison Creek.....	300	Booze Lake.....	100
Stebbins Lake.....	300	Cable Lake.....	100
Blair, Trempealeau River.....	500	Calhoun Lake.....	100
Bloomer, Ax Handle Lake.....	125	Carpenter Lake.....	100
Big Beaver Lake.....	125	Cass Lake.....	100
Boot Lake.....	125	Chippewa Lake.....	100
Chain Lake.....	125	Claire Lake.....	100
Cornell Lake.....	125	Como Lake.....	100
Hennenian Lake.....	125	Cook Lake.....	100

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Wisconsin—Continued.		Wisconsin—Continued.	
Hayward, Crab Lake	100	Hayward, Witz Lake	100
Crandell Lake	100	Hazlehurst, Lake Katherine	200
Crystal Lake	100	Wind Pudding Lake	200
Dandy Lake	100	Heafford, Bass Lake	200
Eagle Lake	100	Manson Lake	200
Elbow Lake	100	Stag Lake	200
Elmo Lake	100	Rudson, Burkhardt Pond	300
Ford Lake	100	Independence, Bugle Lake	2,725
Forest Lake	100	Elk Lake	1,655
Fox Lake	100	La Crosse, Mississippi River	a 11,360
Frances Lake	100	Lake Beulah, Lake Beulah	400
Fredic Lake	100	Lake Millicut, Bingo Lake	100
Frog Lake	100	Boscoe Bay Lake	100
George Lake	100	Butbar Lake	100
Giblin Lake	100	Crow Lake	100
Glenwood Lake	100	Eagle Lake	100
Glover Lake	100	Heart Lake	100
Hallie Lake	100	Lost Lake	100
Harriett Lake	100	Lower Pike Lake	100
Harry Lake	100	Pike Lake	100
Hazen Smith Lake	100	Pine Tree Lake	100
Helen Lake	100	Spring Lake	100
Hellweg Lake	100	Swanson Lake	100
Henry Lake	100	Twin Lakes	100
Hemlock Lake	100	Lake Nebagammon, Lake Neba-	
Horse Lake	100	gammon	300
Island Lake	100	Laona, Birch Lake	300
Jag Lake	100	Silver Lake	300
James Lake	100	Lavalley, Dupens Mill Pond	200
Jane Lake	100	Lavalley Pond	300
Jewell Lake	100	Madison, State fish commission	1,400
Katinka Lake	100	Mattoon, Paker Lake	100
Lenroot Lake	100	Dollar Lake	200
Linden Lake	100	Johnson Lake	200
Little John Lake	100	Menomonie, Asylum Bend Lake	200
Little Long Lake	100	Atlasta Lake	200
Luce Lake	100	Caryville Lake	200
Maple Lake	100	Cedar Lake	200
Mary Lake	100	Cutoff Lake	200
Mayo Lake	100	Doyle Lake	200
Minnie Lake	100	Dunnville Cutoff Lake	200
Muscalongo Lake	100	Eighteen Mile Lake	200
New Lake	100	Goose Lake	200
North Lake	100	Hay River	200
Ore Lake	100	Lake Menomonie	200
Owen Lake	100	Manbeek Cutoff Lake	200
Papoose Lake	100	Manley Bend Lake	200
Peter Lake	100	Miller Lake	200
Pike Lake	100	Moore Farm Lake	200
Pine Lake	100	Mud Lake	200
Pohaquon Lake	100	Pitt Lake	200
Rainbow Lake	100	Red Cedar River	200
Razor Back Lake	100	Rowe Lake	200
Rivkin Lake	100	Stump Lake	200
Rock Lake	100	Wilson Lake	200
Sady Lake	100	Mercer, Trude Lake	1,000
St. John Lake	100	Muscoda, Cross Lake	300
Sand Lake	100	Dixon Lake	300
Shadow Lake	100	High Bank Lake	300
Shell Lake	100	Kendall Lake	200
Sims Lake	100	Mill Creek Pond	300
Sisco Lake	100	Moore Lake	300
Slim Lake	100	Puffenrod Lake	300
Spirit Lake	100	Narrows, Cedar Lake	500
Spruce Lake	100	Nashota, Pine Lake	400
Squirrel Lake	100	New Lisbon, Fish Lake	375
Star Lake	100	Lake Juneau	375
Storm Lake	100	Lake Van Kuren	375
Sunday Lake	100	Lemonweir River	375
Tener Lake	100	Little Yellow River	375
Tompkins Lake	100	Yellow River	375
Thomas Lake	100	New Richmond, Willow River	60
Toba Lake	100	Norrie, Bass Lake	100
Turtle Lake	100	Halfway Lake	100
White Sand Lake	100	Lake Go To It	100
Wildcat Lake	100	Lake Wausau	100
Wilson Lake	100	Long Rice Lake	100
Winnebago Lake	100	Mayflower Lake	100
Witch Lake	100	Mud Lake	100

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Wisconsin—Continued.		Wisconsin—Continued.	
Norrie, Pike Lake.....	100	Sheboygan, Pigeon Lake.....	625
Rice Lake.....	100	Solon Springs, Cabin Lake.....	100
Road Lake.....	100	Lake St. Croix.....	100
Short Portage Lake.....	100	Sullivan Lake.....	100
Smith Lake.....	100	Twin Lake.....	100
Stony Lake.....	100	South Range, Lyman Lake.....	200
Twin Lake.....	100	Superior, Amnicon Lake.....	75
Park Falls, Oxbow Lake.....	70	Dowling Lake.....	100
Shnurs Lake.....	70	Mast Lake.....	100
Pembin, Bass Lake.....	150	Three Lake, Cojumbus Lake.....	100
Lake Nine.....	150	Deer Lake.....	100
Lindquist Lake.....	200	Eagle Chain of Lakes.....	75
Rock Lake.....	150	Island Lake.....	100
PHELPS, Big Bass Lake.....	100	Laurel Lake.....	100
Big Twin Lake.....	100	Little Fork Lake.....	100
Lake No See Um.....	100	Long Lake.....	100
Little Bass Lake.....	100	Medicine Lake.....	100
Long Lake.....	100	Planting Ground Lake.....	100
Phillips, Bass Lake.....	100	Round Lake.....	75
Coulers Lake.....	100	Spirit Lake.....	100
Cranberry Lake.....	100	Thunder Lake.....	75
Crane-Chase Lake.....	100	Tomahawk, Bass Lake.....	150
Dardis Lake.....	100	Burrows Lake.....	100
Deer Lake.....	100	Buteau Lake.....	100
Grassy Lake.....	100	Clear Lake.....	150
Lake Sixteen.....	100	Crescent Lake.....	100
Lake Ten.....	100	Crystal Lake.....	150
Leroy Lake.....	100	Deer Lake.....	150
Little Dardis Lake.....	100	Half Moon Lake.....	150
Long Lake.....	100	Hancock Lake.....	100
Lunt Lake.....	100	James Lake.....	150
Minnow Lake.....	100	King Pond.....	150
Musser Lake.....	100	Lake Clara.....	150
Price Lake.....	100	Lake George.....	100
Riley Lake.....	100	Lake Julia.....	100
Round Lake.....	100	Lake Thompson.....	100
Worcester Lake.....	100	Manson Lake.....	100
Prentice, Worcester Lake.....	300	Muscalonge Lake.....	100
Reedsburg, Dell Pond.....	200	Reno Lake.....	150
Mirror Lake.....	300	Rice Lake.....	100
Reserve, Grindstone Lake.....	300	Road Lake.....	150
Lake Court Oreilles.....	300	Round Lake.....	150
Little Lake Court Oreilles.....	200	Sawyer Lake.....	100
Rhinclander, Bass Lake.....	25	Seven Isle Lake.....	100
Ben Sweet Lake.....	25	Silver Lake.....	100
Boom Lake.....	25	Smith Lake.....	150
Crescent Lake.....	25	Somo Lake.....	150
Hancock Lake.....	25	Somo River.....	150
Jennie Weber Lake.....	25	Swamp Lake.....	150
Lake George.....	15	Tomahawk River.....	150
Lake Julia.....	15	Wisconsin River.....	150
Lake Thompson.....	15	Wisconsin River Pond.....	150
Marshall Lake.....	15	Wabeno, Ada Lake.....	150
Moen Lake.....	15	Bass Lake.....	75
Oneida Lake.....	15	Leach Lake.....	150
Pearl Lake.....	15	Little Long Lake.....	75
Pine Lake.....	15	Perch Lake.....	75
Shepard Lake.....	15	Range Line Lake.....	75
Silver Lake.....	50	Richardson Lake.....	75
Squash Lake.....	50	Shoe Lake.....	150
Stone Lake.....	50	Trump Lake.....	150
Sugar Camp Lake.....	75	Wausau, Big Rib River.....	750
Thunder Lake.....	75	Lake Wausau.....	750
Town Line Lake.....	75	Pine River.....	750
Washburn Lake.....	75	West Bend, Big Cedar Lake.....	500
Wolf Lake.....	75	Wild Rose, Kosel Lake.....	60
Rib Lake, North Harper Lake.....	60	Round Lake.....	60
North Spirit Lake.....	60	Winter, Barber Lake.....	70
South Harper Lake.....	60	Brunett Lake.....	70
Rice Lake, Tuscobia Lake.....	300	Mud Lake.....	70
Richfield, Friess Lake.....	375	Wyoming:	
Rosholt, Mill Pond.....	750	Cheyenne, Lake Minnehaha.....	600
Salmo, Siskiwit Lake.....	100	Sioux Lake.....	600
Sank City, Crystal Lake.....	80	Mexico: Nacozari, Huacal Dam.....	5,000
Koenig Mill Pond.....	80		
Lake Swenson.....	80		
Sheboygan Falls, Lake Ellen.....	625		
Long Lake.....	625	Total <sup>a</sup> .....	{ † 425,045 1,100,420

<sup>a</sup> Exclusive of 805 fry and 3,360 fingerlings lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## SMALLMOUTH BLACK BASS.

Disposition.	Number.	Disposition.	Number.
Alabama:		Massachusetts:	
Birmingham, Black Creek Pond.....	300	Great Barrington, Lake Buel.....	†3,000
Central Waterworks Lake.....	400	Lake Garfield.....	†3,000
Tuscumbia, Town Creek.....	400	Huntington, Norwich Pond.....	†1,500
Arkansas:		Westfield River, East Branch.....	†1,500
Hardy, Forty Island Creek.....	†2,000	Lee, Goose Pond.....	†4,000
Spring River.....	†1,000	Greenwater Pond.....	†1,000
Hot Springs, Alum River.....	†3,000	Laurel Lake.....	†2,000
Glazy Pole Creek.....	†4,000	Lenox, Lake Mahkenac.....	†1,500
Saline River, Middle Fork.....	†4,000	Stockbridge Lake.....	†1,500
Saline River, South Fork.....	†3,000	Littleton, Spectacle Pond.....	80
Imboden, Spring River.....	†5,000	Richmond Furnace, Cranberry Pond.....	†500
Mammoth Spring, Myatt River.....	†3,000	Shelburne Falls, Ashfield Pond.....	†1,500
Spring River and branches.....	960	Deerfield River.....	†1,500
Tracey Creek.....	200	Reservoirs 2, 3 and 4.....	†4,500
Mountainburg, Cedar Creek.....	300	Michigan: Gladwin, Lucas Lake.....	400
Frog Bayou.....	300	Minnesota: Red Wing, Mississippi	
Colorado: Littleton, Ken-Caryl Lakes.....	900	River.....	2,190
Delaware: Wilmington, Brandywine		Missouri:	
Creek.....	300	Aurora, Flat Creek.....	100
Georgia: Toocoa, Toocoa Creek Pond.....	200	Rolla, Big Piney Creek.....	100
Illinois:		Cane Spring Creek.....	300
Antioch, Third Lake.....	675	Little Piney River.....	100
Lawrenceville, Beaverdam Pond.....	200	Salem, Meremece River.....	400
Robison Lake.....	200	Sparta, Finney Creek.....	100
Indiana:		New Hampshire:	
Crandall, Indian Creek.....	1,000	Keene, Spoonford Lake.....	†1,500
Depauw, Blue River.....	400	Newport, Rocky Bound Pond.....	†1,500
Indianapolis, Buck Creek.....	600	Plymouth, Ellsworth Pond.....	†1,000
Eagle Creek.....	†4,000	West Ridge, Perley Lake.....	†1,500
Fall Creek.....	†4,000	New Jersey:	
Jeffersonville, Silver Creek.....	400	Hackettstown, Budd Lake.....	300
White River.....	†4,000	Guard Lock Pond.....	400
Muncie, White River.....	600	Mountain Lake.....	600
New Albany, Graff Pond.....	200	Newburg Pond.....	300
Indian Creek.....	400	Waterloo Pond.....	300
Little Indian Creek.....	400	McAfee, Wildwood Lake.....	300
Silver Creek.....	600	New Mexico: Santa Fe, Catron's Pond.....	200
Silver Creek, Muddy Fork.....	400	New York:	
Paoli, Lock Creek.....	300	Montcalm Landing, Eagle Lake.....	†1,500
St. Paul, Flat Rock River.....	†5,000	Lake George.....	†500
Sellersburg, Balknap Lake.....	†5,000	Port Henry, Deadwater Pond.....	†200
Globe Lake.....	200	Lake Champlain.....	†500
Terre Haute, Wabash River.....	600	Lake Nokomis.....	†500
Iowa:		Ledge Lake.....	†200
Chester, Upper Iowa River.....	†500	Wawamassa Lake.....	†200
Manchester, Maquoketa River.....	820	Whitehall, Metawee River.....	†500
Mason City, Limo Creek.....	1,500	North Carolina:	
Kentucky:		Etowah, Bluff Pond.....	100
Adairville, Red River.....	200	Lenoir, Buffalo Creek Pond.....	200
Red River, South Fork.....	100	Rutherfordton, Cox's Pond.....	450
Cynthiana, Licking River, South		Green River.....	900
Fork.....	600	Green River Lake.....	450
Lawrenceburg, Salt River.....	800	Upper Broad River.....	925
Louisville, Douglas Park Lake.....	†5,000	Oklahoma: Oklahoma City, State fish	
South Park, South Park Lake.....	†3,000	commission.....	400
Maine:		Pennsylvania:	
Bath, Lake Nequasset.....	†1,500	Bushkill, Deer Lake.....	200
Lily Pond.....	†1,000	Delaware River.....	300
Boothbay Harbor, Campbell Pond.....	†1,500	Forest Lake.....	300
Bridgton, Highland Lake.....	†2,000	Lake Tament.....	300
Ellsworth, Walker Pond.....	60	Canton, Lake Nepahwin.....	300
Fryeburg, Kezar Lake.....	†2,500	Easton, Delaware River.....	400
Lovewell Pond.....	†1,500	Echo Lake, Echo Lake.....	300
Gray, Dry Pond.....	200	Kennet, Pusey Lake.....	300
Livermore Falls, Davids Pond.....	†1,500	Lancaster, Conestoga Creek.....	200
Oakland, Little Pond.....	†1,500	Lititz, Conestoga Creek.....	300
Poland, Lake Thompson.....	285	Pequea, Pequea Creek.....	300
Sandy Creek, Woods Pond.....	†3,500	Pittston, Susquehanna River.....	1,000
Maryland:		Statington, Maiden Creek.....	300
Cumberland, Castleman River.....	400	Trout Run, Little Pine Creek.....	700
Evitts Creek.....	400	Lycoming Creek.....	300
Fifteen Mile Creek.....	300	West Chester, Brandywine Creek.....	300
Sidling Hill Creek.....	400	Whitford, Blue Hole Pond.....	300
Town Creek.....	400	Rhode Island:	
Wills Creek.....	400	Apponaug, Fresh Pond.....	†1,000
Williamsport, Potomac River.....	800	Gorton Pond.....	†1,000

2 Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

SMALLMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
<b>Rhode Island—Continued.</b>		<b>Virginia—Continued.</b>	
Apponaug, Wouquonset Pond.....	† 1,000	Emporia, Three Creeks.....	180
Providence, Gorton Pond.....	† 1,000	Front Royal, Shenandoah River.....	† 5,000
Herring Pond.....	† 2,000	Harrison, South River.....	† 2,500
Moswauicutt Lake.....	† 1,500	Hot Springs, Jackson River.....	† 6,000
Quidnick Reservoir.....	† 1,500	Stanley, Shenandoah River, South Fork.....	† 5,000
Southwood Ponds.....	† 500	<b>West Virginia:</b>	
Wouquonset Pond.....	† 1,500	Charleston, Elk River.....	† 9,000
Woonsocket, Scheeneconet Pond.....	† 1,500	Glendon, Birch River.....	† 12,000
<b>Tennessee:</b>		Patterson Creek, Patterson Creek.....	500
Bluff City, Holston River.....	450	Webster Springs, Elk River, Back Fork.....	† 6,000
Chattanooga, Middle Creek.....	† 1,000	White Sulphur Springs, Meadow Pond.....	840
North Chickamanga Creek.....	500	<b>Wisconsin:</b>	
Johnson City, Watauga River.....	1,000	Fond du Lac, Devil Lake.....	200
Murfreesboro, Stone River.....	600	Lake De Neveu.....	400
Rock Island, Caney Fork River.....	† 16,000	Mercer, Trude Lake.....	3,600
<b>Vermont:</b>			
Castleton, Lake Bomoseen.....	† 3,600		
Hydeville, Lake Bomoseen.....	† 500		
<b>Virginia:</b>			
Ashby, Shenandoah River.....	† 500		
Emporia, Meherrin River.....	† 180		
		<b>Total a.....</b>	† 195,700
			43,745

ROCK BASS.

<b>Alabama:</b>		<b>Michigan:</b>	
Anniston, Coldwater Creek.....	300	Jackson, Browns Lake.....	400
Nesbit pond.....	400	Michigan Centre Pond.....	400
Willett's Pond.....	200	Twin Lake, Twin Lakes.....	400
<b>Arkansas:</b>		West Lake.....	400
Bentonville, Bella Vista Lake.....	600	Minnesota: Homer, Mississippi River.....	b 200
Eldorado, Hudson's pond.....	524	Mississippi: Friar Point, Mississippi River.....	b 440
Harrison, Buffalo River.....	200	<b>Missouri:</b>	
Cecil Creek.....	200	Aurora, Flat Creek.....	600
Flat Rock Creek.....	200	Cabool, Crater Pond.....	200
Mill Creek.....	200	Cuba, Huzzah Creek.....	800
Lewisville, Spirit Lake.....	786	Joplin, Sloan's pond.....	250
St. Joe, Cave Creek.....	100	Thomas Lakes.....	400
Springdale, North Osage Creek.....	400	Houston, Arthur Creek.....	400
Patton Lake.....	400	Reeds, Young's pond.....	200
Richland Creek.....	400	Rolla, Little Piney Creek.....	400
Colorado: Longmont, Dawson Lake.....	1,090	St. James, Bourbois Creek.....	400
Delaware: Wilmington, Sedgely Lake.....	200	Sparta, Finley Creek.....	200
<b>Georgia:</b>		Steelville, Meremeo River.....	400
Roberta, Lowe's pond.....	1,000	Montana: Corinth, Springdale Pond.....	20
Rome, Dykes Creek.....	1,000	New Jersey: White House Station, Paul Poppe Pond.....	200
Stilesville, McGowan's pond.....	150	New Mexico: Cutter, Elephant Butte Lake.....	200
Stone Mountain, Nicholes's pond.....	150	New York: Davenport Center, Charlotte River.....	200
Illinois: Warren, Apple River.....	2,500	<b>North Carolina:</b>	
<b>Indiana:</b>		Hendersonville, Imbersley Pond.....	500
Greensburg, Kessing's pond.....	200	Norlina, Fleming Pond.....	400
Jeffersonville, Q. M. Depot Pond.....	600	Largo Pond.....	350
Muncie, Main Lagoon.....	800	Lees Pond.....	325
<b>Iowa:</b>		Owens Creek Pond.....	400
Manchester, Maquoketa River.....	2,250	Rogers Lake.....	325
Spirit Lake, State fish commission.....	13,000	Shocco Lake.....	500
<b>Kansas:</b>		North Wilkesboro, Hendren's pond.....	550
Kincaid, Grindstone Lake.....	200	Reddies River.....	1,000
Silver Spring Lake.....	200	Raleigh, Doctor's Lake.....	500
<b>Kentucky:</b>		Hood Mill Pond.....	500
Cave City, Phoebe Ann Pond.....	500	Milburnie Pond.....	400
Horse Cave, Page's Pond.....	500	Neusecoo Club Pond.....	3,750
Louisville, Lake Lansdowne.....	600	Peachtree Pond.....	1,000
Olive Hill, Tiger Creek.....	300	Rural Hall, Pstree's pond.....	500
Rich Pond, Willow Shade Pond.....	1,000	Smithfield, Holts Lake.....	600
Roulette, Burke's pond.....	500	Woodside, Lake Lottie.....	300
South Park, South Park Lake.....	1,650	<b>Ohio:</b>	
Sullivan, Amerson's pond.....	300	East Monroe, Lees Creek.....	100
<b>Maryland:</b>		Greenfield, Faint Creek.....	100
Easton, Shannahan's pond.....	200		
Hagerstown, Antietam Creek.....	1,200		
Lewistown, State fish commission.....	2,900		
Robinson, Magothy River.....	300		

a Exclusive of 4,900 fry and 1,125 fingerlings lost in transit.

b Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## ROCK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Ohio—Continued.		Texas—Continued.	
Greenfield, Rattlesnake Creek.....	100	Jacksonville, Haberlie Lake.....	50
Rocky Fork Creek.....	100	Hood Pond.....	50
Oklahoma: Lyons, Harper's pond.....	200	Lawrence Lake.....	50
Pennsylvania:		Long Lake.....	50
Doylstown, North Branch Creek....	200	McReynolds Lake.....	50
Swartzlander Mill Pond.....	200	Park Lake.....	50
Meadowbrook, Farm Lake.....	200	Pussler Lake.....	50
South Carolina:		Kemp, Shaw Lake.....	36
Columbia, Messer Mill Pond.....	300	Lampasas, Culver's pond.....	50
St. Mathews, Millwood Pond.....	300	Loraine, Bauman's pond.....	50
Tennessee:		McDade, Bermuda Pond.....	50
Cleveland, Fillauer's pond.....	500	Moody, Gent Pond.....	45
Franklin, West Harpeth River, Murphy Fork.....	1,000	Overton, Strickland Lake.....	50
Harriman, Lovely Springs Pond.....	1,200	Pittsburg, Willow Lake.....	50
Morristown, Light Company Pond....	335	Stamford, City Lake.....	75
Murfreesboro, Stone River.....	6,000	Virginia:	
Prospect Station, Griffin's pond.....	1,000	Ashland, Willow Spring Pond.....	200
Texas:		Buffalo Station, Buffalo Creek.....	50
Brenham, Brenham Club Lake.....	110	Danville, Strawberry Pond.....	200
Center, Hillcrest Lake.....	60	Emporia, Fountain Creek.....	800
Clifton, Dahl's pond.....	45	Slagel's pond.....	600
Floresville, Father Zarb Pond.....	75	Three Creeks.....	1,100
Fort Worth, Westside Lake.....	65	Yarrell Pond.....	600
Jacksonville, Alexander Lake.....	50	Seven Mile Ford, Rice's pond.....	100
Churchill Lake.....	50	Thaxton, McMillan's pond.....	200
Crysup Lake.....	50	Whiteacre, Toms Creek.....	1,000
Deveraux Lake.....	50	Wisconsin: Galesville, Lake Marinuka.	150
Dublin Lake.....	50		
Goodson Lake.....	50	Total.....	75,460

## WARMOUTH BASS.

Mississippi: Tupelo, Gum Pond..... 1,060

## SUNFISH (BREAM).

Alabama:		Alabama—Continued.	
Abbeville, Cowpen Creek.....	500	Falkville, Key's pond.....	300
Danzeys pond.....	250	Fort Deposit, Davis's pond.....	1,200
East Choctawhatchee River.....	1,000	Garland, Joyner's pond.....	300
Espys Lake.....	1,000	Geigers, Liars Lake.....	3,600
Huito's pond.....	1,000	Goodwater, Power Pond.....	1,400
Starling's pond.....	1,000	Greenville, L. & N. Pond.....	500
Vann's mill pond.....	750	Hannon, Three Springs Pond.....	200
Alberta, Atkins's pond.....	300	Headland, Baker's pond.....	500
Alexander City, Hillabee Creek.....	800	Hardwick's pond.....	1,000
Andalusia, Langston's pond.....	1,500	Jennie Lind Pond.....	1,000
Anniston, Allen's mill pond.....	450	Pasture Lake.....	1,250
Bynum's mill pond.....	400	Spivey Mill Pond.....	750
Hughes Mill Pond.....	450	Huntsville, Braham Spring Pond.....	300
Loyd's mill pond.....	400	Jasper, Bankhead's pond.....	300
Nesbitt's pond.....	450	LaFayette, Hall's pond.....	200
Arlington, Dismukes's pond.....	300	Louisville, Flournoy's pond.....	150
Bankston, Gardner's pond.....	300	Mathison's pond.....	1,000
Gladden's pond.....	600	Warr's pond.....	300
Belle Mina, Beaverdam Creek.....	900	Luverne, Kendrick-Ruff Pond.....	250
Benton, Bozeman Pond.....	900	Mathews's pond (A).....	500
Black Belt Pond.....	750	Mathews's pond (B).....	500
Birmingham, Hollis Pond.....	400	Simmons's pond.....	500
Booth, Shanks's pond.....	400	McCalla, Beil's pond.....	1,350
Thompson's pond.....	600	Marion, Perry Lake.....	1,000
Calhoun, Beil's pond.....	600	Woodfin's pond.....	600
Carrollton, Kilpatrick's pond.....	200	Midway, Willow Lake.....	150
Miller's pond.....	200	Millport, Cash's pond.....	300
Childersburg, DeLoach's pond.....	200	Milry, McLemore's pond.....	900
Chocoloco, Brickyard Pond.....	200	Martin's mill pond.....	900
Clio, Ruch's pond.....	300	Milstead, Spring Hill Pond.....	500
Comer, Holly Creek.....	300	Monroe, Lake Dark.....	1,500
Cooper, Edwards's pond.....	300	Montgomery, Line Creek.....	200
Dadeville, McIntosh's pond.....	200	Shooting Club Lake.....	2,700

a Exclusive of 1,400 lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## SUNFISH (BREAM)—Continued.

Disposition.	Number.	Disposition.	Number.
Alabama—Continued.		California:	
Murphy Station, Roberts Pond.....	500	Mecca, Dunn's pond.....	120
New Brockton, Folsom's pond.....	1,000	San Diego, Ellens Pond.....	200
Oneonta, Little Warrior River.....	400	Colorado: Paonia, Winter's pond.....	400
Opelika, Crest Lake.....	800	Connecticut:	
Davis's pond.....	400	Hartford, State fish commission.....	1,400
Orrville, Lake Wallace.....	200	Wintergreen Pond.....	400
Moseley's pond.....	200	Stamford, Robins's pond.....	200
Pelham, Palmeto Mill Lake.....	1,500	Delaware: Wilmington, Bellevue Pond.....	600
Peterman, Bramley's pond.....	1,200	Florida:	
Pine Hill, Stokes Pond.....	600	DeFuniak Springs, Chipley Park	
Repton, Dee's pond.....	300	Lake.....	200
Riderwood Upper Choclahana Lake.....	900	Greensboro, Cowen's pond.....	450
Roanoke, Johnson's pond.....	300	Tampa, Strawberry Lake.....	600
Samson, McCall Pond.....	2,009	Georgia:	
Seale, Benton's pond.....	450	Alamo, Kent's pond.....	200
Dudley's pond.....	450	Alvaton, Swygert's pond.....	500
Sellers, Boyd's pond.....	250	Americus, Muckalee Creek.....	300
Selma, Stoddard's pond.....	400	Athens, Hodgson's pond.....	300
Whites Pond.....	400	Mitchell's pond.....	300
Speigner, Mortar Pond.....	900	Atlanta, Brookhaven Lake.....	750
Three Notch, Thornton's pond.....	150	Norris's pond.....	250
Troy, Jones's pond.....	250	Augusta, Belding's pond.....	150
Youngblood Mill Pond.....	1,500	Erchert Pond.....	300
Tunnel Springs, Hardee's pond.....	600	Tarver's pond.....	300
Arizona:		Whitney Pond.....	450
Benson, Boyles's pond.....	120	Beach, Sweet's pond.....	500
Fry's pond.....	120	Bishop, Hattaway's pond.....	100
Merriall's pond.....	120	Boneville, Mill Creek Pond.....	450
Cochise, Wilson's pond.....	120	Bostwick, Anderson's pond.....	100
Globe, Sleeping Beauty Pond.....	300	Buena Vista, Bridge Creek Pond.....	600
Nogales, Pasture Pond.....	120	Shorts Mill Pond.....	150
Arkansas:		Chipley, Culpepper Pond.....	150
Arberg, Abb Smith Creek.....	452	Clarkston, Pasture Pond.....	100
Arberg Creek.....	452	Coffee, Harrison's pond.....	250
Little Red River.....	604	Colbert, Fortson's pond.....	150
Sugar Camp Creek.....	452	Hopkins's pond.....	150
Barber, Indian Pond.....	200	Columbus, Bussey's pond.....	150
Barnett, Little Red River.....	904	Christian's pond.....	150
Meadow Creek.....	452	Lummas Pond.....	150
Black Rock, Black River.....	a 3,245	Conyers, Farmer's pond.....	100
Bonanza, Smith Pond.....	400	Walker's pond.....	200
Elba, Hurricane Creek.....	200	Cordele, Williams's pond.....	600
Moon Creek.....	200	Crawfordsville, Chapman Creek.....	400
Red River.....	200	Cox Lake.....	150
Emerson, Randall's pond.....	200	Hardins Creek.....	200
Stevens's pond.....	406	Cyclonetta, Cycloneta Ponds.....	500
Everton, Anderson Pond.....	400	Douglas, Railway Pond.....	450
Harrison, Buffalo River.....	678	Dublin, Dreamland Lake.....	350
Carlton Branch.....	500	Edna, Lake Kilkare.....	500
Cove Creek.....	500	Fitzgerald, Dickson's mill pond.....	500
Farmer's pond.....	452	Fort Valley, Magnolia Pond.....	600
Murray's pond.....	232	Fowlstown, Dasher's pond.....	400
Heber Springs, Peter Creek.....	678	Guysie, McCreas's pond.....	500
Red River.....	904	Hampton, Hampton Pond.....	500
Sulphur Creek.....	904	Higgston, Morris's pond.....	450
Higden, Little Red River, South		Hogansville, Lazylands Pond.....	500
Fork.....	1,130	Holly Springs, Steeles Pond.....	250
Hunter, Engell's pond.....	400	Macon, Hogans Branch.....	450
Leola, Lea's pond.....	150	Sherwood Creek.....	300
Marshall, Bear Creek.....	678	Madison, Oak Branch Pond.....	200
Big Creek.....	678	Manor, Greezy Creek.....	250
Buffalo River.....	678	Monroe, Lake Linda.....	300
Rocky Creek.....	678	Towler's pond.....	100
Spring Creek.....	678	Mystic, Willis's pond.....	300
Miller, Cave Creek.....	1,130	Nicholls, Kirkland's pond.....	500
Little Red River.....	1,130	Lott's pond.....	500
Ozan, Smisson Farm Pond.....	300	Saginaw Ponds.....	500
Pangburn, Little Red River.....	904	Ocilla, Holt Pond.....	300
Pine Bluff, Kennelwood Pond.....	400	Paulk's pond (A).....	600
Poe, Indian Creek.....	452	Paulk's pond (B).....	450
St. Joe, Cave Creek.....	200	Paulk's pond (C).....	300
Mill Creek.....	400	Pavo, McGraw Pond.....	500
Spirit Lake, Spirit Lake.....	1,200	Raymond, Raymond Lake.....	750
Texarkana, Hogans Lake.....	300	Reynolds, Horse Creek Pond.....	450
Waldo, Hosier's pond.....	500	Rockingham, Camp Head Creek.....	500

<sup>a</sup> Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## SUNFISH (BREAM)—Continued.

Disposition.	Number.	Disposition.	Number.
Georgia—Continued.		Kentucky:	
Rockingham, Delge's pond.....	500	Adairsville, Red River.....	100
Rome, Coosa Moore Lake.....	150	Bowling Green, Blue Hole Pond.....	400
Sale City, LaNona Belle Pond.....	250	Campbellsville, Public Utilities Lake.....	800
Screven, Mill Pond.....	500	Covington, Michels Pond.....	400
Soperton, Gillis's pond.....	300	East Cairo, Ohio River.....	a 106,000
Sparta, Rocky Pond.....	200	Haags Spur, Clear Lake.....	a 15,000
Stephens, Cheney's pond.....	200	Prairie Lake.....	a 12,000
Stilesboro, McGowan's pond.....	150	Horse Cave, Hedgepeth's pond.....	200
Stockton, Crews Pond.....	750	Jeffersonville, Q. M. Depot Pond.....	600
Swainsboro, Little Ohoopce River.....	450	Lawrenceburg, Carroll's pond.....	600
Watson's pond.....	300	Witherspoon Lake.....	400
Sycamore, Ray's pond.....	300	Lebanon, Nattingly's pond.....	200
Tallapoosa, Cauthen's pond.....	300	Louisville, Bear Grass Creek.....	11,000
Summerlin's pond.....	350	Cane Run Creek.....	10,000
Temple, McGarity's pond.....	200	Harrods Creek.....	6,000
Thomson, Bowden's pond.....	300	Lake Lansdowne.....	5,200
Tifton, Cypress Log Lake.....	500	Lyndon, Willowbrook Pond.....	200
Gum Pond.....	750	Mayfield, McCall's pond.....	450
Price's pond.....	750	Mount Sterling, Greene's pond.....	300
Webb's pond.....	500	Reid's pond.....	400
Tucker, Tanner's pond.....	150	Munfordville, Wood's pond.....	150
Ty Ty, Black Gum Pond.....	500	Nichlasville, Hooverhurst Ponds.....	600
Gibbs Pond.....	500	Olmstead, Paris's pond.....	200
Valdosta, Jones's pond.....	750	Science Hill, Keller's pond.....	200
Vidalia, Rountree's pond.....	200	Shelbyville, Clear Creek.....	200
Willacoochee, Paulk's pond (A).....	500	South Park, South Park Lake.....	15,500
Paulk's pond (B).....	750	Trenton, Crusher Pond.....	300
Woodbury, Gilbert's pond.....	150	Maple Lawn Pond.....	300
Powers-Sims Pond.....	450	Willard, Porter's pond.....	200
Illinois:		Louisiana:	
Alpha, Crescent Lake.....	800	Bayou Sara, Parker Pond.....	1,000
Apple River, Apple River.....	600	Homer, Shaw's pond.....	400
Aquaka, Mississippi River.....	a 3,215	Longstreet, Longstreet Pond.....	175
Blanding, Mississippi River.....	a 1,750	Mansfield, Wemple's pond.....	405
Cairo, Mississippi River.....	a 50,000	Rushton, Breedlove's pond.....	450
Dallas City, Lake Cooper.....	a 5,965	Wakefield, Cutrer's pond.....	500
Freeport, Yellow Creek.....	200	Maryland:	
Galena, Mississippi River.....	a 2,838	Aberdeen, Glenburnie Pond.....	200
Meredosia, Illinois River.....	a 18,500	Baltimore, Gwynn Oak Lake.....	125
Meredosia Bay.....	a 1,400	Glendale, Folly Run.....	600
New Boston, Mississippi River.....	a 15,335	Great Falls, Potomac River.....	600
Nora, Apple River.....	800	Hoods Mill, Patapsco River.....	200
Quincy, Spring Lake.....	1,600	Lansdowne, Sulphur Spring Lake.....	200
Sand Prairie, Mississippi River.....	a 25,425	Laurel, Waskey's pond.....	200
Scales Mound, Apple River.....	600	Lewistown, State fish commission.....	1,415
Scioto Mills, Richland Creek.....	250	Owings, Sewell Pond.....	200
Yellow Creek.....	250	Riverdale, Heurich's pond.....	800
Stonefort, Hill Farm Pond.....	400	Massachusetts:	
Warren, Apple River.....	1,000	Concord, Punkstasset Pond.....	200
Winslow, Pecatonica River.....	200	Lowell, Ames Pond.....	600
Indiana:		Michigan:	
Brazil, American Sewer Pipe Pond.....	450	Crystal Falls, Lake Marie.....	55
Cambridge City, Paul's pond.....	400	Little Tobin Lake.....	55
Cicero, Bandonner's pond.....	200	Railroad Lake.....	55
Corydon Junction, Hartman's pond.....	200	Tobin Lake.....	55
Eddy, Dallas Lake.....	200	Gwinn, Norine Lake.....	200
Elberfeld, Fiedler's pond.....	150	Holton, Horseshoe Lake.....	250
Huntingburg, Ferdinand Lake.....	300	Norwegian Lake.....	250
Indianapolis, Sugar Creek.....	200	Houghton, Lake Eva.....	220
New Albany, Blue Itasca Pond.....	200	Munising, Annie River.....	110
Falling Run Creek.....	400	Minnesota:	
Ramsey, Fairview Pond.....	200	Arco, Lake Stay.....	400
Iowa:		Homer, Mississippi River.....	a 610,200
Bellevue, Mississippi River.....	a 615	Red Wing, Mississippi River.....	a 8,950
Fairport, Mississippi River.....	a 1,869	Rochester, Lake Florence.....	150
Fort Madison, Dobson's pond.....	400	Lake Shady.....	700
Lime Springs, Upper Iowa River.....	1,250	Mayo Park Pond.....	200
Lovilia, McDonald's pond.....	400	Stockton, Bigelow's pond.....	500
Manchester, Maquoketa River.....	1,690	Tamarack, Round Lake.....	600
Pleasant Creek, Mississippi River.....	a 30,900	Mississippi:	
Smiths Ferry, Mississippi River.....	a 11,110	Amory, Spring Lake.....	600
Wyalusing, Mississippi River.....	a 6,000	Ashwood, Hughes's pond.....	500
Yellow River, Mississippi River.....	a 250	Thompson's pond.....	500
Kansas:		Bay Spring, Willow Spring Pond.....	600
Garnett, Cedar Creek.....	500	Canton, Big Lake.....	1,200
Parsons, Club Ponds.....	500	Ring's pond.....	600
Pittsburg, Country Club Lake.....	800	Round Lake.....	900

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## SUNFISH (BREAM)—Continued.

Disposition.	Number.	Disposition.	Number.
<b>Mississippi—Continued.</b>		<b>Missouri—Continued.</b>	
Centerville, Cox's pond.....	1,000	Saginaw, Walker's pond.....	200
Midway Pond.....	500	St. James, Meramec River.....	750
Montrose Pond (A).....	1,000	Springfield, Kunzmer's pond.....	300
Montrose Pond (B).....	500	Sweet Springs, Shirader's pond.....	300
Mayfield's pond.....	500	Nevada: Fallon, Cottonwood Canon Creek.....	150
Columbus, Bank's pond.....	600	New Jersey:	
Lake Willis.....	600	Branchville, Lake of the Woods.....	200
Myrtle Terrace Lake.....	600	White House Station, Paul Poppe Pond.....	200
Crawford, Richard's pond.....	900	New Mexico:	
Decatur, Spivey's pond.....	1,200	Aztec, Animas Sunfish Pond.....	200
Duffee, Calvert's pond.....	200	Cambridge, Nunns Ranch Pond.....	150
Durand, Dodd's pond.....	300	Cutter, Elephant Butte Lake.....	600
Elliott, Mier's pond.....	500	Deming, Ruebush's pond.....	150
Fayetteville, Coffey's pond.....	500	Lake Valley, Greeley Lake.....	240
Friar Point, Mississippi River.....	a39,025	Las Cruces, Hackberry Pond.....	200
Grenada, Pasture Pond.....	500	Orange, Justice's pond.....	120
Hazlehurst, Carter's mill pond.....	300	Portales, Eden Valley Ranch Pond.....	450
Jackson, Clearwater Pond.....	900	Goodwin's pond.....	120
Fraiser's pond.....	900	Raton, Lojcek's pond.....	400
Hughes's pond.....	900	Vaughn, Lucero's pond.....	300
Jones's pond.....	300	New York:	
Williams's pond.....	600	Albany, State fish commission.....	100
Kosciusko, Fenwick's pond.....	600	Altamont, Summit Club Lake.....	400
Janison's pond.....	300	Central Valley, Leo's pond.....	200
Lauderdale, Wadsen's pond.....	600	Derby, Shepard's pond.....	100
Meridian, Asylum Pond.....	600	Far Rockaway, Emmerich's pond.....	400
City Lake.....	1,800	Knowlesville, Spring Brook Pond.....	100
Country Club Pond.....	900	Monticello, Von Isakorie's pond.....	100
Wagner Pond.....	400	<b>North Carolina:</b>	
Waterworks Lake.....	1,500	Badin, Tallahassee Lake.....	2,000
Mississippi City, Green Creek Pond.....	300	Benson, Hardee's pond.....	200
Monticello, Fair River Pond.....	250	Bessemer, Beaverdam Pond.....	400
Mooreville, Ward Mill Pond.....	300	Bryson City, Tuckasegee River.....	800
Natchez, Kenilworth Pond.....	1,000	Burlington, Big Alamance Pond.....	500
Morgantown Pond.....	1,000	Little Alamance Pond.....	500
Peale's pond.....	1,000	Moser Mill Pond.....	400
Neshoba, Blue Fountain Pond.....	600	Stony Creek Pond.....	500
Newton, Everett's pond.....	900	Cary, Jones's pond.....	200
Nola, Prine's pond.....	250	Knights's pond.....	200
Picayune, Puyper's pond.....	900	Clayton, Hinton's pond.....	200
Pocahontas, Middleton's pond (A).....	900	Clinton, Mill Pond.....	300
Middleton's pond (B).....	600	Corinth, Buckhorn Pond.....	400
Raymond, Meadow View Pond.....	1,000	Elkin, Laster's pond.....	500
Newman's pond.....	200	Fayetteville, Bonnie Brook Pond.....	400
Sandersville, Sycamore Farm Pond.....	200	Garner, Wilder's pond.....	200
Selma, Lake Catherine.....	500	Goldboro, Little River.....	500
Sumrall, Blue Pond.....	500	Woods Mill Pond.....	300
Terry, Marlow's pond.....	500	Graham, Clapp's pond.....	400
Tupelo, Pierce's pond.....	200	Greensboro, Lakewood Farm Pond.....	500
Voosburg, Donald's pond.....	200	Hazlewood, Welch's pond.....	200
West Point, Palo Alto Pond.....	600	Hope Mills, Parker's pond.....	600
Woodville, Harris Pond.....	500	Julian, Chockley Pond.....	500
Henderson's pond.....	1,000	Kinston, Kennedy's mill pond.....	250
Lake Clement.....	200	Kittrell, Clear Pond.....	100
Lewis's pond.....	200	Knightdale, Willow Club Pond.....	300
McGehee's pond.....	200	Liberty, Major Hill Pond.....	500
Morgan's pond.....	500	Louisburg, Jones Mill Pond.....	300
North Pond.....	500	Lumberton, McMillen Pond.....	400
Ogden's pond.....	1,000	Mine Creek Pond.....	400
Sessions's pond.....	1,000	Macclesfield, Warren's pond.....	200
Wallace's pond.....	1,000	Marshville, Marsh's pond.....	200
Westmoreland Pond.....	500	Moore's pond.....	200
Word's pond.....	500	Mayodan, Balsam Pond.....	500
<b>Missouri:</b>		Maysville, White Oak River.....	1,300
Buffalo, Evans's pond.....	300	Morven, Martin's pond.....	600
Callao, Wainscot's pond.....	200	Williamspon's pond.....	800
Carthage, Coolbrook Lake.....	50	Mount Airy, Brooks's pond.....	1,000
Goodman, Ritter's pond.....	100	Nashville, May's pond.....	400
Joplin, Moore's pond.....	150	North Wilkesboro, Hendren's pond.....	900
Lebanon, Ballinger Pond.....	250	Hickory Groove Pond.....	500
Little Blue, Dirks Lake.....	400	Pee Dee, Blewett Falls Pond.....	1,800
Merwin, Corbin Lake.....	800	Pittsboro, Hinton's pond.....	200
Neosho, Hickory Creek.....	364	Nooe's pond.....	100
Pleasant Hill, Baldwin Lake.....	300	Potocasi, Hicks Mill Pond.....	400
Scander's pond.....	600	Raleigh, Hinton Creek Pond.....	300
Rolla, Gasconade River.....	1,000		
North Spring Creek.....	500		

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## SUNFISH (BREAM)—Continued.

Disposition.	Number.	Disposition.	Number.
North Carolina—Continued.		South Carolina—Continued.	
Raleigh, Milburnie Pond.....	300	Edgefield, Hollingsworth's pond.....	1,000
Neuseoco Club Pond.....	1,000	May's pond.....	750
Roseboro, Willow Oaks Pond.....	200	Edgemoor, Atkinson Pond.....	400
Ruffin, Cox's pond.....	500	Edmund, Thresher Pond.....	300
Salisbury, Harkey Pond.....	500	Graniteville, Coldwater Creek.....	1,200
Statesville, Beechwood Pond.....	300	Greenville, Southern Power Pond.....	600
Washington, Broad Creek Mill Pond.....	200	Greenwood, Beaverdam Creek.....	400
Hodges's pond.....	200	Reedy Creek.....	400
Upper Broad Creek.....	200	Willow Brook Pond.....	400
Wise, Hicks's pond.....	200	Langley, Langley Mill Pond.....	1,200
North Dakota:		Town Creek Pond.....	300
Petrel, City Lake.....	600	Livingston, Strauss's pond.....	200
Margason's pond.....	400	Lydia, Marcos Mill Pond.....	800
Ohio:		McBee, Cedar Creek.....	400
Akron, Turkey Foot Lake.....	200	Gum Pond.....	400
Cincinnati, Bullskin Creek Pond.....	100	Sand Hill Pond.....	200
Fernwood, Floyd's pond.....	100	McCormick, Huggins's pond.....	400
Oklahoma:		Mars Bluff, Black Creek.....	1,400
Alderson, Mountain Lake.....	200	Mount Croghan, Klondike Pond.....	300
Ardmore, Lake Provence.....	400	Mountville, Holmes's pond.....	600
Claremore, Walnut Lake.....	625	Newberry, Matthews's pond.....	200
Helena, Schmidt's pond.....	80	North Augusta, McKie's pond.....	1,000
Kiowa, Barranger's pond.....	100	Orangeburg, Edgewood Pond.....	400
Meridian, McDaniel's pond.....	80	Edisto River.....	1,000
Oklahoma City, Lord's pond.....	160	Fish Pond.....	600
Pauls Valley, Williams's pond.....	160	Fogle Pond.....	600
Spiro, Bowman's pond.....	200	Zeiglers Pond (A).....	500
Stillwater, Needell's pond.....	80	Zeiglers Pond (B).....	600
Westville, Haupt's pond.....	100	Pacolet, Bonner's pond.....	200
Pennsylvania:		Pageland, Rock Pond.....	600
Chicora, Craig's pond.....	100	Rock Hill, Fennell's pond.....	800
Downingtown, Mellvaine's pond.....	200	South Land Pond.....	600
Doylestown, Cooks Run.....	100	Stony Creek Pond.....	400
Deep Run.....	100	Rockton, Castles's pond.....	400
Elmhurst, Lake Worth.....	200	Ruby, McGregor's pond.....	200
Everett, Juniata River, Raystown Branch.....	300	Moore's pond.....	200
Gap, Ellmaker Creek.....	100	Wilson's pond.....	300
Kaylor, Sugar Creek Pond.....	200	St. Matthews, Hair's pond.....	800
Lancaster, Pequea Creek.....	300	High Hill Creek.....	1,400
McKeesport, Margaret Pond.....	100	Pine Creek Pond.....	800
Mars, Overbrook Pond.....	100	Riley's pond.....	1,200
Moscow, Bearbrook Lake.....	100	Spigener's pond.....	800
Hartford Pond.....	100	Salley, Cook's pond.....	1,250
Ives Pond.....	100	Sharon, Rainey's pond.....	200
Rattlesnake Pond.....	100	Thomson's pond.....	200
Sayre Pond.....	100	Society Hill, Carrigan Pond.....	600
Water Company Creek.....	100	McCown Mill Pond.....	500
Wilson Pond.....	100	Rocky Dundee Pond.....	500
New Bethlehem, Leatherwood Creek.....	100	Spring Pond.....	600
Marshall's pond.....	100	Sumter, Barkley's pond.....	300
Pen Argyl, Broadhead Lake.....	100	Midway Park Pond.....	800
Johnsonville Pond.....	100	Walhalla, Owens's pond.....	200
Lake Pauponoming.....	100	Woodford, Stear Branch Pond.....	200
Lesizys Pond.....	100	York, Wallace's pond.....	200
Seguins Pond.....	100	South Dakota: Elk Point, Aase's pond.....	200
Smalls Pond.....	100	Tennessee:	
Snydersville Creek.....	100	Jackson, Long's pond.....	1,000
Phoenixville, Valley Forge Creek.....	450	Lexington, Henry Pond.....	600
Safe Harbor, Meadow Valley Run.....	250	Perryville, Brandon's pond.....	200
St. Claire, Kaufman Pond.....	300	Persia, Barn Pond.....	500
Saltsburg, Marshall's pond.....	200	Roland Pond.....	500
Slatincton, Meadow Brook Pond.....	200	Woodland Pond.....	1,000
Wynnewood, Indian Pond.....	100	Tasso, Byrd's pond.....	500
Rhode Island: Tiverton, Church's pond.....	100	Texas:	
South Carolina:		Alice, Adams's pond.....	†500
Aiken, Beaver Pond.....	2,000	Alleyton, Willow Creek Lake.....	50
Belton, Belton Mills Pond.....	1,000	Alto, Wilow Pond.....	100
Blaney, Brown's pond.....	800	Aquila, Robertson's pond.....	25
Camden, Little Pine Tree Pond.....	600	Austin, Willow Lake.....	180
Central, Issaqueena Mill Pond.....	400	Bangs, Hall's pond.....	25
Chapin, Kelly's pond.....	400	Bardwell, Sullivan's pond.....	50
Charleston, Laurel Spring Pond.....	600	Wright's pond.....	50
Clover, Clover Cotton Pond.....	400	Bedias, McAdams's pond.....	50
Columbia, Cobb's pond.....	800	Wilson's pond.....	50
Lawrence's pond.....	1,600	Ben Arnold, Crevan Lake.....	32
		Big Wells, Webb's pond.....	†250
		Buck, Bigby's pond.....	50

## TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

## SUNFISH (BREAM)—Continued.

Disposition.	Number.	Disposition.	Number.
Texas—Continued.		Texas—Continued.	
Caro, Lackawana Pond .....	50	Nacogdoches, Mamie Ross Lake....	50
Childress, Crew's pond .....	25	West End Pond .....	50
Clawson, Clawson Lake .....	100	Wilson's pond .....	100
Coleman, Hillside Lake .....	25	Navasota, Zulch Lake .....	125
Collinsville, Hollingshead's pond ..	65	Paint Rock, Lacy's pond .....	25
Corsicana, Burk Pond .....	146	Palestine, Campbell Pond .....	35
Derden Upper Pond .....	†250	Crystal Lake .....	35
Eden's pond .....	36	Pearsall, Malone's pond .....	†250
Refinery Reservoir .....	†250	Pecan Gap, Shady Pond .....	25
Crockett, Burton Lake .....	33	Pleasanton, McCoy's pond .....	†500
Eastside Lake .....	33	Purdon, Moore's pond .....	100
Hack Lake .....	33	San Angelo, Adams's pond .....	25
Ossunna Lake .....	33	San Augustine, Fuitts's pond .....	45
Tanglefoot Lake .....	33	San Marcos, Alexander's pond .....	80
Cross Plains, Hart's pond .....	25	San Saba, Moore's pond .....	25
DeKalb, May's pond .....	20	Walter's pond .....	25
Denton, Hoffman's pond .....	65	Sarber, Club Lake .....	30
Siboll, Conn's pond .....	50	Sherman, Chapman Park Lake .....	195
Dilley, Edwards's pond .....	†250	Stamford, City Lake .....	200
Ennis, City Lake .....	†150	Sterling, North Concha Pond .....	25
New Lake .....	†150	North Concha River .....	25
Enstace, Cook's pond .....	30	Stratford, Beaver Lake .....	25
Falfurkas, Lakota Pond .....	†250	Streetman, Grayson's Lake .....	37
Franklin, Dowdy's pond .....	35	Taft, Willow Lake .....	80
Fredericksburg, Vorauer's pond .....	50	Taylor, Thong's pond .....	65
Gary, Graves's pond .....	90	Teague, Henderson's pond .....	38
Hall's pond .....	30	Thorndale, Heintze's pond .....	65
Lane Pond .....	30	Noack's pond .....	65
Roper's pond .....	45	Schilwalt's pond .....	65
Giddings, Mertink's pond .....	32	Worley's pond .....	65
Gorman, Scales's pond .....	25	Timpson, Garrison Lake .....	50
Grapeland, Fulton's pond .....	33	Vernon, Harris Pond .....	25
Herod Lake .....	33	Waelden, Rabb's pond .....	40
Green, Dadisman's pond .....	30	Whitesboro, Crabtree's pond .....	65
Hallsburg, Holmes Lake .....	400	Whitesboro Stock Pond .....	65
Henrietta, Gilbert's pond .....	50	Winnboro, Willow Lake .....	75
Houston, Hyacinth Pond .....	52	Virginia:	
Huntington, Wilroy's pond .....	50	Alton, Coleman's pond .....	200
Huntsville, Hampton's pond .....	51	Ashland, Willow Spring Pond .....	100
Lake Birmingham .....	51	Beaver Dam, Beaver Dam Pond .....	200
Jacksonville, Alexander's pond .....	100	Boone Mill, Turner's pond .....	300
Club Lake .....	100	Claverdale, Dalesville College Pond ..	200
Crysum Lake .....	100	Edinburg, Forest Service .....	400
Haberle's pond .....	100	Elkton, Wyant's pond .....	100
Hillside Lake .....	100	Farmville, Waterview Pond .....	100
Lane Lake .....	100	Forest Depot, Parks's pond .....	400
Park Lake .....	100	Galax, Kenworthy Pond .....	200
Ragsdale's pond .....	100	Haysi, Big Sandy River, Russell	
Smith Lake .....	100	Fork .....	2,000
Tucker Lake .....	100	Jarratt, Mayes's pond .....	200
West Lake .....	100	Limeton, Mauck's pond .....	100
Kemp, Shaw Lake .....	50	Manasas, Clover Hill Pond .....	200
Kingsville, Flato's pond .....	50	Middletown, Cedar Creek .....	200
Lampassas, Townsen's pond .....	35	Milford, Terrell Pond .....	100
Laredo, Rio Grande Pond .....	†250	Petersburg, Lees Mill Pond .....	500
Leggett, Hayes Lake .....	26	Suffolk, Lake Cahoun .....	800
Llano, Collier's pond .....	35	Lake Kelly .....	2,000
Lockhart, Harris's pond .....	32	Sweet Hall, Custis Lake .....	300
Lometa, Conradt's pond .....	85	Troutville, Harvey Pond .....	200
Longview, Lake Devernia .....	65	Victoria, Smith's pond .....	100
Pecan Lake .....	75	Yale, Stottart's pond .....	300
Lorraine, Baumann's pond .....	50	Zuni, Nebtill Mill Pond .....	800
Louise, Ivy's pond .....	50	West Virginia:	
McDade, Bermuda pond .....	50	Charles Town, Shenandoah River ..	600
Mabank, Chamblee's pond .....	50	Clarksburg, Davison Run .....	400
Marion, Hoese's pond .....	26	Point Pleasant, Squawk Creek .....	200
Linne's pond .....	50	White Sulphur Springs, White Sul-	
Voigt's pond .....	50	phur Springs Lake .....	900
Memphis, Browder Lake .....	25	Wisconsin:	
Lake Bryant .....	25	Japan Slough, Mississippi River .....	a 1,500
Midland, Bryan Place Pond .....	40	La Crosse, Mississippi River .....	a 15,500
Mineola, Bowdoin's pond .....	50	La Forge, Big Slough Pond .....	500
Sand Spring Pond .....	50	Evans Pond .....	500
Nacogdoches, Harris Pond .....	100	Kickapoo River .....	500

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## SUNFISH (BREAM)—Continued.

Disposition.	Number.	Disposition.	Number.
Wisconsin—Continued.		Wisconsin—Continued.	
La Forge, Seeley Pond.....	500	Muscoda, Hoyt Lake.....	300
Slayback Pond.....	500	Jones Lake.....	300
Lake Millicent, Clubine Lake.....	100	Pospickial Lake.....	300
Heart Lake.....	100	Somerset, Pine Lake.....	400
Huber Lake.....	100	Sicor Lake.....	400
Manson, Manson Lake.....	450		
Mason, Kern Lake.....	750	Total <sup>a</sup> .....	{ 1,350,115
Muscoda, Big Cat Pond.....	300		{ 3,050
Elston Lake.....	300		

## PIKE PERCH.

Connecticut:		Michigan—Continued.	
East Hampton, Midwood Pond.....	†100,000	Roscommon, Higgins Lake.....	†600,000
Hazardville, Seantic River.....	†200,000	St. Ignace, St. Martins Bay.....	†400,000
New Canaan, Lake Sisowitt.....	†200,000	Traverse City, Boardman Lake.....	†400,000
Straford, Fresh Pond.....	†200,000	Watersmeet, Anderson Lake.....	†150,000
Wilmantic, Wangumbaug Lake.....	†300,000	Weelington Tank, Bass Lake.....	†100,000
Illinois:		Miller Lake.....	†100,000
Antioch, Druse Lake.....	†300,000	Minnesota:	
Grayslake, Druse Lake.....	†400,000	Chisholm, Clearwater Lake.....	†100,000
Indiana:		Dewey Lake.....	†100,000
Columbia City, State fish commission.....	*8,050,000	Island Lake.....	†100,000
La Grange, Mongo Mill Pond.....	†240,000	McCormick Lake.....	†100,000
Logansport, Fletcher Lake.....	†160,000	Shoepack Lake.....	†100,000
Iowa:		Crookston, Mill Pond.....	†250,000
Fraser, Des Moines River.....	†600,000	Deer River, Deer River.....	†500,000
Rockford, Shell Rock River.....	†600,000	Ersline, Head Lake.....	†100,000
Spirit Lake, State fish commission.....	*5,000,000	Lake Lena, Lake Lena.....	†100,000
Kentucky: Louisville, Ohio River.....	†1,500,000	Lake Ten, Lake Ten.....	†100,000
Massachusetts:		New Hampshire:	
East Walpole, Bird Mill Pond.....	†100,000	Claremont, Rockybound Pond.....	†200,000
Forge Village, Forge Pond.....	†200,000	Meredith, Lake Waukevan.....	†300,000
Framingham, Waushakum Pond.....	†200,000	Nashua, Horseshoe Pond.....	†200,000
Great Barrington, Lake Garfield.....	†100,000	Robinson Pond.....	†200,000
Hudson, West Pond.....	†100,000	Warren, State fish commission.....	*6,000,000
Lowell, Knopps Pond.....	†100,000	New Jersey:	
Merrimack River.....	†200,000	Branchville, Culver Lake.....	†200,000
Round Pond.....	†100,000	Denville, Cedar Lake.....	†200,000
Newburyport, Lake Attitash.....	†500,000	New York:	
Palmer, State fish commission.....	*5,100,000	Albany, State fish commission.....	*60,000,000
Michigan:		Cobleskill, Bear Gulf Lake.....	†100,000
Bay City, Saginaw Bay.....	†3,200,000	Roosman Vie Lake.....	†200,000
State fish commission.....	*288,800,000	Congers, Rockland Lake.....	†300,000
Bergland, Lake Gogebic.....	†600,000	Cornwall, Popolo Lake.....	†300,000
Beulah, Crystal Lake.....	†600,000	Highland Falls, Roe Lake.....	†100,000
Brighton, Worden Lake.....	†200,000	New York City, Aquarium.....	*2,000,000
Calumet, Medora Lake.....	†150,000	Peekskill, Lake Mohegan.....	†200,000
Channing, Lake Helen.....	†150,000	Pleasant Valley, Bowers Pond.....	†200,000
Charlevoix, Cunningham Lake.....	†1,000,000	Port Henry, Lake Champlain.....	†400,000
Lake Michigan.....	†6,000,000	Westport, Deadwater Lake.....	†200,000
Matchett Lake.....	†1,000,000	North Dakota:	
Crystal Falls, Deer River.....	†250,000	Bottineau, Lake Mettigoshee.....	†600,000
Fortune Lake.....	†150,000	Wimbleton, Spiritwood Lake.....	†200,000
Lake Marie.....	†150,000	Ohio:	
Michigamme River.....	†200,000	Columbus, Scioto River.....	†300,000
Tobin Lake.....	†100,000	Isle St. George, Lake Erie.....	†9,700,000
Dumham, Lake Celeste.....	†150,000	Kellys Island, Lake Erie.....	†10,000,000
Ewen, Ontonagon River.....	†200,000	Lake View, Indian Lake.....	†300,000
Gwinn, Bass Lake.....	†150,000	Middle Bass, Lake Erie.....	†10,000,000
Little Lake.....	†200,000	Port Clinton, Lake Erie.....	†5,000,000
Meal Lake.....	†150,000	Put in Bay, Lake Erie.....	†15,000,000
Iron River, Chicagoan Lake.....	†300,000	Sandusky, Lake Erie.....	†10,000,000
Stanley Lake.....	†200,000	Toledo, Lake Erie.....	†10,000,000
Sunset Lake.....	†200,000	Pennsylvania: Erie, State fish commission.....	*15,050,000
Ishpeming, Beaver Creek.....	†100,000	Rhode Island: Providence, Wallum Lake.....	†200,000
Grass River.....	†150,000	Tennessee: Manchester, Duck River.....	†200,000
Mink Creek.....	†50,000	Vermont:	
Mulligan Creek.....	†100,000	Bennington, Barber Pond.....	†200,000
Otter Creek.....	†200,000	Lake Hancock.....	†200,000
Silver Lake.....	†200,000	North Bennington Pond.....	†200,000
Little Lake, Godin's lake.....	†50,000	Woodford City Big Pond.....	†200,000
Republic, Martel Lake.....	†150,000		
Milwaukee Lake.....	†150,000		

<sup>a</sup> Exclusive of 3,520 fingerlings lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## PIKE PERCH—Continued.

Disposition.	Number.	Disposition.	Number.
Vermont—Continued.		Wisconsin—Continued.	
Brattleboro, Connecticut River.....	†300,000	Couderay, Namakagon Lake.....	†100,000
Hunts Meadow Lake.....	†100,000	Rice Lake.....	†200,000
Sunset Lake.....	†100,000	Round Lake.....	†200,000
West River.....	†100,000	Spring Lake.....	†200,000
Burlington, State fish commission.....	*16,200,000	Tener Lake.....	†100,000
Canaan, Wallis Pond.....	†200,000	Gordon, Bardou Lake.....	†200,000
Enosburg Falls, Lake Carmi.....	†400,000	St. Croix Lake.....	†200,000
Hardwick, Lake Greenwood.....	†400,000	La Crosse, Black River.....	†5,000,000
Lake Champlain, Lake Champlain.....	†60,000,000	Mississippi River.....	a 10,710
Rocky Point, Groton Pond.....	†400,000	Tomahawk, Big Rice Lake.....	†100,000
Vergennes, Otter Creek.....	†200,000	Clear Lake.....	†150,000
Wells, Lake St. Catherine.....	†750,000	King Pond.....	†100,000
Wells River, Connecticut River.....	†300,000	Little Somo River.....	†100,000
Windsor, Runnemead Pond.....	†200,000	Muskallonge Creek.....	†100,000
Wisconsin:		Muskallonge Lake.....	†100,000
Chippewa Falls, Lake Wissota.....	†400,000	Pickarel Lake.....	†100,000
O'Neill's Creek.....	†200,000	Rice River.....	†100,000
Couderay, Bass Lake.....	†100,000	Silver Lake.....	†100,000
Bear Lake.....	†100,000	Skanawan Creek.....	†100,000
Big Bass Lake.....	†250,000	Skanawan Lake.....	†100,000
Big Chetek Lake.....	†200,000	Somo River.....	†100,000
Big Couderay Lake.....	†150,000	Spirit River.....	†100,000
Blueberry Lake.....	†150,000	Tomahawk River.....	†100,000
Chief Lake.....	†250,000	Winter, Bass Lake.....	†100,000
Devils Lake.....	†100,000	Black Dan Lake.....	†100,000
Hunter Lake.....	†250,000		
Knudson Lake.....	†150,000		
Lake Weirgor.....	†100,000		
Little Couderay Lake.....	†100,000		
		Total b.....	{ *106,200,000 †175,550,000 10,710

## YELLOW PERCH.

Arizona:		Maryland—Continued.	
Globe, Roosevelt Lake.....	800	Broad Creek, Potomac River.....	†19,209,940
Williams, Cataract Ponds.....	625	Cumberland, Potomac River.....	200
Connecticut:		Potomac River, North Branch.....	200
Bristol, Old Pond.....	†200,000	Piscataway Creek, Potomac River.....	†19,209,940
Pine Lake.....	†200,000	Swan Creek, Potomac River.....	†9,604,970
Greenwich, Wildwood Lake.....	†100,000	Massachusetts: Pittsfield, Pontoosuc	
Hartford, State fish commission.....	1,625	Lake.....	†800,000
Meridian, Hanover Pond.....	†300,000	Michigan: Brighton, Big Worden Lake	
Stamford, Robins's pond.....	250	Minnesota:	
District of Columbia: Highway Bridge,		Homer, Mississippi River.....	a 2,208,020
Potomac River.....	†2,500,000	Red Wing, Mississippi River.....	a 3,110
Illinois:		Mississippi: Meridian, Waterworks	
Alexander, Davenport Lake.....	375	Lakes.....	1,250
Apple River, Apple River.....	150	Missouri:	
Galena, Mississippi River.....	a 18	Neosho, State fish commission.....	{ *160,000 †40,000 †90,000 1,000
Meredosia, Illinois River.....	a 5,900	Newton, Hearrell Creek.....	
Nora, Apple River.....	300	St. Louis, Wabash Club Pond.....	
Quincy, Spring Lake.....	625	Montana:	
Scales Mound, Fevre River.....	150	Glendive, Yellowstone River.....	360
Warren, Fevre River.....	600	Miles City, Yellowstone River.....	420
Indiana:		New Jersey:	
Huntingburg, Ferdinand Lake.....	125	Butler, Hennions Lake.....	80
Indianapolis, White River.....	125	Hackettstown, State fish commis-	
Kimmell, Lake Lucid.....	200	sion.....	*21,500,000
Iowa:		Palisades, Overpeck Creek.....	80
Bellevue, Mississippi River.....	a 190	Towaco, Surprise Lake.....	80
Harpers Ferry, Mississippi River.....	a 40,000	New York:	
Le Mars, Dalton Pond.....	740	Cape Vincent, St. Lawrence River.....	†2,000,000
Manchester, Maquoketa River.....	290	Grass Bay, St. Lawrence River.....	†3,000,000
Yellow River, Mississippi River.....	a 100	New York City, Aquarium.....	*1,000,000
Kentucky:		Perch Hole, St. Lawrence River.....	†2,000,000
Frankfort, State fish commission.....	†100,000	North Carolina:	
Louisville, Ohio River.....	†180,000	Highlands, Hawkins Pond.....	50
Mount Sterling, Graves's pond.....	125	Roseboro, Baggett's pond.....	50
South Park, South Park Lake.....	†100,000	Ohio:	
Vine Grove, Westmouth Lake.....	375	Apple Creek, Fountain Valley Pond.....	100
Maryland:		Isle St. George, Lake Erie.....	†6,000,000
Aberdeen, Glenburnie Pond.....	200	Kelleys Island, Lake Erie.....	†6,000,000
Accokeek, Potomac River.....	†19,209,940		

a Rescued from overflowed lands and restored to original waters.

b Exclusive of 1,150,000 fry lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## YELLOW PERCH—Continued.

Disposition.	Number.	Disposition.	Number.
Oklahoma: Sentinel, Spring Lake.....	50	Virginia:	
Pennsylvania:		Boydton, Sydnor Old Mill Pond....	54
Arcola, Perkiomen Creek.....	90	Bylesby, Meadow Creek.....	300
Canton, Lake Nephawin.....	100	Dogue Creek, Potomac River.....	†38,419,870
Everett, Juniata River, Raystown Branch.....	200	Edinburg, Forest Service.....	200
Gratersford, Perkiomen Creek.....	90	Emporia, Jones Pond.....	30
Harrisburg, Wildwood Lake.....	100	Taylor's pond.....	30
Landisville, Chickies Creek.....	300	Little Hunting Creek, Potomac River.....	†9,604,970
Lititz, Hubers Pond.....	200	Pehick Creek, Potomac River.....	†38,419,870
Mance, Berkely Pond.....	200	Wytheville, Reed Creek.....	600
Walker Lake.....	200	Reed Creek, South Fork.....	300
Oaks, Perkiomen Creek.....	90	West Virginia:	
Phoenixville, French Creek.....	300	Berkeley Springs, Sleepy Creek....	400
Pottstown, McFarland Sheep Farm Pond.....	150	Clarksburg, Davisson Run.....	400
Powys, Lycoming Creek.....	100	Wisconsin:	
Schwenksville, Perkiomen Creek....	90	Blair, Trempealeau River.....	750
Slatington, Cartright Pond.....	40	Trempealeau River Pond.....	750
Meadow Brook Pond.....	40	Galesville, Lake Marinuka.....	1,250
Spring Mount, Perkiomen Creek....	90	La Crosse, Mississippi River.....	a 76,260
Troy, Mountain Lake.....	150	Rice Lake, Rice Lake.....	185
Valley Forge, Schuylkill River....	150		
Tennessee:		Total b.....	*22,660,000 †179,289,500 2,353,800
Nashville, Buell's pond.....	250		
Springfield, Murphy's pond.....	125		
Vermont:			
Miles Pond, Miles Pond.....	†700,000		
St. Johnsbury, Shadow Lake.....	†300,000		
West Danville, Joes Pond.....	†1,000,000		

## WHITE PERCH.

North Carolina: Edenton, Albemarle Sound.....	†2,035,000		
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## WHITE BASS.

Arkansas: Black Rock, Black River..	a 560	Minnesota:	
Illinois:		Homer, Mississippi River.....	a 1,500
Galena, Mississippi River.....	a 1,256	Red Wing, Mississippi River.....	a 250
New Boston, Mississippi River....	a 225	Wisconsin: Clayton, Mississippi River.	a 1,000
Sand Prairie, Mississippi River....	a 500		
Iowa: Bellevue, Mississippi River....	a 2,574	Total.....	8,865
Kentucky: East Cairo, Ohio River....	a 1,000		

## YELLOW BASS.

Mississippi: Meridian, Waterworks Lake.....	600		
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## STRIPED BASS.

North Carolina: Weldon, Roanoke River.....	†13,540,000		
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a Rescued from overflowed lands and restored to original waters.

b Exclusive of 750 fingerlings lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## MACKEREL.

Disposition.	Number.	Disposition.	Number.
Massachusetts:		Massachusetts—Continued.	
Falmouth, Buzzards Bay .....	† 7,179,000	Woods Hole, Vineyard Sound .....	† 215,000
Gosnold, Buzzards Bays .....	† 2,114,000	Total .....	† 9,508,000

## COD.

Maine: Boothbay Harbor, Boothbay Harbor .....	† 1,067,000	Massachusetts—Continued.	
Massachusetts:		Lackeys Bay, Vineyard Sound .....	† 1,507,000
Beverly, Massachusetts Bay .....	† 20,550,000	Naushon Island, Vineyard Sound .....	† 1,370,000
Gloucester, Atlantic Ocean .....	† 7,230,000	Rockport, Ipswich Bay .....	† 15,100,000
Gloucester, Atlantic Ocean .....	* 243,870,000	Woods Hole, Eel Pond .....	† 4,729,000
Great Harbor, Vineyard Sound .....	† 10,644,000	Total a .....	† 64,331,000
Jobs Neck, Vineyard Sound .....	† 2,134,000		* 243,870,000

## POLLOCK.

Maine: Boothbay Harbor, Boothbay Harbor .....	† 1,714,000	Massachusetts—Continued.	
Massachusetts:		Marblehead, Massachusetts Bay .....	† 17,520,000
Beverly, Massachusetts Bay .....	† 69,340,000	Rockport, Atlantic Ocean .....	† 207,120,000
Gloucester, Atlantic Ocean .....	† 309,098,000	Ipswich Bay .....	† 36,180,000
Ipswich Bay .....	† 15,000,000	Total .....	† 703,972,000
Manchester, Massachusetts Bay .....	† 48,000,000		

## HADDOCK.

Maine: Boothbay Harbor, Boothbay Harbor .....	† 192,000	Massachusetts—Continued.	
Massachusetts:		Rockport, Atlantic Ocean .....	† 7,830,000
Beverly, Massachusetts Bay .....	† 22,120,000	Ipswich Bay .....	† 21,830,000
Gloucester, Atlantic Ocean .....	† 58,350,000	Total a .....	† 129,592,000
Gloucester, Atlantic Ocean .....	* 200,390,000		* 200,390,000
Marblehead, Massachusetts Bay .....	† 19,270,000		

## WINTER FLOUNDER.

Maine:		Massachusetts—Continued.	
Boothbay Harbor, Boothbay Harbor .....	† 12,893,000	Waquoit Bay .....	† 229,702,000
Linskins Bay .....	† 470,441,000	Gloucester, Annisquam River .....	† 7,710,000
Lobster Cove .....	† 67,303,000	Gloucester Harbor .....	† 75,320,000
Mill Cove .....	† 58,269,000	Ipswich Bay .....	† 17,880,000
Townsend Gut .....	† 64,278,000	Gosnold, Hadley Harbor .....	† 109,978,000
Bristol, Robinson Cove .....	† 24,196,000	Lackeys Bay .....	† 110,871,000
Cundy Harbor, Hen Cove .....	† 79,402,000	Manchester, Massachusetts Bay .....	† 12,150,000
Piddley Cove .....	† 68,059,000	Provincetown, Provincetown Harbor .....	† 30,144,000
East Boothbay, Linekins Bay .....	† 78,633,000	Rockport, Atlantic Ocean .....	† 4,640,000
Pemaquid, Johns River .....	† 87,004,000	Vineyard Haven, Lagoon Pond .....	† 64,118,000
Pemaquid Harbor .....	† 75,621,000	Woods Hole, Eel Pond .....	† 56,551,000
Rockland, Rockland Harbor .....	† 54,775,000	Great Harbor .....	† 50,410,000
Southport, Ebencook Harbor .....	† 22,686,000	Little Harbor .....	† 74,516,000
Thomaston, Seal Harbor .....	† 115,696,000	New York: Edgemere, Jamaica Bay .....	† 64,966,000
Massachusetts:		Rhode Island: Wickford, Wickford Harbor .....	† 116,920,000
Beverly, Massachusetts Bay .....	† 21,290,000	Total .....	2,654,192,000
Chilmark, Menemsha Pond .....	† 118,687,000		
Falmouth, Falmouth Harbor .....	† 34,916,000		
Quissett Harbor .....	† 174,167,000		

a The eggs were taken, fertilized, and planted on spawning grounds.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—  
Continued.

## MISCELLANEOUS FISHES.

Disposition.	Number.	Disposition.	Number.
Arkansas: Black Rock, Black River..	a 655	Maryland: Baltimore, State fish commission.....	†1,000,000
Illinois:		Minnesota:	
Aquauka, Mississippi River.....	a 95	Homer, Mississippi River.....	a 70,400
Galena, Mississippi River.....	a 36,550	Red Wing, Mississippi River.....	a 3,025
New Boston, Mississippi River.....	a 1,915	Wisconsin:	
Iowa:		Clayton, Mississippi River.....	a 70,000
Bellevue, Mississippi River.....	a 40,570	La Crosse, Mississippi River.....	a 352,600
Fairport, Mississippi River.....	a 1,455	Lynxville, Mississippi River.....	a 8,000
Harpers Ferry, Mississippi River.....	a 44,000	Prairie du Chien, Mississippi River..	a 20,000
McDolans Dam, Mississippi River.....	a 20,000		
Manchester, Maquoketa River.....	85		
Smiths Ferry, Mississippi River.....	a 11,900		
Yellow River, Mississippi River.....	a 66,000	Total.....	{ 747,250
			{ †1,000,000

## LOBSTER.

Maine:		Maine—Continued.	
Boothbay Harbor, Harpswell Harbor.....	†2,000,000	Pemaquid Harbor, Johns Bay.....	†2,000,000
Hodgdon Cove.....	†1,000,000	Southport, Ebencook Harbor.....	†1,500,000
Johnson Cove.....	†1,000,000	Total.....	†7,500,000

a Rescued from overflowed lands and restored to original waters.

# ARTIFICIAL PROPAGATION OF THE SALMONS OF THE PACIFIC COAST

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REVISED AND ENLARGED BY

HENRY O'MALLEY

*Field Assistant, U. S. Bureau of Fisheries, In charge of  
operations on the Pacific coast*

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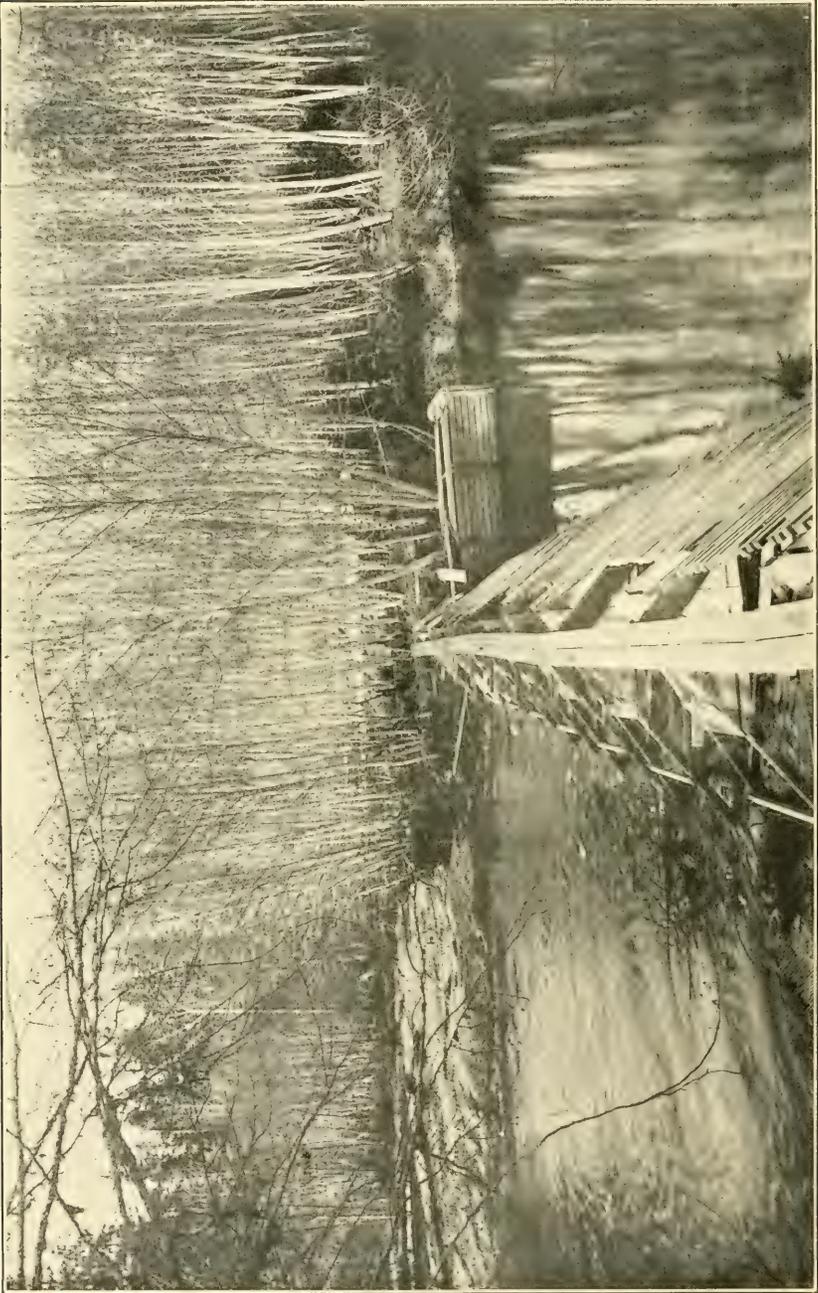
Appendix II to the Report of the U. S. Commissioner of Fisheries for 1919

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RACK WITH UPSTREAM TRAP, DUCKABUSH RIVER, WASH.

# ARTIFICIAL PROPAGATION OF THE SALMONS OF THE PACIFIC COAST.<sup>a</sup>

Revised and enlarged by HENRY O'MALLEY, *Field Assistant, U. S. Bureau of Fisheries, in Charge of Operations on the Pacific Coast.*

## THE SALMONS OF THE PACIFIC COAST.

There are five species of salmon on the Pacific coast belonging to the genus *Oncorhynchus*, namely, the chinook, spring, king, or quinnat salmon (*Oncorhynchus tshawytscha*); the blueback, sock-eye, or redfish (*Oncorhynchus nerka*); the humpback or pink salmon (*Oncorhynchus gorbuscha*); the silver or coho salmon (*Oncorhynchus kisutch*); and the chum or dog salmon (*Oncorhynchus keta*). Among the features which distinguish the Pacific salmon from the Atlantic salmon are the larger number of rays in the anal fin and the invariable habit of spawning but once and then dying; the Atlantic salmon may spawn several times.

The characters noted in the following key will usually be sufficient to distinguish the different species of Pacific salmon:

*Chinook salmon*.—Scales in longitudinal series, about 135; pyloric cæca, 110 to 200, averaging 150; gillrakers comparatively short, from 20 to 25 in number, 9 being above the angle; rays in anal fin from 14 to 19, average 16; branchiostegals, 14 to 19, average 16. Body robust; head conic; caudal fin lunate. Color above dusky, sometimes with bluish or greenish tinge; sides and belly silvery; head dark, with metallic luster, back and sides with prominent spots, usually X-shaped.

*Blueback salmon*.—Scales in longitudinal series, about 130; pyloric cæca, 75 to 100; gillrakers comparatively long and slender, from 30 to 40 in number; rays in anal fin, 14 to 18; branchiostegals, 13 to 15. Body rather slender; caudal fin lunate; anal and dorsal fins low. Color, sides silvery, no spots on back, which is frequently bright blue.

*Humpback salmon*.—Scales very small, 200 or more in longitudinal series; pyloric cæca very slender, about 180 in number; gillrakers short, from 20 to 25; anal rays, 15; branchiostegals, 11 to 12. Color, bluish above, silvery on sides; lower part of back, adipose fin, and tail with numerous black spots, largest and of oblong form on tail.

*Silver salmon*.—Scales large, about 130 in longitudinal series; pyloric cæca comparatively few and large, 40 to 110 in number,

<sup>a</sup> This paper represents a revision and enlargement of the chapter on "The Salmon of the Pacific Coast," from the Manual of Fish-Culture, published in the Report of the U. S. Commission of Fish and Fisheries for 1897, a first revised edition of which was published separately in 1900. The chapter was subsequently issued in separate form under the title "Artificial Propagation of the Salmon of the Pacific Coast."

average 70; gillrakers long and slender, 20 to 25 in number; anal rays, 11 to 15, average 13; branchiostegals, 12 to 14. Body long; head short, conic; snout blunt; eye small; fins small, caudal deeply lunate. Color, bluish green, sides silvery, finely punctulated, as in the chinook, but not so conspicuous.

*Chum salmon*.—Scales of medium size, about 150 in lateral line; pyloric cæca, 140 to 185; gillrakers from 20 to 25; 13 or 14 rays in anal fin; branchiostegals, 13 or 14. Form of chinook, but head longer and more depressed. Dusky above and on head; paler on sides; very fine spots on back and sides, often wanting; tail deeply lunate, plain dusky or finely spotted, with black edge; other fins blackish.

These salmon are the most important group of fishes entering the rivers of North America. The steelhead (*Salmo gairdneri*), popularly regarded as a salmon, also inhabits the waters of the Pacific coast and adds to the importance of the salmon tribe.

In recent years the annual catch of salmon in the Pacific Coast States, British Columbia, and Alaska has been approximately 585,000,000 pounds, with a value, as placed on the market, of nearly \$40,000,000. In 1918 the quantity of salmon canned was 7,829,212 cases of forty-eight 1-pound cans.

#### CHINOOK SALMON.

The chinook salmon (*Oncorhynchus tshawytscha*) is also known by other names than those given above, as Columbia, Sacramento, and tye salmon. It is one of the most important of the salmon, being superior in food qualities and attaining a vastly larger size than any of the others. When fresh from the ocean, it is a very handsome, resplendent, well-formed fish. The flesh is of a rich red color in the greater number of individuals, but all runs contain a smaller or larger percentage of fish having white meat. Buyers cut into the shoulder of the fish for arriving at the color. The white meat is equally as good as the red as a food, but the rich red fish have the greater market value, both in the fresh condition and for canning.

No other salmon in the world compares in size with the chinook. In the Yukon River, Alaska, it occasionally attains a weight of over 100 pounds; and in the Columbia River there have been well-authenticated cases of specimens weighing over 80 pounds. Farther south the size is smaller, although in the Sacramento River individuals from 50 to 60 pounds in weight are not rare. In the Columbia 20 pounds is a fair average, and in the Sacramento about 16 pounds.

The known range of the chinook in American waters is practically from Monterey Bay (latitude  $36\frac{1}{2}^{\circ}$ ) to the Yukon River, but individuals have been seen in Norton Sound, somewhat north of the Yukon, and as far down the coast of California as the Santa Barbara Channel. However, it is not known to spawn naturally in any stream south of the Sacramento River. It extends across Bering Sea to Kamchatka and south to Hokkaido, Japan.

Fish of this species prefer the larger rivers, like the Sacramento, Columbia, Skagit, Nushagak, and Yukon, and they are very persistent in making the ascent. The summer and later runs seek spawning grounds not far from the ocean, but the first or early

spring runs ascend to extreme headwaters. They have been seen crowding up rivulets forming the headwaters of the Sacramento and Columbia Rivers with nearly half their bodies exposed above water. No matter how far the headwaters are from the ocean, some of the run will proceed till forced to yield to an impassable obstruction. On reaching their goal the early fish remain several weeks in deep, quiet holes before going on the spawning grounds. The rate of ascent varies with climatic conditions, the season, and the condition of the rivers, which are affected by melting snow during the spring and summer and by rains in the fall months. They proceed very slowly at low-water stage, sometimes lying for weeks or months in deep pools, and rapidly when the water is at a moderate stage; but at extreme high or flood stage they remain quiet until the water begins to fall and clears, when they resume their journey.

When they first come from the ocean the sexes are very similar in appearance, but as the time for spawning approaches a difference is noted between them, becoming more pronounced as the season advances. The developing ova of the female produces a round, plump form, while the male becomes thin, his head flattening, and his upper jaw curving like a hook over the lower. His eyes sink; large, powerful, white, doglike teeth appear on both jaws; and the fish acquires a gaunt and savage appearance. From the time they reach fresh water their appetites decrease, and their throats and stomachs gradually shrink, until, at the near approach of the spawning season, they have become entirely incapacitated for food, and the desire and the ability to feed has left them entirely. The great reserve of flesh and oils brought with them from the ocean enables them to keep the vital organs active until their mission is accomplished. After reproduction they die on or near the spawning grounds. This singular fact has been disputed, but its truth has been proved conclusively and repeatedly. After they are entirely spawned out they remain on the beds, deteriorating rapidly, the flesh shading off to a light, dirty pink, and they become foul, diseased, and much emaciated. Their scales are partly absorbed and, in the males, wholly enveloped in the skin, which is of a dark-olive or black hue; blotches of fungus appear on their heads and bodies; and in various places there are long, white patches where the skin has been partly worn off. Their tails and fins become badly mutilated, and in a short time the fish die.

They are found feeding in Monterey Bay in any month of the year when food is there. On their way to the spawning beds they reach this body of water about the second week in January and may be caught with hook and line. In February they may be observed in numbers in the Sacramento River. In the Columbia River they appear in March but are not abundant until April or May. They arrive in southern Alaska in May and farther north in June, while it is probably still later before they ascend the Yukon, where the running season is short and may not exceed a month or six weeks. The early runs in the Columbia River are usually from one to three weeks in passing from the mouth of the river to Clifton, a distance of about 20 miles. They first arrive at The Dalles, 200 miles up the river, in the middle of April, and are found in numbers at this point about the middle of June, two months after appearing in larger numbers at the river bay, thus covering a distance of about

100 miles a month. As the season advances the rate of progress up the rivers is more rapid.

The spawning season varies in different rivers and covers a period of at least four months. The spring run begins to spawn at the headwaters of the Willamette and Salmon Rivers, tributaries of the Columbia, in August, while the summer run at the Little White Salmon and Big White Salmon stations, nearer the ocean, begins spawning about September 20. At the Clackamas (Oreg.) station, eggs are secured from the fall run from the last of September to about December 1.

For the deposition of their eggs chinook salmon invariably seek a shallow, gravelly riffle, where the water is a foot or more deep, and the current sufficiently swift to carry and spread the eggs and milt. There is no doubt that in many instances the so-called nest, which is an elongated cavity or depression, often several feet across and 12 or more inches in depth, is started by either the male or female in advance of actual spawning, but as a general thing it is formed by the fish in the act of spawning. At this time both the male and female turn on their sides and by contraction of the abdominal muscles, which produces a quivery motion of the body, effect the simultaneous emission of milt and eggs. At about the same time a forceful movement of the tail and posterior part of the body serves to loosen the gravel and propel the fin forward more or less, thus, by frequent repetition, enlarging the depression and covering the eggs with the loose gravel. It seems evident that this is nature's provision for the protection of the eggs, during the incubation period. With every effort made by the fish in the extrusion of the eggs and milt the depth of the covering is increased, and this serves not only to screen them from the light, which is conducive to the growth of fungus, but also protects them from the prying eyes of trout and other active aquatic enemies.

The length of time consumed in spawning is largely governed by the number of eggs a female contains and also by the temperature of the water. In some instances all of the eggs will be deposited within a day or two, while in others spawning will extend over a period of a week or 10 days.

Both the eggs and the fry are subject to destruction by freshets washing them out of the gravel or covering them so deep that, if they are not actually killed by the pressure on them, it becomes impossible for the fry to work their way out. In many streams spawning occurs during high-water stages in the fall, the eggs in numerous instances being deposited in gravel which is entirely above the water later in the season. Many eggs are lost also by trout lying close in behind the salmon and catching them as they are emitted. Some are rooted out of the nest, and the natural enemies take their toll as the fry emerge from the gravel. It is the instinct of the fry to lie quiescent until the umbilical sacs have been absorbed, when they leave the nest in search of food.

Experiments conducted some years ago by John P. Babcock<sup>a</sup> have demonstrated clearly that only those eggs in natural spawning which are embedded beneath from 5 to 6 inches of sand and gravel produce

<sup>a</sup> Some experiments in the burial of salmon eggs, suggesting a new method of hatching salmon and trout. Transactions, American Fisheries Society for 1910, pp. 393-395, Washington, 1911.

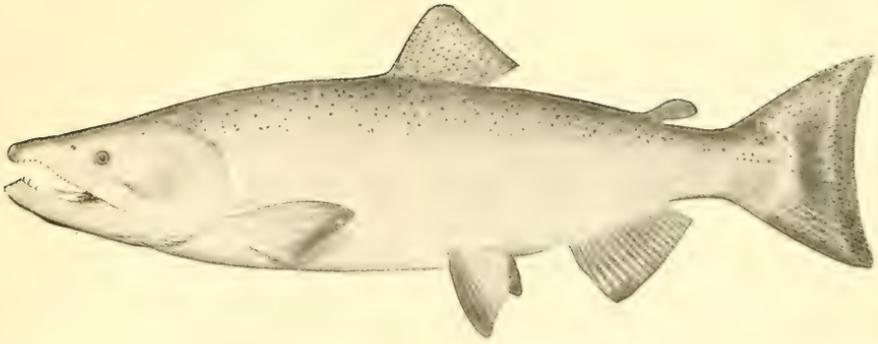


FIG. 1.—CHINOOK SALMON. BREEDING MALE.

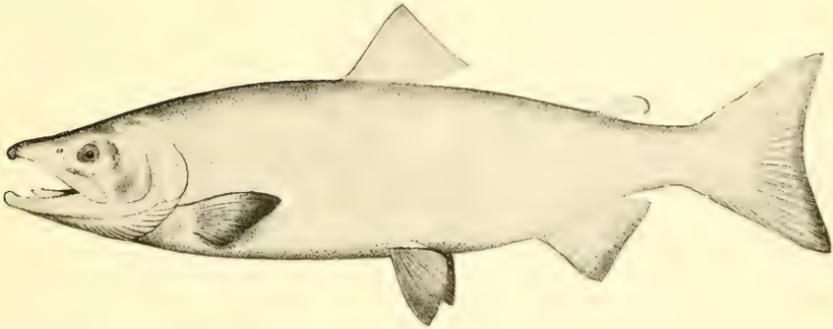


FIG. 2.—BLUEBACK SALMON. ADULT MALE.

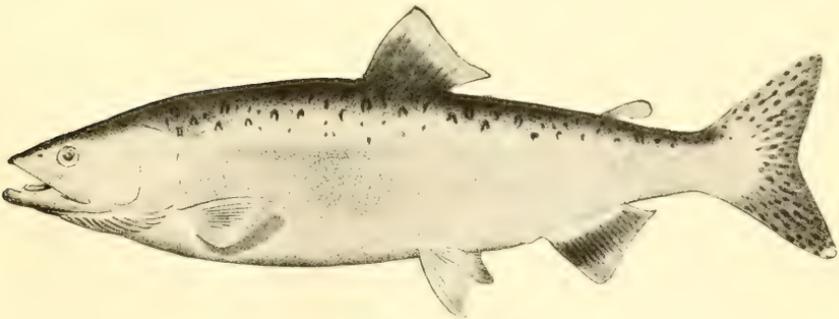


FIG. 3.—HUMPBACK SALMON. ADULT MALE.

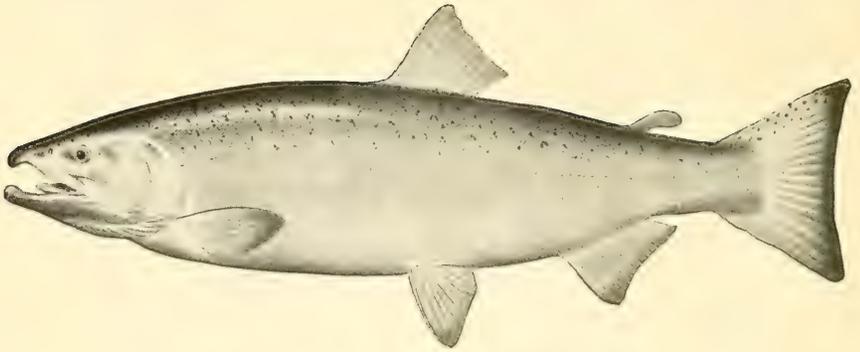


FIG. 1.—SILVER SALMON. BREEDING MALE.

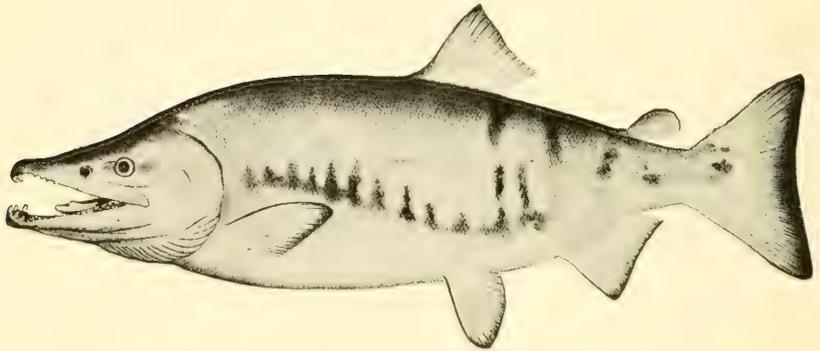


FIG. 2.—CHUM SALMON. BREEDING MALE.

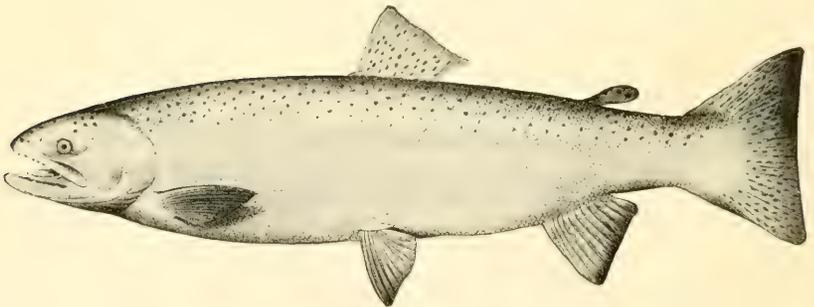


FIG. 3.—STEELHEAD.

alevins that live to attain the fry stage, and that the eggs not so covered are either consumed by active natural enemies or are destroyed by the vegetable mold known as fungus. The experiments have shown that the burial of freshly fertilized eggs of Pacific salmon in sand or gravel to the depth stated does not smother them, but that eggs so treated will hatch, and the resulting alevins will possess the instinct and power to work their way gradually to the surface after the disappearance of the food sacs, at which stage of development they are not attacked by fungus. Eggs buried under from 2 to 3 inches of gravel were found to produce alevins coming to the surface before the sacs had been absorbed, and they were therefore subject to fungus, a very large percentage of them being destroyed in that way, as well as by the more-developed forms of aquatic life. The sacs of fry resulting from eggs buried less than 4 inches deep are so thinly covered when they reach the surface that few, if any, of the fish survive the effects of fungoid growths, and, as such growths are very common in the beds of streams where large numbers of salmon have spawned and died, it follows that very heavy losses of eggs must occur on eggs naturally deposited.

The yield of eggs from the chinook salmon will average from 3,000 to 6,000 per fish. The eggs are of a deep, salmon-red color, measuring about one-fourth of an inch in diameter, and are heavier than water.

In view of the enormous annual catch of this salmon for commercial purposes, the necessity for its propagation became manifest at an early period in the history of the Pacific fisheries. Fortunately, it is readily susceptible of artificial production on a large scale; otherwise the supply in western rivers would by this time have materially fallen off. Since the work began in 1873 on the McCloud River it has grown to larger proportions. It now engages the attention of all the coast State governments, as well as that of the Federal Government, and the work is steadily growing in importance.

As the salmon ascend the rivers they are caught by gill nets, fyke nets, pounds, weirs, seines, wheels, and other devices, but in the Sacramento and Columbia Rivers the greater numbers are caught as they head upstream with gill nets drifting with the current or tide. In the rivers they are comparatively safe from enemies, but immense numbers are destroyed at the mouths of the streams by seals and sea lions.

This species has been introduced into Australia, New Zealand, and Europe, but so far as is known New Zealand is the only country where its acclimatization has been effected. Efforts have been made to establish it in Atlantic streams of the United States, but without permanent results. In some of the fresh-water lakes of New England the chinook salmon has been introduced purely for angling purposes. In such instances permanent fisheries can not be expected save by restocking.

#### BLUEBACK SALMON.

This species (*Oncorhynchus nerka*) is known in different regions under the names of blueback, redfish, Fraser River salmon, and sockeye. It ranks first of the salmon in commercial value, being es-

pecially important in the Fraser River and in Alaska. The color of the flesh is a rich red, which persists after canning. Large quantities are canned on Puget Sound, in British Columbia, and in Alaska, and its commercial value to that territory is indicated by the fact that during the calendar year 1916 the total pack on the Pacific coast amounted to 2,432,048 cases. Of this total 2,119,442 cases were put up in Alaska, at a valuation of \$13,147,994. Comparatively few red salmon are sold fresh in the United States.

It is next to the smallest of the salmons, the maximum weight being 12 pounds, but it seldom attains a weight of over 6 pounds in any instance.<sup>a</sup>

It ranges from Columbia River, Wash., to the far north. In general it ascends only such rivers as rise in glacial and snow-fed lakes. Practically nothing is known of its ocean life. Straggling specimens occur in the Quinault River late in December. It ascends the Columbia River in June and July, and at Kodiak Island it comes in numbers in June. There the heaviest run is in June and July, spawning occurring in August and September. In the Fraser River the largest runs enter during July and August, and in the watershed of this river spawning occurs from late October to the end of December, being at its maximum during November. Quinault and Baker Lakes, together with their tributaries, may be considered typical spawning grounds for this fish in the United States, and in those regions the spawning season extends from early September to late December.

The individuals of this species enter only such streams as have lakes at their headwaters, usually reaching the vicinity of the latter several weeks in advance of spawning time. Many of them deposit their eggs along the lake shores in depths of from 1 to 12 feet of water. Others ascend the creeks or rivers flowing into the lakes and spawn on the riffles in a way similar to that of the chinook salmon. The average number of eggs per fish ranges from 2,500 to 3,000. Except in the breeding season, the color is a clear, bright blue above, with silvery sides and belly. At spawning time the body becomes blood red and the head light green. The male loses his symmetrical form and develops an extravagantly hooked jaw.

#### HUMPBACK SALMON.

The humpback salmon (*Oncorhynchus gorbuscha*) is the smallest of the Pacific salmons, its average weight being only 5 pounds and its maximum rarely 9. Its range is from Puget Sound northward, probably as far as the Mackenzie River, and it is also common on the Asiatic coast. The southernmost spawning record is in the San Lorenzo River at Santa Cruz, Calif. In Alaska it is the most abundant and generally distributed of the salmons, and in that region there is an annual run of the species. In Puget Sound waters, however, it makes its appearance in numbers only in alternate years. No satisfactory explanation as to the cause of this phenomenon has been

<sup>a</sup> So-called landlocked forms occurring in various lakes weigh only one-half pound when mature. They are commonly referred to as little redfish and have long been regarded as merely dwarfed forms of the anadromous species. At one time they were believed to ascend also from the sea; later it was conclusively proved that they are permanent residents of fresh water, and there is strong evidence that they constitute one or more distinct species.

given. During the fall of 1916, which is known as the off season in Puget Sound, 1,887 cases were packed. This shows a healthful increase over the seasons previous to the Bureau's attempting the establishment of an annual run in this region.

In nutritive value the fresh-run humpback is scarcely inferior to any other salmon. While the flesh has a very fine flavor, it is paler than that of the chinook or blueback salmon, and it loses its color when canned. The total amount of this species canned during the calendar year 1916 was 2,036,077 cases, of which amount 1,753,546 cases, valued at \$6,446,168, were packed in Alaska.

The humpback salmon usually seeks the smaller streams for reproduction, depositing its eggs a short distance from the sea, sometimes within a few rods of the ocean. At Kodiak Island, Alaska, where it is often very abundant, it arrives in the latter part of July, the run continuing only a few weeks. Spawning occurs in August. The eggs, of which there are about 2,000 per fish, are smaller than those of the chinook, but larger than those of the blueback and paler than either.

Shortly after its arrival from the ocean, and with the approach of the spawning season, it develops on its back a prominent hump, which, with the distortion of the jaw, gives the fish a very singular appearance. As is the case with the other salmons, it dies on the spawning bed or after being swept to sea by the current.

#### SILVER SALMON.

The silver salmon (*Oncorhynchus kisutch*) is also known as silver-sides and coho salmon. It is a beautiful fish, having a graceful form and a bright, silvery skin. Its flesh is usually of a bright-red color; but, as this fades on cooking, it is less highly regarded for canning, though large quantities are thus utilized on the Columbia River, Puget Sound, and the short coastal streams of Oregon and Washington.

In 1916 the total pack was 715,815 cases, of which 265,184 were put up in Alaska. Its range is from Monterey Bay to northern Alaska, and as far south on the Asiatic coast as Japan. It ascends the rivers to spawn in the fall and early winter, when the waters are high. In most of the rivers which it frequents there appear to be two well-defined runs, the early run ascending to the headwaters, while the later run is found in the streams nearer the ocean. The early run is composed of small-sized specimens. In Alaska the average weight of this salmon is nearly 15 pounds, and in the streams farther south about 8 pounds. It rarely attains a weight of 30 pounds. The average egg production per fish is about 3,500.

#### CHUM SALMON.

The chum salmon (*Oncorhynchus keta*) is the least valuable of the Pacific salmons, although it is canned and dried in large quantities on the Pacific coast and in Alaska. Its average weight is 10 pounds, and the maximum is about 20 pounds. It is found from the Columbia River northward, being especially abundant in Alaska. It is taken occasionally in the Sacramento River. When just from the ocean, the flesh is of a very pale red color. At that time it is a very

good fish, but it deteriorates rapidly in fresh water, and it loses its color in the can. It spawns in shallow riffles and creeks, usually at no great distance from the ocean. Large quantities are packed in Oregon, Washington, and Alaska. The production of canned chum salmon in 1916 amounted to 1,500,332 cases, of which 715,238 cases were put up in Alaska.

#### STEELHEAD.

Another anadromous fish found in Pacific coast waters is the steelhead (*Salmo gairdneri*), commonly known as steelhead and steelhead trout, and in many instances erroneously classed with the Pacific salmon in the State laws. It resembles in form, size, and somewhat in general appearance the salmon of the Atlantic coast, but is distinguished from the Pacific salmon by its short anal fin of not over 12, and usually 9 or 10, rays, square tail, small head, rounded snout, comparatively slender form, light-colored flesh, and its spring-spawning habit. Its average weight in the Columbia is about 12 pounds, but specimens weighing 42 pounds have been found in the Skagit River.

Its range is very extended, reaching from Santa Barbara on the southern coast of California to the Alaskan Peninsula, and perhaps to the Arctic Ocean. It is found in almost all the streams of the Pacific States which empty into the ocean. The only run of this species of commercial importance in the Columbia River begins in late June and is in full force in July and early August. It reaches Seufert, Oreg., about the close of the blueback run, and some of the fishing wheels catch practically nothing else. This fish feeds while in fresh water, and does not always die after spawning, but it deteriorates from the time it enters fresh water until the following spring, and spawns between the months of February and May. Its movements in other rivers on the coast are not materially different, except that it enters the southern rivers earlier and the northern rivers later than it enters the Columbia. Like the chinook salmon, the steelhead ascends for long distances, and it has been found as far up tributaries of the Columbia as the ascent of fish is possible. The number of eggs per fish ranges from 6,000 to 8,000. The greater quantities of steelhead trout are caught during the winter and spring months and are utilized in a fresh state, large quantities being shipped to eastern markets in refrigerator cars. However, during the calendar year of 1916 cases of this species to the number of 24,999 were packed.

#### ARTIFICIAL PROPAGATION.

Artificial propagation having been first applied on the Pacific coast to the chinook salmon, the description of methods which follow is based mainly upon the practices employed with that species. In 1916 the number of salmon and steelhead eggs collected by the Bureau of Fisheries, expressed in millions, was as follows: Chinook, 108; blueback, 105; humpback, 32; silver, 13; chum, 29; steelhead, 14. These were collected at the Afognak and Yes Bay stations in Alaska; at stations located on tributaries of Puget Sound and in the Quinault Indian Reservation, Wash.; at Clackamas and its auxiliaries in the Columbia River Basin and in southern Oregon; and



FIG. 1.—SALMON HATCHERY, AFOGNAK, ALASKA.



FIG. 2.—SALMON HATCHERY AND REARING PONDS, YES BAY, ALASKA.



FIG. 1.—ROGUE RIVER (OREG.) HATCHERY.



FIG. 2.—CLACKAMAS (OREG.) HATCHERY.



FIG. 3.—BIRDSVIEW (WASH.) HATCHERY.

at the California stations on tributaries of the Sacramento and Klamath Rivers. In addition, the private hatcheries operated by the salmon-cannery interests of Alaska, known as Fortmann, Karluk, Quadra, Hetta, and Klawak, which have been hatching blue-back salmon for years, collected in 1916 over 87,000,000 eggs. The normal capacity of these five establishments is 197,000,000 eggs per annum. The Bureau's two hatcheries in Alaska have each a capacity of 72,000,000 eggs.

## CONSTRUCTION OF RACKS.

The eggs found in salmon that are captured for commercial purposes are in a green state, and, therefore, in all hatchery operations of importance it has been found necessary to provide for the egg supply by installing requisite devices for the capture and retention

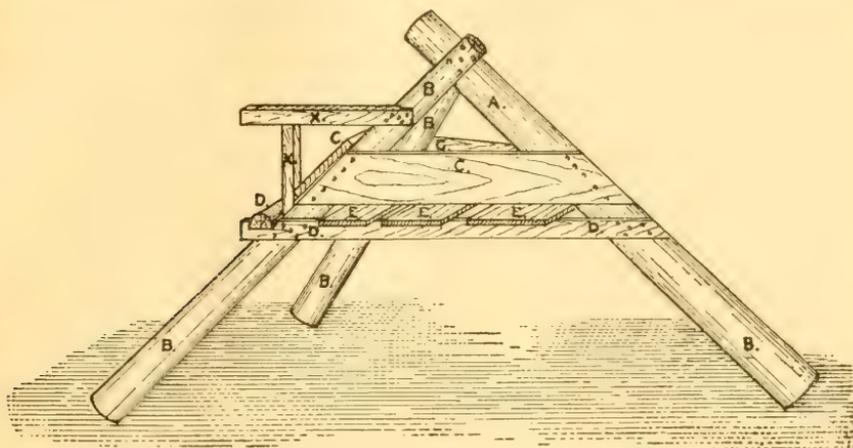


FIG. 1.—Three-legged rack horse or trestle: *A.*, horse head; *B.B.*, horse legs; *C.C.C.*, 12-inch boards to make sides of crib and also to act as braces; *D.D.D.*, leg braces which also support bottom of crib; *E.E.E.*, bottom of crib; *X.X.*, bracket for supporting walk.

of the brood fish. Such fishing is conducted at or near the spawning grounds.

The site selected for the placing of the racks should be in a good spawning locality. The upper rack is placed at the head of a riffle, and the stop or lower rack is installed just below a deep pool, the distance between the two depending upon topographical conditions. There is thus provided between the upper and lower racks a proper spawning and fishing area, with a deep pool for a resting place for the immature fish. In this inclosure the fish are held until removed for stripping. The racks are designed to control the movements of the fish regardless of the water stages, as failure to do so means the loss of a season's take of eggs.

The usual form of rack constructed in the rivers of Washington and Oregon and in most of the streams in California is built on trestles or three-legged horses, their sizes depending upon the character of the streams to be closed, and their length upon the depth of water and the angle or slope to be given the rack. The legs are made of pile timber from 8 to 12 inches in diameter. The upper leg

is longer than the other two, which are of equal dimensions, and is attached to them at an angle of  $90^\circ$ , the spread between the others being about  $60^\circ$ . The legs are braced and held in place by poles about 4 inches in diameter, which are spiked to the sides midway from the ground to where the legs are joined, and, as an extra precaution, an additional brace is nailed across the two rear legs.

The braces strengthen the bottom of the crib, which is made of 1-inch rough lumber, and the 12-inch boards composing its sides serve as an additional brace to the legs. Such a crib will hold from 100 pounds to almost a ton of rock, the amount varying with the size of the braces used and the current which it is expected to withstand.

The trestles are set from 8 to 12 feet apart directly across the stream on the site selected for the rack, the distance between each being governed by the size of the stream and the strength of rack desired. The trestles are then lined up and loaded with stones, and two stringers from 8 to 12 inches in diameter are put on and spiked to the upstream side of the forward leg. While the position of the stringers must be governed to some extent by the height of the rack, it is usual where the rack is of ordinary construction to place the upper stringer about 30 inches above the water surface and the lower one midway between that point and the river bottom. On large streams a third stringer is sometimes used to good advantage.

Where the bed of the stream is of hard formation 2 by 3 fir pickets are put down even with the bottom at intervals of  $1\frac{1}{2}$  inches and nailed to the stringers, the 2-inch surface being placed to the current and the upstream edge beveled in order to present the least possible resistance to the current. In streams with soft shifting bottoms it is often necessary to drive the pickets. As a further precaution against the escape of the salmon by the loosening and displacement of the pickets by the current, or by the struggling of the fish, a block 3 inches long by  $1\frac{1}{2}$  inches wide is nailed to each picket at a point halfway between the lower stringer and the bottom. A layer of bowlders and rock from 3 to 5 inches in diameter is then placed in front of the rack at the point of the pickets to close effectually all openings between the ends of the pickets and the river bottom; and brackets for supporting a walk are nailed to the downstream side of the trestles, thus providing a means of keeping the rack cleared of debris at all times.

In streams where shingle bolts, cordwood, and driftwood occur, a gate is provided for their passage, and the necessary sheer booms are constructed in front of the racks to guide the timbers to the opening. The gate should be built between two trestles which have been placed 8 feet apart, and the open space connected by a stringer placed below the surface of the water at a depth of at least 18 inches. Pickets are attached to this stringer in the usual manner, except that they must be sawed off even with its top, and the sides of the space are squared up and walled with 1-inch lumber.

The gate is constructed of 1 by 4 inch strips 12 or more feet long, which are placed on edge at intervals of  $1\frac{1}{2}$  inches, well blocked and braced. It is then hinged to the stringers in such a manner that it will swing freely. One way to accomplish this is to bore holes through the ends of the strips and insert 1-inch pipe, the ends of which, projecting a few inches on either side of the gate, allow it to

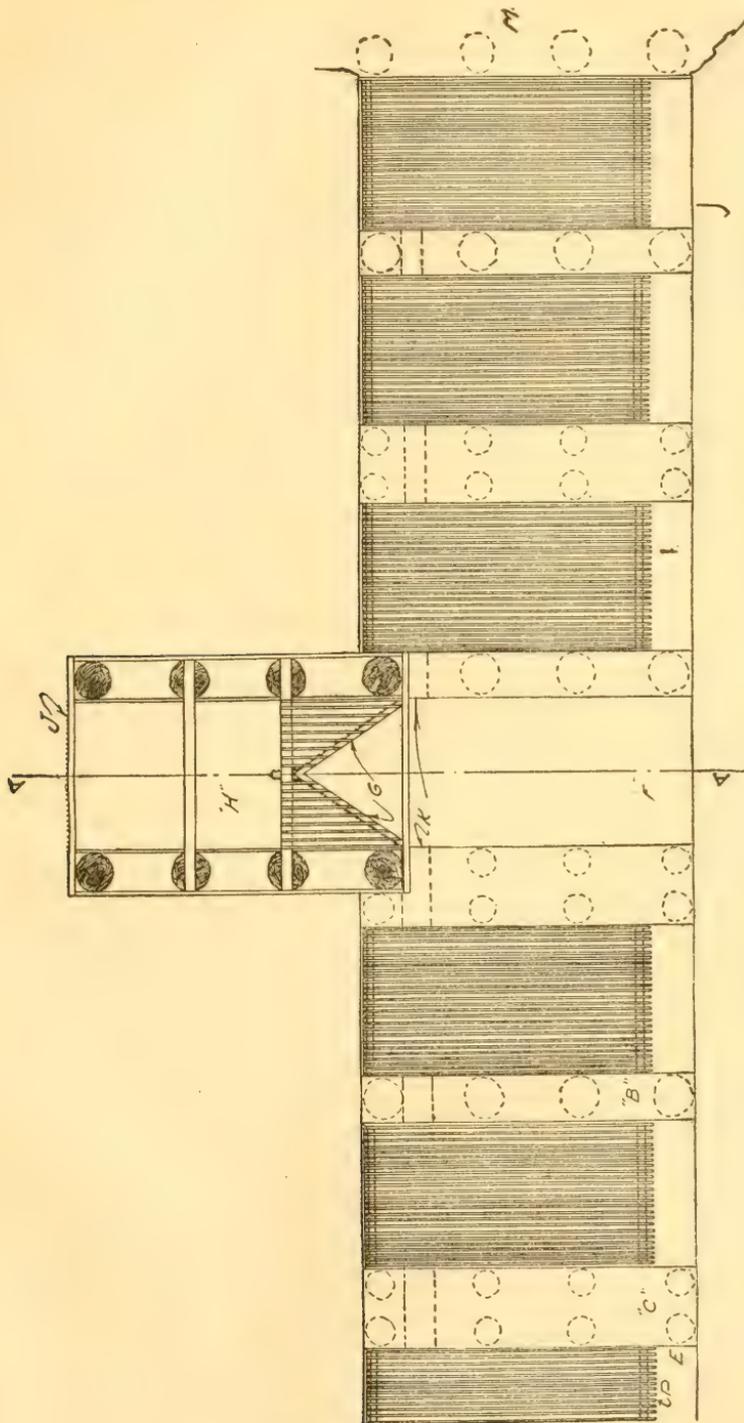


FIG. 2.—Plan of barrage in Phinney Creek, near Birdsview, Wash.; *B* and *C*, single and double rows of piles, respectively; *D*, downstream end of racks; *E*, floor under racks; *F*, open channel to trap; *G*, walls of V-shaped approach to trap; *H*, trap; *J*, screen at head of trap; *K*, openings in pier for passage of fish to *G*; *L*, door in north side of V-shaped approach; *M*, abutments.

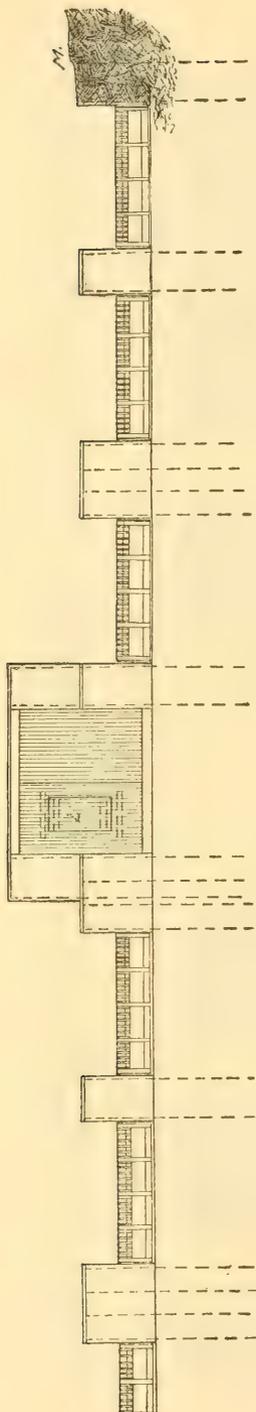


FIG. 3.—Front elevation of barrage shown in figure 2.

turn in eyebolts in the side walls. To prevent the fish passing through when the gate is open, a 12-inch board should be nailed across its under side at such an angle that the current rushing against it will lift the lower end of the gate just above the surface of the water. Floating objects coming down the stream are carried onto the gate, which sinks from their weight, and as the current carries the object on the gate closes automatically.

Racks constructed in accordance with this method will often stand submerging several times in the course of a spawning season, and at its close remain practically undamaged.

A barrier that has stood the test of several years and has proved that it will operate successfully in almost any stage of water is described in the following paragraphs.<sup>a</sup> The design is to be credited to A. H. Dinsmore, former superintendent of the Baker Lake (Wash.) station.

A permanent barrier at the Birdview station, an auxiliary of the Baker Lake station in Washington, is of novel construction and calls for more than passing notice. This barrier is located in a portion of Phinney Creek, where formerly there was a dam built for the purpose of obstructing the passage of steelhead trout. When the dam washed out, a new channel formed and the river bed was very much broadened.

The first step in the construction of the new barrier was the laying of four heavy log stringers across this new channel from the abutment on the north to the new bank on the south side of the stream. The logs were let down through the dam foundation to low-water level on the north side, and the deep channel under them on the south side was filled with brush and gravel. The logs were spotted down to form a practically level bed, reaching the width of the stream. Heavy piles were then driven behind each stringer to form alternate single and double rows extending up and down stream. The log stringers were next planked over, forming a platform 18 feet wide, similar to a regular dam apron, extending from the north abutment to the final row of piles on the south side, a distance of about 140 feet.

By planking the sides of the single row of piles and all around the double rows and filling the space with rocks, piers 4 feet high and approximately 2 feet and 4 feet wide were formed. Through each pier at the bottom, behind the upstream pile, openings 1 foot square were left,

<sup>a</sup> Titcomb, John W.: Fish-cultural practices in the Bureau of Fisheries. Bulletin, U. S. Bureau of Fisheries, Vol. XXVIII, for 1908, part 2, pp. 728-732. Washington, 1910.

connecting the spaces between the piers. These spaces, 12 in number, are approximately 8 feet wide and are filled by swinging gates hinged to a 3 by 12 inch timber, spiked securely to the piers on either side and forming a dam or flashboard across the space above. By the insertion of other flashboards above this one a tight dam 4 feet high can be quickly formed at any time. The utility of this feature will be explained elsewhere.

The gates are made of 1 by 4 inch fir set on edge and nailed to 2 by 4 inch joists, being strengthened by 2-inch blocks set between the rack bars and nailed to them and the joists. These blocks thus determine the width of the interstices in the gates. At the upper end of each gate an auger hole is bored through the bars and blocks, to accommodate a 2-inch iron pipe, which passes through the entire upper end of the gates. Ringbolts clasp these pipes and are fastened to the 3 by 12 inch timber forming the flashboard, acting as hinges upon which the gates swing. At the lower end of each gate a wide board,  $1\frac{1}{2}$  by 16 inches, is secured by means of braces, forming an angle of  $45^\circ$  with the lower end of the gate.

At an ordinary stage of the stream the downstream ends of the gates rest on supports which hold them a foot or more higher than the upper ends, the water passing down through them to the floor of the apron, where it runs away. The fish working up under the gates to the dam board find the cross passages through the front end of the piers and finally reach the trap. It was expected that during freshets the current acting on the flashboard would always keep the lower ends of the gates above the surface of the water, and up to a certain

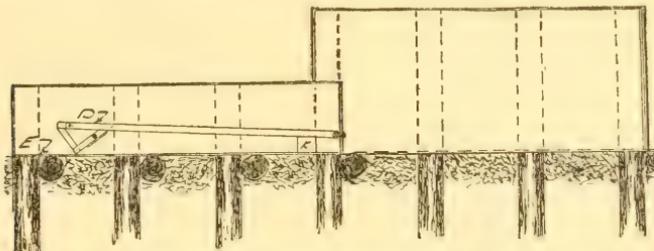


FIG. 4.—Side elevation of barrage shown in figures 2 and 3.

point this expectation was realized, but at very high stages of the stream the large quantity of gravel in the water soon clogs and sinks the gates. As the gates are only two-thirds the length of the apron, however, and rise toward the lower end, the water shoots over them with such force that it is projected some distance below the end of the apron, and fish attempting to scale the obstruction fall far short of the ends of the gates. The barrier has been watched many times when fish were jumping and when the largest drift ran clear, and none has ever been seen to pass it.

By means of the dam boards entire control of the current can be had during ordinary stages of water and any desired quantity sent to any section of the barrier. Thus a strong current can be maintained through the trap section, leading the fish to it, and when it is desired to remove the fish from the trap the water can practically all be turned to some other section of the barrier.

One of the greatest difficulties in maintaining traps in the streams in this section is due to the tremendous quantities of gravel carried in the water during freshets, a sufficient amount being frequently deposited in front of a trap at such times to change the course of the stream. With the present form of barrier no trouble is experienced from this source, the insertion of the dam boards and the opening of one space at a time quickly clearing away the accumulated gravel.

The ninth and tenth piers were continued upstream by driving three additional piles above each. The piers form the sides of the trap. Its floor is a plank bottom, similar in construction to the apron, and the front is barred by  $1\frac{3}{4}$ -inch pickets placed  $1\frac{1}{2}$  inches apart, the fish entering by the usual upstream V of pickets. To protect the trap from high water the two piers between which it is located were carried to a height of 8 feet. When it is desired to fish the trap, the gate at its head is closed and entrance is made from below by means of a door in the north side of the V.

The upper end of the fishway of the old dam was left in place, the narrow passage between it and the new trap protecting the spaces at the south end of the barrier from the current and from drift. These spaces have been racked above and below to form commodious pens for males and unripe females. The south end of the barrier is protected by a substantial abutment.

The maintenance of the racks in Phinney Creek has been a very heavy item of expense in past years, and the trap was frequently carried away by freshets just at the height of the season, allowing large numbers of fish to escape and considerably reducing the season's take of eggs.

Concrete piers have been used in some of the California rivers, but they are now considered too expensive for fish-cultural work on an economical scale. In some of the streams in that State piles are substituted for trestles. These are sawed at the proper angle, capped with timbers of the right size, and used for supporting the rack stringers. In constructing racks in this way the pickets are usually placed in sections and hoisted into position by means of a derrick. Mudsills are embedded in the gravel beneath the rack and a floor placed thereon.

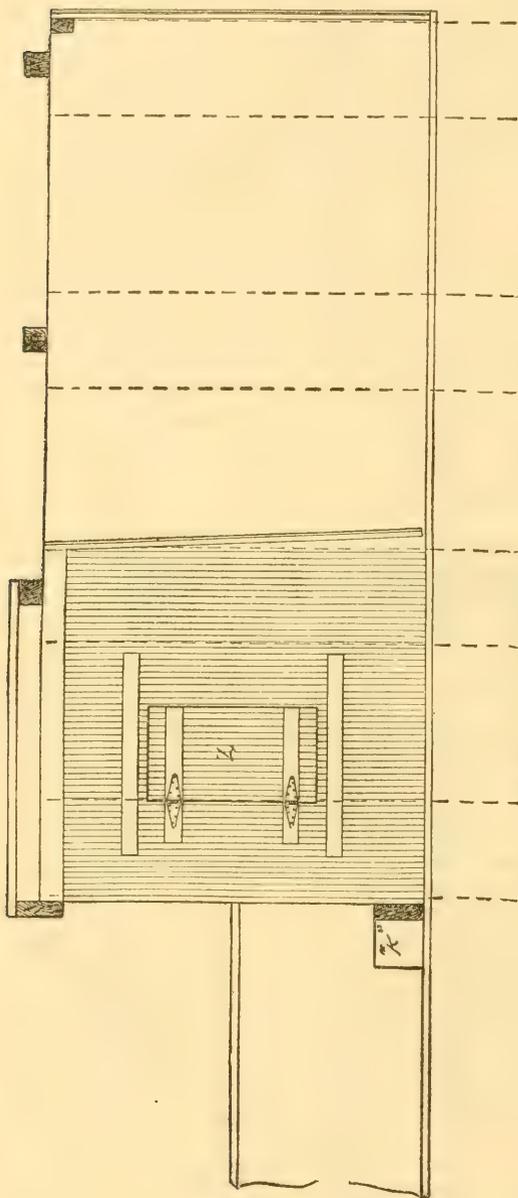
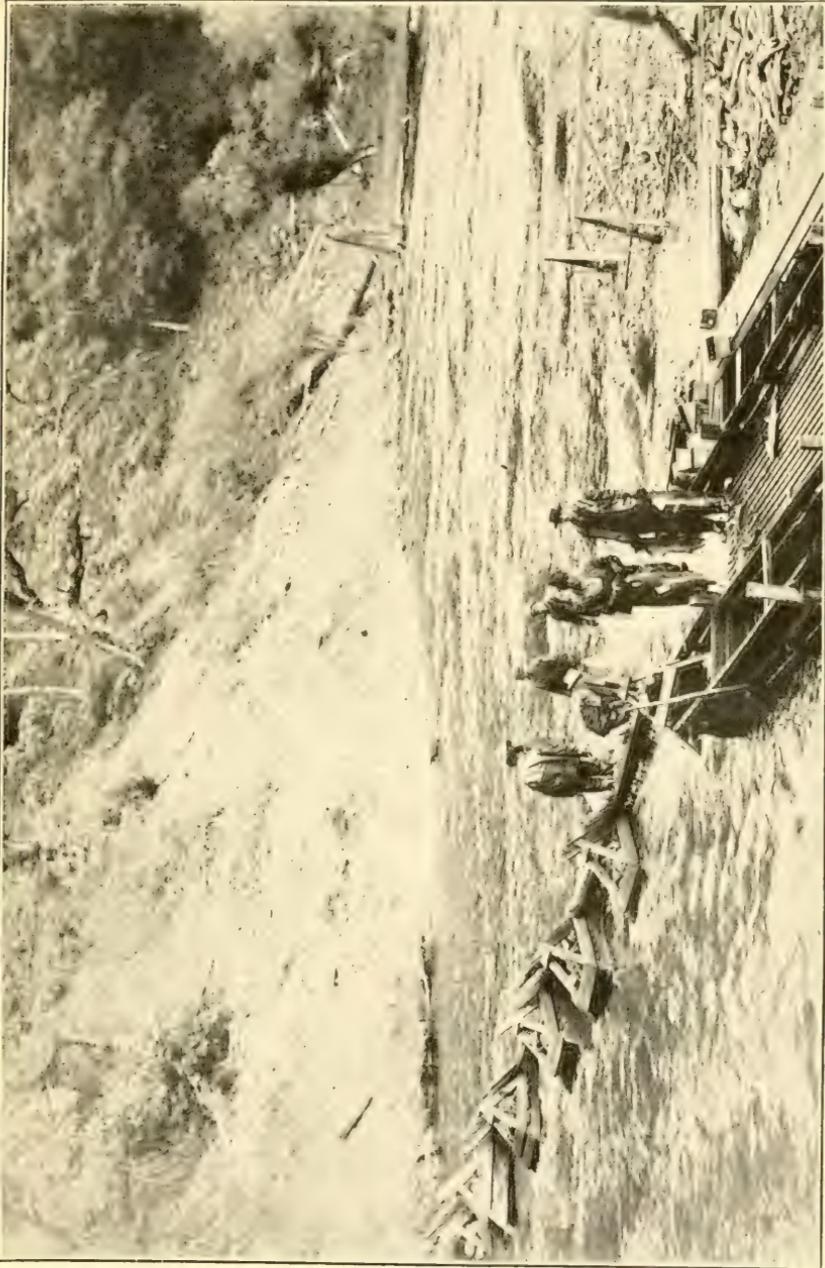


FIG. 5.—Section on line A—1 of figure 2.

#### OBTAINING SALMON FOR PROPAGATION.

The manner of capturing the brood fish varies in accordance with the nature of the stream where the work

is conducted. On some rivers the upstream trap is successfully used in connection with the head rack (Pl. 1). The tray used is sometimes a square or oblong inclosure; at other times it is a pen constructed of lumber. In either case the entrance is made on the principle of



DOWNSTREAM TRAP, LITTLE WHITE SALMON RIVER, WASH.



the ordinary pound net. In their eager efforts to pass upstream the fish go through the V-shaped mouth of the trap, and, having once entered, they seldom find their way out. The trap is usually covered to prevent the escape of the fish by jumping.

In streams where the current is strong, as in Oregon and Washington, the fish are sometimes taken on the riffles by means of gill nets; but, as many are killed or injured when so caught, this method should be employed only as a last resort.

In the comparatively slow streams of California it is customary to employ drag or sweep seines of suitable length and depth, which are operated below the head rack and above the retaining rack.

Where the natural conditions will permit, the most economical means of capturing salmon is by the use of a downstream trap. The use of this device necessitates that the upper rack be placed across the river at the head of a spawning riffle having a good fall. The wings of the trap, constructed on the same principle as the rack and with openings provided near the shore ends for the entrance of the salmon to the spawning waters below the main rack, are run downstream from one or both shores, as local conditions may require, and at their convergence the trap is located. The trap, which is usually about 5 feet wide, is made of smoothly dressed slats or poles, the small ends of which are nailed to a light sill sunk in the bed of the stream, with a space of  $1\frac{1}{2}$  inches between each pole, to allow the water to flow through freely. From the sill they rise in a gentle incline downstream to a level a few inches above the point where the water runs through, and they are then sprung down and nailed to sills, forming the bottom of the trap. The sides of the entrance and the trap proper are usually made of poles or pickets placed horizontally, with sufficient space between to permit water to escape freely. The sides of the entrance are well braced to withstand the pounding of the salmon when rushing into the trap in numbers, and on either side of the trap live pens for holding the ripe fish are constructed. Across its entrance a grating is placed to prevent the fish from being carried into it when not in use.

When the trap is to be fished, the openings in the lead are closed and the grating at the entrance removed. The seine is laid out at the head of the riffle, whence it is rapidly carried by the current downstream toward the trap. The fish on the riffle become frightened at the seine and run downstream. Following the converging leads and traveling rapidly with the current, they are driven into the mouth of the trap. Before they can turn, their momentum carries them high and dry onto the trap floor, where an attendant picks them up, liberates the green fish in the water below, and places the ripe males and females in their respective pens. The fish which try to turn back before reaching the trap are caught by the heavy leaded seine and held against the lead racks until the fishermen find them.

At the Big White Salmon station of the Bureau of Fisheries success has been attained by purchasing salmon from the fish-trap men and towing them in live cars to an inclosure made by racking a spring creek having a soft, sandy bottom, which is particularly adapted to the successful ripening of immature fish. The death rate of the fish while being held there to ripen is small, and the eggs taken from them are of excellent quality.

At Baker Lake the fish are taken in a web trap as they enter the lake and are impounded in a slough at the head of the lake and held there successfully for several months. When mature, they are removed from the inclosure by means of a drag seine.

Where immature salmon are to be held for any length of time, an inclosure with a soft, muddy bottom should be provided for the purpose, it having been found by experience to be far superior to a gravel bottom.

A rather novel method is employed for capturing silver salmon and steelheads where the barrier preventing the ascent of the fish chances to be a dam or a natural fall. At an advantageous point, where the water pours over the crest of the barrier and where the fish are known to jump in their attempt to ascend the river, a device known as a jumping box is installed, being placed back of the fall at a sufficient height, so that when the fish jump they will be likely to fall through the water into it. The length of this box or trough is governed by local conditions; its width varies from 18 to 24 inches, and it is given a fall of at least 12 inches to each 10 feet of length. A covered flume with a sharp fall connects it with a live box, which is placed in the stream in such a manner as to insure its protection so far as possible from high water, and at the outlet of the flume leading to the live pen a downstream V is placed. This, together with a secure cover, serves to prevent the escape of the fish from the pen.

In the operation of this contrivance the fish fall into the jumping box, and before they can regain their equilibrium they are carried into the live pen and are held there until removed. Care must be taken to prevent overcrowding in the pen, as, when the fish are jumping from 6 to 9 a. m. and from 3 in the afternoon until sundown, they are apt to be taken in such numbers that loss from smothering will result, unless the pen is emptied at frequent intervals.

#### TAKING AND IMPREGNATING THE EGGS.

When chinook-salmon eggs are taken on a large scale, say from a half million to three or four millions per day, as is customary at the Little White Salmon station on the Columbia River, spawning usually occurs daily throughout the egg-collecting season, it being impracticable to hold the fish in pens for any length of time, as they injure themselves more or less in fighting against confinement, and many eggs are dropped.

The females are placed in pens by experienced men, and ripe ones only are put in. Of the signs that indicate ripeness in a female salmon the separation of the eggs in the ovaries is the surest. Specific signs are all fallible, however, and the spawn taker must rely mainly on an indescribable ripe look, which is neither color, shape, nor condition of organs, but a general appearance which shows at a glance that the fish is ripe. This knowledge can be gained only by experience.

An attendant gets into the pen containing the females and catches a fish by the tail with his left hand, on which is worn a woolen glove or mitten as an aid in maintaining his hold. He kills the fish by a blow on the head with a club and, casting it on the trap floor, repeats the operation until from 40 to 50 have been killed. At some stations it is customary to cut off the tails at the base of the caudal



STRIPPING FEMALE CHINOOK SALMON, LITTLE WHITE SALMON (WASH.) STATION.



FERTILIZING EGGS OF CHINOOK SALMON, BIG WHITE SALMON (WASH.)  
STATION.

with a broadax, so that the fish may bleed freely. While this is not absolutely essential, it prevents the eggs from coming in contact with a large quantity of blood. The fish are washed by dashing water over them, the blood escaping through the open floor.

Male fish are then thrown out from their pen and left long enough to undergo the exhaustion necessary to permit their being handled without much difficulty.

The spawn taker uses a "straight-jacket," as it is called, merely for the convenience of holding the fish. This is a sort of trough made the average length of a salmon and hollowed out to fit its general shape. A female is picked up by the gills and placed in this device. With a sharp, short-bladed knife the spawn taker makes an incision from the vent through the thin abdominal wall along the side, and the eggs flow out into a spawning pan or bucket held by another attendant. This is immediately passed to a third man, while a fourth man picks up a male fish. Grasping the tail of the fish with his left hand, and thrusting its head under his right arm, or in the case of a larger fish, between the knees, with his right hand he presses the milt out upon the eggs as soon as possible after they are taken. The eggs and milt are then thoroughly mixed by stirring with the hand. After being allowed to stand for a few minutes the milt is washed off, and the eggs are transferred to buckets and carried to the hatchery. Here they remain undisturbed until they have become water hardened and separate, when they are measured into egg baskets. The male fish is returned to the stream for use in future spawning operations.

Blueback salmon in Alaska begin to leave the lakes in late August and September and ascend the streams to their headwaters to spawn. At suitable places near the mouths of such streams the fish are intercepted by racks, and seining operations are conducted in the waters below. The seine used, which is about 300 feet long, is loaded on a boat at a point below the rack, and, one end being held on shore, the remainder is distributed to posts projecting from the rack to the farther side of the stream. From here the boat continues downstream in a long sweep until the seine is played out to form a semicircle. The end last played out is operated by a man in waders, while the boat with the lead rope continues on to the starting point on the shore. At a given signal men stationed along the rack release the seine and follow it as it is hauled toward the shore, the two ends being brought together so as to completely envelop the fish, which are gradually worked toward the center. The seine is then stretched or hung on horses or tripods, and men equipped with woolen gloves grasp the corralled fish by the tail, segregate the sexes, and distribute them in boxes conveniently placed for the purpose. These boxes, supported on legs about 3 feet long, are made of three-fourths-inch lumber and divided by partitions into from 8 to 10 cells, each of them large enough to hold a fish placed in it head foremost, leaving about 6 inches of the tail protruding.

An operator stands at a box in which females have been placed and ascertains them to determine as to their spawning condition, placing the ripe ones in another box and throwing the unripe ones back into the stream. A second man stands at the box containing the ripe fish and removes them one by one, killing them by a blow on the head with a club. They are then placed on a spawning table having a top 2 by

10 feet in dimensions, 6-inch sides, and legs about 3 feet long, with a slope toward the operator at the other end. Across the table, for convenience in taking the eggs, is placed a small platform or bridge 1 foot in width, with a slope of about 30° toward the upper end of the table, the face of which is studded with sharp-pointed nails one-half inch long to hold the fish in place.

The spawn taker removes a fish from the table and places it on the platform with the head toward him, his left hand resting near the middle of its back. With his right hand he rips open the abdomen from a point between the pectoral fins to the egg vent by means of a sharp-bladed knife, having a guard which permits the blade to project three-fourths of an inch. If the eggs are ripe they are easily removed by slightly inclining the fish toward the lower side of the board, where they gently fall into a pan placed to receive them. The dead fish is then thrown aside and the operation repeated. After two females have been spawned a man at the opposite side of the table removes the pan, replaces it with an empty one, which has first been moistened with water, and passes the pan of eggs to the operator handling the male fish, to be fertilized. After fertilization has been accomplished, the eggs are turned into a washing box and held in a quiet current in the stream to clean up. This box somewhat resembles a corn popper in its construction, being made of fine-meshed wire and provided with a long handle and a hinged cover, with a clasp to hold it in position. In its bottom is a small trapdoor, operated by a lever near the end of the handle. After remaining in the stream a few minutes the eggs are emptied through the trapdoor into a bucket submerged about a foot under the surface of the water. Here they are held for half an hour to harden and are then carried to the hatchery, measured, and distributed in standard salmon-hatching baskets, 50,000 being placed to a basket.

#### HATCHING APPARATUS AND METHODS.

The hatching apparatus usually employed is the so-called standard salmon trough, with wire-cloth baskets. The troughs, which are generally constructed of cedar and redwood from 1½ to 2 inches, dressed, are 16 feet long, outside measure, and 14 by 6½ inches, inside measure. They are arranged in pairs, two or three pairs being placed end to end on different levels, with a fall of about 6 inches between each pair.

Metal partitions divide each trough into compartments just enough longer than the baskets to permit of their being raised and lowered and subjected to slight tilting. The essential feature of this trough is the perfection of water circulation attained by means of cross partitions or riffle dams inserted at either end of each compartment. These partitions are made of No. 20 galvanized sheet iron and are held in place by saw scarfs in the sides and bottom of the trough.

The first riffle dam is placed 7½ inches from the head end of the trough, reaches entirely across, and extends from the bottom to within about 1½ inches of the top. Two inches below this point a similar dam extends across the trough, reaching from the top to within 1½ inches of the bottom. Twenty-six inches farther down similar dams are arranged, and so on throughout the entire length of



the trough, with the exception of the space between the second and third and the fourth and fifth compartments. Here the dams are placed  $2\frac{3}{4}$  inches apart for the accommodation of iron braces, which prevent the troughs from bulging. Only one dam is used at the foot of the trough. This reaches across and extends from the bottom to within  $1\frac{1}{2}$  inches of the top. In the center of the space at the foot of the trough is a 2-inch outlet, provided with a hollow cedar or metal plug, placed at the proper height. The water is thus forced to flow under the upper dam upward through the basket of eggs, and thence over the lower dam, etc. The troughs are provided with canvas covers stretched upon light frames and made sunproof by saturation with asphaltum varnish, which is also thickly applied to the interior surface.

The egg receptacles are oblong-mesh wire-cloth baskets about  $13\frac{1}{2}$  inches wide, 24 inches long, and from  $5\frac{1}{2}$  to 6 inches deep, thus allowing them to project an inch or two above the surface of the water in the troughs. When wooden-rimmed baskets are used, the rim rests on the top of the trough and holds the basket 1 inch from the bottom. Arranged in this way the water passes under the riffle dam at the head of the compartment, beneath the basket, and then upward through the eggs. The metal rim, which has been adopted in recent years, is supported by metal lugs fastened to the edge of the basket, rests on the top of the trough, and holds the basket in the same position as the wooden rim. In both cases the basket, when in operation, should be kept flush against the lower riffle dam of the compartment in which it is placed, to force the ascent of the water through the eggs.

The number of eggs that can be incubated in a basket depends upon the species of salmon and the volume of the water supply. This varies with the chinook from 20,000 to 30,000; blueback, from 50,000 to 60,000; silver, from 30,000 to 35,000; humpback, from 40,000 to 50,000; and chum, from 33,000 to 38,000.

The eggs suffer no injury from being in numerous layers, as water is constantly forced through the mass, partially removing the pressure. The baskets are constructed of galvanized wire containing from four to six meshes per inch, three-fourths of an inch long, the size of the mesh varying with the size of the eggs to be handled. The oblong mesh permits the fry to pass through onto the bottom of the troughs when hatched, but it is not large enough for the passage of the eggs. The advantages of this apparatus are: (1) The top of the basket is above water, so that the eggs can not overrun or escape; (2) by tilting one end of the basket a little, or by lifting it and settling it back gently in place, the bad eggs are forced to the top and can be easily removed with the ordinary egg picker; (3) space is conserved, as the basket provides many times the number of eggs that could be accommodated on trays with an equal volume of water, the proper flow per trough being from 10 to 15 gallons per minute; (4) the ease and facility with which the mud can be discarded make it possible to remove all sediment collecting on the eggs by gently moving the basket up and down in the water several times.

The period of incubation of salmon eggs depends upon the water temperature. A very safe rule to follow is one originally formulated by Seth Green:

In a temperature of 50° F. the eggs will hatch in 50 days. Every additional degree of warmth lessens the incubation period by 5 days, and every degree lower than 50 prolongs it 5 days.

Salmon eggs are very hardy during the first few days, and while in this condition they are thoroughly gone over for the removal of the dead ones. At some stations it is customary after doing this to cover the eggs and leave them undisturbed until the spinal column is well formed, when the delicate stage has passed. This is not absolutely necessary, however, where skilled operators are employed. Men experienced in the work can handle the eggs throughout the entire period of incubation, and this is the most efficient method to pursue. When the number of unimpregnated eggs is great enough to warrant, they may be most advantageously removed by means of a salt solution, which should be applied only after the spinal column is well formed.

By means of this solution, which should consist of one part salt to nine parts of water, one is able to distinguish dead or unfertilized eggs at an early stage of development. The solution is held in a water-tight box or trough of 1-inch lumber, 40 inches long, 18 inches wide, and 12 inches deep. Inside of it is a second box of one-half inch lumber 3 inches less in width, 3 inches deeper, and provided with handles and a screen bottom. The dead eggs are removed with a net or scoop made of basket wire. The trough or outer box is filled to within a few inches of the top with water, and salt is added gradually and dissolved until the proper density is attained, this being determined by testing a few good and bad eggs in a small portion of the solution each time salt is added. This has been demonstrated to be a more satisfactory method than weighing or measuring, as salt readily absorbs moisture and varies in purity.

The box with the screen bottom is placed in the solution, wedged down, and a full basket of from 35,000 to 60,000 eggs poured into it. In less than one minute the good eggs will settle to the bottom, and the bad ones can be removed with the wire scoop. The inner box can then be lifted out and the good eggs returned to the basket and to fresh water, the whole process not requiring over three minutes. One solution can be used over and over again by adding sufficient salt to maintain a uniform density.

The box or trough was adopted because of convenience in handling and because it furnished the necessary amount of surface, a very important feature to consider, as the bad eggs, if crowded, would cause the good ones to float by mingling with them. Quite an extensive use of this method of cleaning the eggs has shown no deleterious results, and where there are over a thousand dead eggs in the basket at the time the empties are turned, the use of the solution will effect a saving of labor.

#### PACKING SALMON EGGS FOR SHIPMENT.

Cases made of 1-inch lumber and of suitable size for packing on horses or mules are used for moving eyed salmon eggs over rough mountain trails from the collecting fields. The bottom of the case is lined with a thick layer of moss and covered with a piece of mosquito netting. On this a layer of eggs is spread and covered with netting. Successive layers of moss, netting, and eggs are thus arranged up to the middle line of the case, where a firm wooden parti-

tion is fastened on. The packing is then resumed as before until the case is filled, when the cover is screwed on, and the eggs are ready to be transported.

For shipping eyed salmon eggs to various points in the United States what is known as the Atkins-Dinsmore case has been quite generally substituted for the old tray-shipment method described on page 84 of the Appendix to the Annual Report of the U. S. Commissioner of Fisheries for 1897. Eggs can be transported in the Atkins-Dinsmore case as soon as the eye spot is plainly visible and up to within a few weeks of hatching. When shipped at too late a period of development, however, the eggs will hatch en route and the embryos perish.

This method of packing eggs \* \* \* has the special advantage of making a comparatively light package—a factor of great economic importance in transportation. The outside case may be an ordinary box of suitable dimensions.

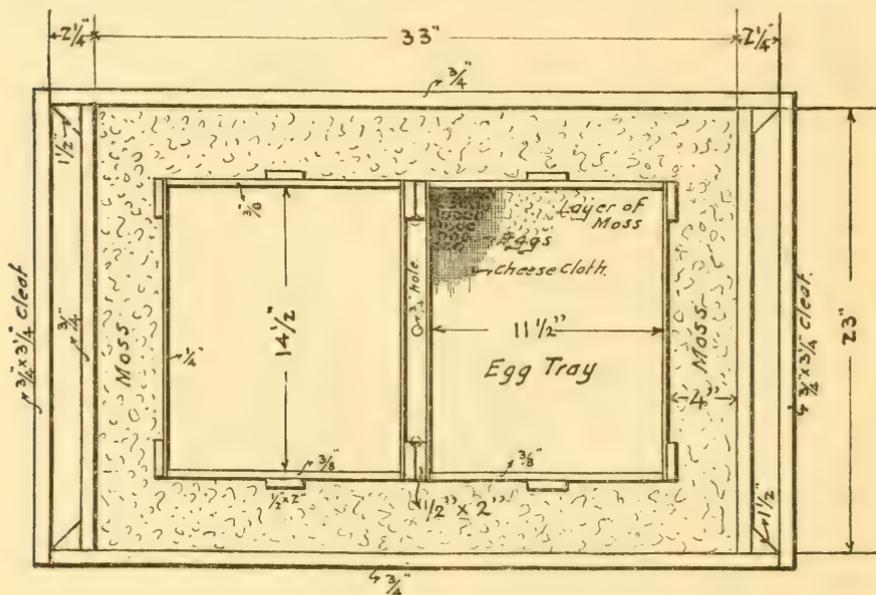


FIG. 7.—Atkins-Dinsmore shipping case. Plan.

In it are packed, surrounded by moss, several boxes made of three-eighths-inch boards, and usually 12 inches wide by 15 inches long by  $3\frac{1}{2}$  inches deep, each box containing a mass of 10,000 to 20,000 eggs in mosquito netting, with moss around all sides. No ice is used, care being taken that the packing be done in a temperature below  $50^{\circ}$ , that all packing material be kept in a place slightly below freezing point, and that the moss in which the eggs are packed be sprinkled with snow. This method of packing is an economical one for shipments of eggs of Salmonidæ during cold weather, but can not advantageously be used for eggs of spring-spawning fishes unless there is available a cold-storage room in which to do the packing. Recently the superintendent of the Baker Lake (Wash.) station, who has had occasion to ship eggs of steel-head trout and Pacific salmon in warm weather, has packed them in light cases with alternate layers of moss, and then placed two tiers of these thin cases side by side in an outer case with a large hopper of ice over the whole, the drip passing down between the two tiers of inner cases. The chief advantage of this case for long-distance shipments is in the fact that less ice is required than in other forms of cases using ice, with a consequent saving in transportation charges. It can also be used in warm as well as cold weather.<sup>a</sup>

<sup>a</sup>Titcomb, John W. Loc. cit., pp. 743.

While the methods described above have been successfully employed in the transportation of eggs across the United States and

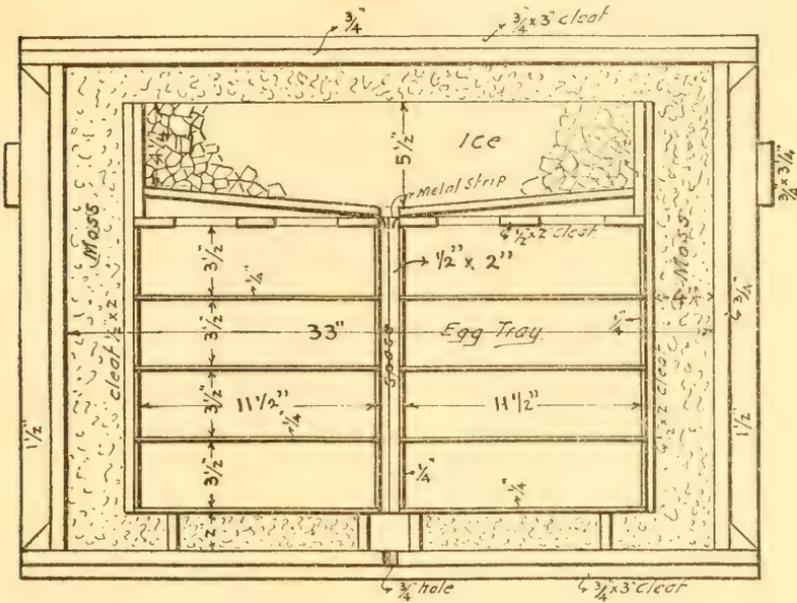


FIG. 8.—Atkins-Dinsmore shipping case. Longitudinal section.

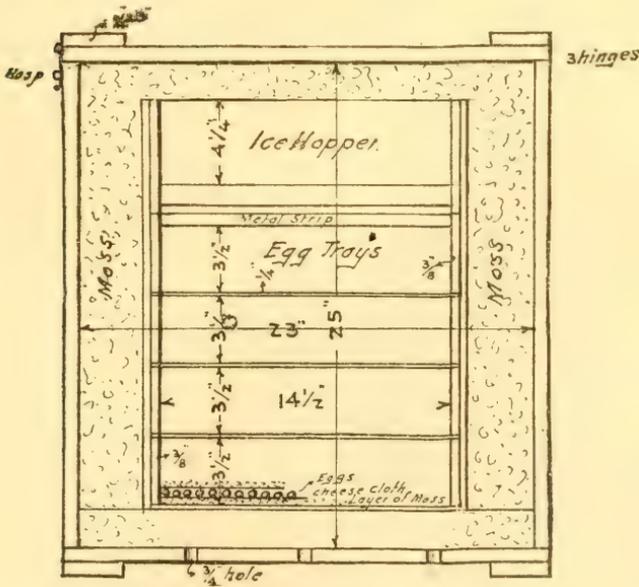


FIG. 9.—Atkins-Dinsmore shipping case. Cross section.

also to Europe without an attendant, shipments of eggs to points south of the Equator, usually leaving this country in winter and arriving at their destination in summer, have called for more than

usual attention to the methods of packing them, and a caretaker is quite essential.

The Argentine shipping case, successfully used under such conditions, has been described by John W. Titcomb as follows:<sup>a</sup>

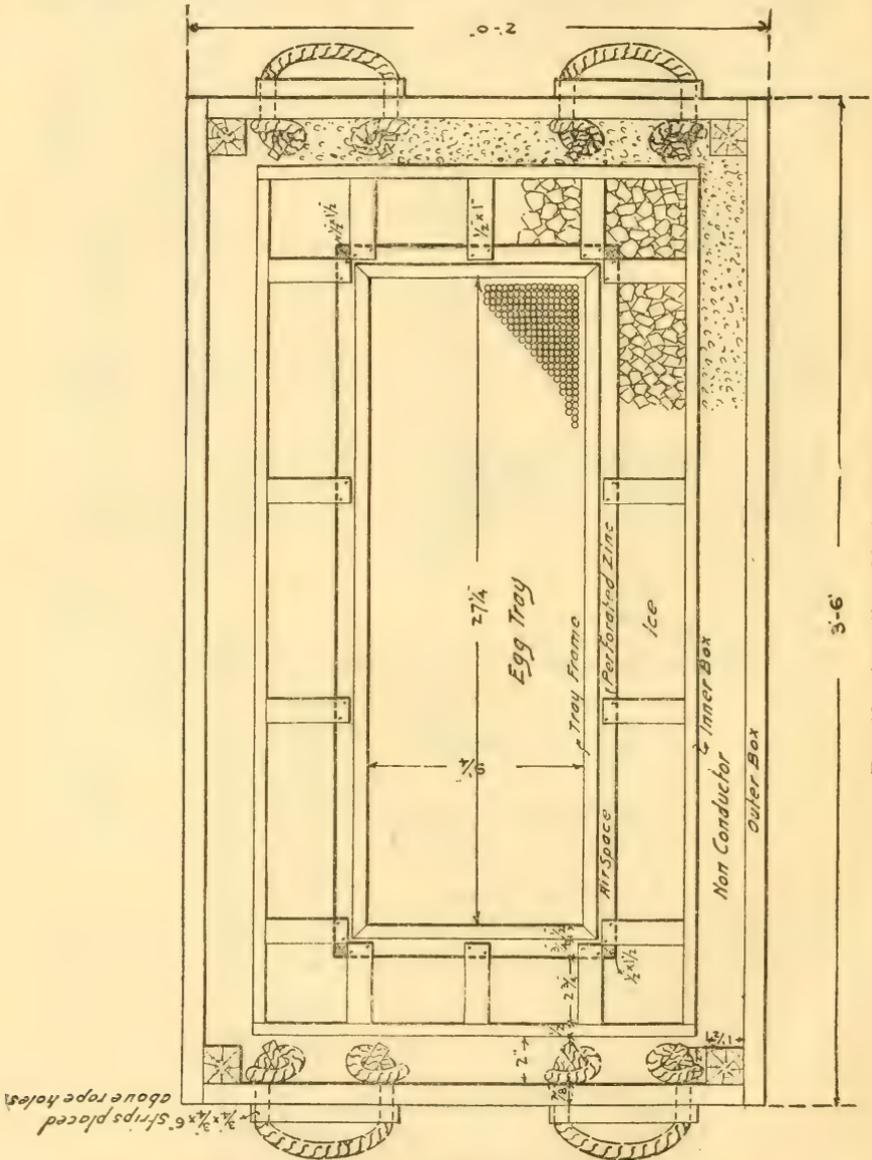


FIG. 10.—Argentine shipping case. Plan.

A highly efficient form of shipping case has been developed during the past few years for the transportation of eggs of the Salmonidae from this country to Argentina. This case is 3 feet 6 inches long, 2 feet wide, and not exceeding 30 inches high, outside measurement, and is constructed of selected tongued and grooved lumber. It has double walls, with bottom and top common to

<sup>a</sup> Titcomb, John W. Loc. cit., pp. 747-749.

both, the 2-inch space between the walls being filled with nonconducting material, preferably tightly packed shavings. Between the inner wall and the stack of trays is a  $2\frac{3}{4}$ -inch space for ice, separated from the trays by perforated zinc. Between the latter and the trays, in a three-fourths-inch space, are the vertical supports of the zinc, viz, double corner supports, one being one-half by  $1\frac{1}{2}$  inches, the other being one-half by 1 inch; two intermediate supports of one-half by 1 inch material, which are provided on either side of the case and one at each end; and cross braces of one-half by 1 inch material, which extend from the uprights to the inner walls of the case.

The ice hopper, 3 inches in depth, and having the same outside dimensions as the trays, rests upon the latter and fills the space between the uppermost tray and the top of the case. It has a perforated zinc bottom, and, to facilitate handling, cleats of small ropes are attached to it. The top of the case is insulated with a 2-inch thickness of nonconductor covered with sheet zinc, this insulation fitting closely into the chest when closed, and thus covering not only the ice hopper, but the ice spaces around the sides as well. In the bottom grooves lead to a three-fourths-inch drain hole, which is provided with a

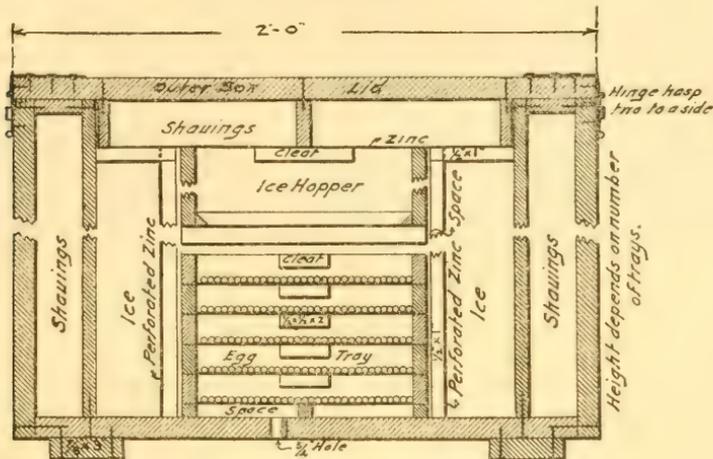


FIG. 11.—Argentine shipping case. Section.

cork. Two cleats seven-eighths by 3 inches are attached lengthwise to the bottom on the outside.

The trays are one-half inch deep, 27 inches long, and 9 inches wide, inside measurement, the frames being of one-half by one-fourth inch material. The bottom of each tray is covered with wire cloth, No. 25 gauge, about 12 meshes to the inch, stretched tightly to prevent sagging and consequent uneven distribution of the drip water. A narrow binding of cloth is tacked around the bottom of each tray to prevent the wire edge from catching on the mosquito-net covering of the tray beneath. On the inside ends of the trays are fastened short lifting cleats, and wedges hold the trays securely in place. The bottom tray rests on three one-half-inch cleats extending lengthwise of the case, one at either side and the other in the middle. It is important to have the trays of uniform size that they may be interchangeable.

The trays and interior of the case are coated with asphaltum. To facilitate opening from either side, four hasps are used, two on each side of the case. Two rope handles side by side are placed on each end of the case, with a cleat of three-fourths-inch material just above the holes for each handle.

Eggs selected for shipping should barely show the eyespots without the aid of a glass. In packing, a layer of damp moss is spread one-fourth of an inch deep as evenly as possible over the tray bottom, and upon this is placed a covering of mosquito net or bobbinet. The eggs are laid upon the netting one or two layers deep, spread to within one-half inch of the tray frame, and covered with another piece of netting to keep them separate from the moss, which is sprinkled in a light layer over it, filling the tray. The netting is cut large enough to extend over the outer edges of the tray, so that the eggs may not be disturbed when a tray is lifted for examination.

On shipboard, as the greater part of the journey is made, the cases of eggs are kept in one of the fruit or cold-storage rooms having a temperature of about 38° F. To this room the attendant has access, and it is his duty daily to moisten the eggs by pouring through the ice hopper water of the same temperature as the eggs, 34° to 35°. The ice compartments are frequently replenished, and the eggs are picked over whenever necessary.

It will be seen that the method of caring for the eggs is not novel. The chief improvements in the case are to make it easy for the caretaker to handle the eggs in the crowded quarters of a ship's storage compartments and to facilitate handling each individual tray.

#### WATER SUPPLY FOR HATCHERY.

One of the most important factors to be considered in connection with salmon propagation is the water supply, which should always be taken from a stream that salmon are known to frequent for spawning. Spring water or water from a spring-fed creek is objectionable, as it shortens the incubation period, bringing out the fry at an earlier period than if hatched under natural conditions and at a season of the year when the natural food supply in the streams is at its lowest ebb.

In choosing a site for a salmon hatchery the matter of conveying water thereto at a proper height for a gravity service should be planned for, if possible. The supply may be conducted through a substantially built flume or by a pipe line, the dimensions of either to be governed by the extent of the work contemplated, having in mind the further development of the plant and the size of the pond system it is desired to establish. The point for the intake should be selected with the view to its protection, so far as is possible, from the ravages of floods and ice. This may be accomplished by means of piling or sheer booms. In some cases the construction of a low dam will be required in order to raise the water to the proper level to enter the flume or pipe line.

Water taken from an open stream always contains more or less sediment, necessitating the use of a filter for the elimination of the greater part of it. A small quantity of sediment in the water supply is not objectionable; in fact, it is apparently beneficial.

Where a proper fall can be secured, with a sufficiently rapid current at the point of intake, the water can be delivered by means of a current wheel, provided climatic conditions are favorable to its operation. A wheel for this purpose should be constructed on the order of a large undershot water wheel, with buckets on the outside of the rim. As the wheel revolves the buckets fill and empty into a trough or tank connecting with the supply flume leading to the hatchery.

#### CARE OF THE FRY.

The eggs of the chinook salmon, as do those of the other Salmonidæ, hatch very gradually at first, only a small percentage coming out the first day. But the number increases daily until the climax is reached, when large numbers of young burst their shells in a single day. Great care and vigilance are required at this time. The vast numbers of shells rapidly clog up the guard screens at the outlets of the troughs, which should be kept as free as possible by thorough cleansing from time to time.



FIG. 1.—HATCHERY AND FEEDING PONDS, DUCKABUSH (WASH.) STATION.

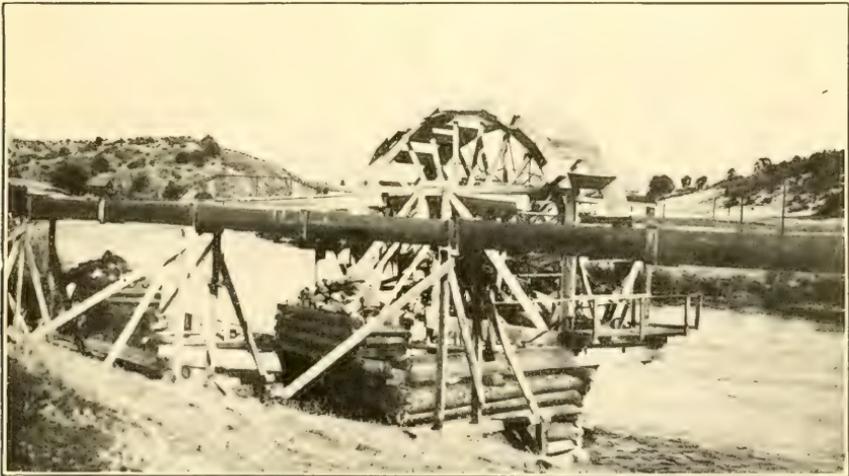


FIG. 2.—CURRENT WHEEL, HORN BROOK STATION, KLAMATH RIVER. CALIF.



After all the eggs are hatched and the baskets and riffle dams are removed from the troughs, each trough is divided into three equal compartments for holding a certain proportion of fry by inserting in the saw scarfs which carry the riffle dams 7 by 14 $\frac{3}{4}$  inch screens, made of No. 9 gauge zinc. The size of the perforations, which are horizontal in shape, should be governed by the species handled, and the four outer edges of each screen should have a one-half inch margin of unperforated metal. The number of fry that can be held until the absorption of the yolk sacs ranges from 30,000 to 50,000 per trough, varying with the species and the water supply available.

In the deep trays the newly-hatched fish are mixed with unhatched eggs, and the advantage of the oblong mesh in the bottom of the trays becomes apparent. This mesh is too narrow to allow the eggs to fall through, but the hatched fish, being comparatively long and narrow, easily slip through the long meshes into the space below. They should be assisted by gently raising and lowering the tray at intervals, taking care not to raise them out of the water, as at this tender age a slight pressure against the wire of the tray will often produce fatal injuries. On this account too much caution can not be exercised in regard to handling them out of water during the first stages of the yolk-sac period, for the injuries can not be seen at first, and often the death of the fry is the first warning that they have been injured.

After the eggs are all hatched and the young fish are safely out of the trays and on the bottom of the troughs, their dangers are few, and they require comparatively little care. Almost the only thing to be guarded against at this period is suffocation. Even where there is an abundance of water and room, with a good circulation, they often crowd together in heaps, or dig down under one another until some of them die from want of running water, which is not an inch away from them. The best remedy in such a case is to thin them out.

#### FEEDING THE FRY.

In recent years it has become well recognized that real success in the propagation of the Pacific salmons is determined in large measure by the extent to which the young are reared to the fingerling stage before liberating. The former practice of planting defenseless fry in wholesale numbers a short time before the final absorption of the yolk sac is now almost obsolete. This pertains particularly to the blueback and silver salmons and in less degree to the chinook, for these are known to pass a part or the whole of their first year's existence in fresh water, a period of residence that has been determined conclusively, chiefly as the result of general investigations and study of salmon scales conducted in recent years by Dr. C. H. Gilbert, of Stanford University, Calif.

The demand for fingerlings which has naturally followed this recognition of the great value of fingerlings over fry has developed the necessity for a cheap food, one that will furnish proper nourishment for the young fish and be available in large quantities, as the cost of liver, which has long been a favorite article of food for young fish on the west coast, has become prohibitive, except for occasional use and to afford a change of diet for a short period.

One of the first cheap foods to be utilized in large quantities by the Bureau of Fisheries was the Columbia River smelt, which was first tried at the Oregon stations about five years ago. These fish can be purchased during the run at the height of the season for \$20 per ton at a cold-storage plant in Portland, Oreg. An additional charge of \$20 per ton covers sharp freezing and storing for a period of six months, and this, together with transportation charges, makes the average cost of the fish about  $2\frac{1}{2}$  cents a pound delivered.

Smelt have been fed both raw and cooked. When used in the raw state the fins and heads are removed, and the fish are ground once through the coarse plate of an Enterprise meat chopper, after which they are run through the fine plate twice. However, this method has not proved very satisfactory, as smelt are very oily, and, in feeding, difficulty has been experienced in keeping the troughs clean. Intestinal trouble is also feared from the innumerable small, sharp bones.

The method which has given most satisfactory results is to place the smelt in 50 or 100 pound lots in a farm kettle and cook them until the bones become softened. After this a quantity of the cooked mass convenient for handling is placed in gunny sacks and permitted to drain thoroughly. The mass in the sack is then transferred to a press of convenient size, operated by an ordinary house jack, and is pressed into cakes 12 inches square and varying from  $3\frac{1}{2}$  to 4 inches in thickness. The burlap forming the sack is peeled away and is serviceable for further use. Quantities of this food can be prepared at one time, and, if kept in a cool, dry place, will remain in a wholesome condition for several days. When needed for food it is grated by means of a homemade power grater and screen, the degree of fineness depending upon the age of the fish to be fed. After this operation it presents the appearance of coarse meal. It can be scattered over the surface of the water and is cleaned up by the fish before it reaches the bottom. Prepared in this manner it makes a good, clean, rich food, and the fish take it readily. Its cost is also very moderate.

Beef and hog melts have been successfully used in conjunction with mush, both for the purpose of varying the diet, and with the view of eliminating the use of liver in large amounts after the fish are a few weeks old. The cost of this material will average about 3 cents per pound.

Culled canned salmon, or "do overs," have also been employed to good advantage in the feeding of young salmon. The contents of the cans are first thoroughly heated and then pressed and grated in the manner described above in the preparation of smelt. Particular attention is invited to this method of using canned salmon as fish food in view of the fact that considerable complaint has been made as to the results of its use in the past. If prepared in the manner specified, the material is certain to give satisfactory results.

After several years' success in the feeding of canned salmon it occurred to representatives of the Bureau that the fish used in a spawning operation, if properly preserved and prepared, would make a good and inexpensive food. Instructions were accordingly issued to all the west coast superintendents, including those in Alaska, to put up a quantity of the spawned salmon, and it is extensively used at those stations at the present time. After being relieved of their eggs the fish are skinned, split, and carefully boned.

They are then placed in tanks or barrels, with alternate layers of salt, water being added in sufficient amount to keep the brine well over the top layer.

The material has also been prepared by dry salting in dairy salt and packing it in a dry, tight box or other container, weighing it down in a solid mass. The fish are then taken out, rinsed in fresh water, and hung over a pole in the dry house. A slow heat is applied at first to toughen the fiber, following which they are kept in the dry house until quite hard and dry, when they are packed in boxes between layers of papers to absorb any moisture and held in a dry storage until needed.

Still another method was tried at the Bureau's California stations, where a quantity of sundried or sun-cured salmon was prepared without salt, the climatic conditions being favorable for curing salmon in that manner until late in the fall.

Several methods of preparing this food were adopted. In all cases, however, the fish were first soaked well, preferably overnight, in running water, to remove the salt. Some were then cooked, pressed, and grated; others were prepared by grinding in an Enterprise meat chopper and mixing the meat with a mush made from middlings. Quantities have also been prepared and fed in the raw state. In all forms the material has proved excellent, and when used in conjunction with small quantities of liver or plucks, to vary the diet, the results have been eminently satisfactory. Its cost, based on the lots which have so far been put up, has averaged 1 cent a pound. When prepared in large quantities, it should be materially cheaper.

Most excellent results were attained with this food at one of the Puget Sound stations of the Bureau of Fisheries. In a slough where several hundred thousand fish had been placed at the time of the absorption of the yolk sac, sides of salted salmon were laid on the bottom. As the meat softened, hundreds of young fish could be seen working on it, and it was finally all devoured. The fish remained in the slough under the care and observation of an attendant, attained a rapid growth, and developed into splendid fingerlings.

Under such an arrangement the expense of salmon rearing is reduced to a minimum, and work of similar character should be encouraged on all salmon streams where the natural conditions are favorable.

In connection with rearing operations the importance of providing a mixed diet can not be too strongly emphasized. If the principal food consists of the prepared fish, a food of liver and mush should be given frequently. Where this is done as often as once a day, it will be found to produce the most rapid growth. No matter how good any one food may be, nor how cheaply it is prepared, the best possible results will be attained where a variety is used.

#### PLANTING YOUNG SALMON.

When the salmon have reached the proper age for distribution, they should be released on or near the natural spawning grounds, in the most protected spot that can be found. It is unwise to liberate young salmon before they have absorbed the yolk sac, and where the

necessary facilities exist it is advisable to feed them until they have attained a length of at least  $2\frac{1}{2}$  inches, as fish of that size are much more likely than fry to elude their enemies.

The following information bearing upon the ages at which salmon should be planted is taken from reports of Dr. C. H. Gilbert, Professor of Zoology, Stanford University, on investigations made by him for the U. S. Bureau of Fisheries and for the commissioner of fisheries of British Columbia:

The blueback spawns normally either in its fourth or fifth year, the chinook salmon in its fourth, fifth, sixth, or seventh year, the females of both species being preponderatingly four-year fish.<sup>a</sup>

The young of both blueback and chinook salmon may migrate seaward shortly after hatching, or may reside in fresh water until their second spring. Those of the first type grow more rapidly than the second, but are subject to greater dangers and develop proportionately fewer adults.<sup>a</sup>

[In the case of the blueback salmon] examination of scales from all the important blueback streams of the Province has shown for each basin that adult fish are derived from yearling migrants, to the practical exclusion of those which migrate as fry. Out of some 8,000 bluebacks of the 1913 run, only 12 fish seemed with some probability to have developed from fry migrants. It would seem, then, that with few exceptions the fry of this species perish after entering the sea. The only alternative to this conclusion is that fry develop in the sea in precisely the same manner, at the same rate, and with all the local peculiarities marking those of their own basin, which develop for a year in their native lake. To one acquainted with all the facts, such an hypothesis appears impossible and absurd.<sup>b</sup>

The deplorable waste occasioned by the loss of vast numbers of fry can not be checked, it would seem, in the case of such progeny as are the result of natural spawning. They can not be held back from migrating as fry if the instinct seizes them. But the case is different in hatchery practice. Here [British Columbia] it is still the custom to release the young as soon as the egg sac is absorbed and free feeding begins. But, in view of the conditions here pointed out, it would appear to be imperative that the fry of the year hereafter should be held in troughs or ponds and fed until midsummer, when the time for downward migration will have passed. They can then be deposited in the lake, with full confidence that they will pass to sea as yearlings the following spring.<sup>b</sup>

Silver salmon spawn normally only in their third year. The young migrate either as fry or yearlings, but adults are developed almost exclusively from those which migrate as yearlings.<sup>a</sup>

Chum salmon mature normally either in their third, fourth, or fifth year; humpback salmon always in their second year. The young of both species pass to sea as soon as they are free swimming.<sup>a</sup>

The term "grilse" as used for Pacific salmon signifies conspicuously undersized fish which sparingly accompany the spawning run. They are precociously developed in advance of the normal spawning period of the species. So far as known, the grilse of the chinook, silver, and chum salmons are exclusively males, of the blueback, almost exclusively males, except on the Columbia River, where both sexes are about equally represented. The larger grilse meet or overlap in size the smaller of those individuals which mature one year later at the normal period.<sup>a</sup>

The great differences in size among individuals of a species observed in the spawning run are closely correlated with age, the younger fish averaging constantly smaller than those 1 year older, though the curves of the two may overlap.<sup>a</sup>

<sup>a</sup> Gilbert, C. H.: Age at maturity of the Pacific coast salmon of the genus *Oncorhynchus*. Bulletin, U. S. Bureau of Fisheries, Vol. XXXI, for 1912, pp. 21-22. Washington, 1913.

<sup>b</sup> Gilbert, C. H.: Summary of Contributions to the life-history of the sockeye salmon. (No. 1.) British Columbia. Report, Commissioner of Fisheries, for 1913. pp. R10-R11. Victoria, 1914.

# ARTIFICIAL PROPAGATION OF STURGEON

## REVIEW OF STURGEON CULTURE IN THE UNITED STATES

By GLEN C. LEACH

*Assistant in Charge Division of Fish Culture  
U. S. Bureau of Fisheries*

and

## ARTIFICIAL PROPAGATION OF STURGEON IN RUSSIA

By NICOLAS A. BORODIN

*Formerly Chief Specialist in Fish Culture  
Russian Department of Agriculture*

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Appendix III to the Report of the U. S. Commissioner of Fisheries for 1919



# ARTIFICIAL PROPAGATION OF STURGEON.

## Part 1. REVIEW OF STURGEON CULTURE IN THE UNITED STATES.

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By GLEN C. LEACH,

*Assistant in Charge Division of Fish Culture, U. S. Bureau of Fisheries.*

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A number of attempts have been made in the United States at various times to propagate the sturgeon by the artificial manipulation of the eggs, but in every instance they have been rendered practically null by certain unusually persistent difficulties. An account of the efforts may be of interest and value, particularly in view of the fact, as appears from the accompanying paper of Prof. N. A. Borodin, formerly connected with the Russian department of agriculture, that most of these obstacles were overcome in the course of some experimental work performed under his direction as chief specialist in fish culture in that department.

The first attempt at sturgeon propagation by a representative of the United States Government was in 1888 at Delaware City, Del., in the course of an investigation of the sturgeon fishery by Dr. John A. Ryder (Bulletin, U. S. Fish Commission, 1888), but experiments along that line had been conducted by Seth Green at New Hamburg, N. Y., as early as 1875, and were described by him in his book entitled "Fish Hatching and Fish Catching," published at Rochester in 1879.

The eggs for the experiment at Delaware City were obtained from fish landed for the market. A number of such fish were examined, but of the various lots of eggs secured only one small lot was successfully hatched. In this instance they were taken by opening the female fish, and after fertilization had been accomplished by the application of milt secured in the customary manner, the eggs were spread in a single layer over the cheesecloth bottoms of shallow boxes and anchored in a small sluiceway where there was a constant current of water.

The same drawbacks—viz. difficulty in finding ripe eggs and milt at the same time, imperfect aeration of the eggs during the incubation period, and the unusual tendency of the eggs to develop fungus—were again encountered in the course of a second attempt to propagate sturgeon at Delaware City by Dr. Bashford Dean in 1893. The work of that year disclosed the feasibility of using as a fertilizing medium milt secured by the removal of testes from male fish which

were not sufficiently matured to void the secretion by the application of external pressure. The milt was separated from the cut testes by straining through a coarse cloth and proved just as effective as that taken from live fish, even after being held for several minutes in the rubber-bulb container. In an effort to overcome past troubles, the style of hatching apparatus was changed. The eggs were spread evenly under water on shallow trays in boxes whose sides and bottoms were covered with metal gauze. The necessity for quick handling soon became apparent, as the viscid nature of the eggs causes them to cling so firmly to any surface with which they come in contact that they are invariably injured in the attempt to loosen them, and it was found that if not placed on the trays within 10 or 15 minutes after being fertilized they would form into a gluelike mass, which speedily became compact and hard. After allowing sufficient time for the eggs to become firmly attached, the trays containing them were fitted into the boxes and anchored in various places in the river bed.

By the end of the second day thereafter the eggs in the boxes, which had been moored in marginal waters having a sluggish current and carrying much silt, were found to be entirely enveloped in fungus and dead. Those placed where the water current was strong and comparatively free from sediment had sustained a loss of 60 per cent by the close of the fifth day from the same cause, while those which had been installed in a strong current in salt water showed practically no fungoid growth and were hatched in good condition.

In the spring of 1890 Frank N. Clark, superintendent of the Northville (Mich.) station, made preparations for the collection of sturgeon eggs at Fox Island, Mich., and under his direction 142 female and 32 male fish were examined between May 26 and June 14. Examination showed that 23 of the females had already spawned, 98 were very immature, the eggs in 6 were nearly ripe, and 5 were in spawning condition. Of the males 21 were hard, 2 almost mature, and 9 entirely so. In all, 20,000 eggs were secured and fertilized by cutting open and squeezing the milt sacs after moistening them with water. Much difficulty was experienced from adhesion, three hours of constant stirring being required to break up and separate the bunches of eggs. Ninety-five per cent of them were developed to the eyed stage, but shortly afterwards a growth of fungus began spreading in the floating boxes in which they were being incubated, and, as a result, very few of the eggs were hatched. Had it been possible to incubate them in whitefish jars it is estimated that at least 85 per cent would have been saved.

In the course of experimental work conducted in 1901 on the Misisquoi and Lamoyille Rivers, tributary to Lake Champlain, efforts were made to hold green sturgeon in artificial inclosures for ripening. These efforts proved utterly futile, as in every instance the eggs caked together in a hard mass and development was arrested. Notwithstanding the great difficulty experienced in securing ripe eggs and milt together, 1,500,000 eggs were taken and fertilized, and their viscosity was effectively overcome by the method that is employed for the separation of pike-perch eggs. They were then successfully hatched in McDonald jars, the incubation period being

about six days in a water temperature of 65° F. The fish from which they were secured were taken especially for the work, and their violent struggles when caught frequently resulted in the loss of many of their eggs. Such losses were unavoidable, as it was possible to distinguish a ripe female only when the eggs ran from it after it was taken from the water.

In 1911 experimental sturgeon propagation was undertaken in Minnesota in the Lake of the Woods region. In advance of the season's run of fish an inclosure large enough to hold 30 adult sturgeon was constructed in Rainy River, and a hatching apparatus of sufficient capacity to accommodate 3,000,000 eggs and fry was set up in a convenient building. During the spring 16 sturgeon were captured in a pound net and transferred to the pen. Though held for several months under apparently favorable conditions, they failed to mature, and in the following October they were released without having produced any eggs. Another trial was made in the following year with the same results.

From the observations made it was concluded that sturgeon do not spawn until the water has attained a temperature of 60° F.; that the eggs do not ripen in fish held in confinement; and that unless nearly ripe males are available when the eggs are taken no results can be expected. The spawning season at the various grounds has always been short, seldom exceeding three or four days. It is believed that jars similar to those used in the propagation of whitefish and pike perch are the most suitable form of equipment for the development of sturgeon eggs.

## Part 2. ARTIFICIAL PROPAGATION OF STURGEON IN RUSSIA.

By NICOLAS A. BORODIN,

Formerly Chief Specialist in Fish Culture, Russian Department of Agriculture.

Every fish-culturist knows how difficult it has been to secure any genuine success in the artificial propagation of any species of sturgeon of the genus *Acipenser*. There must be acknowledged almost complete failure in both America and Europe as far as practical results go. One drawback has been the difficulty of keeping sturgeon eggs alive and sound, owing to their liability to be attacked and killed by *Saprolegnia* and other kinds of fungus. Yet another and very serious matter has been the scarcity of sturgeon in the rivers and lakes; in fact, these fish in many waters have become practically exterminated, and there has been no possibility of securing ripe eggs.

While America and western Europe have lost most of their sturgeon supplies, Russia still remains rich in sturgeons, especially the rivers emptying into the Caspian Sea—the Volga, the Kura, and the Ural. Even in these waters, however, there has occurred positive diminution in the number of sturgeon, and it is the general belief that, in order to prevent the entire extermination of these fish, it is quite necessary to resort to artificial propagation on a large scale.

Just prior to the outbreak of the war the central administration of the fisheries in Russia received a special appropriation for sturgeon propagation. Three of the commercial species were selected for attention, namely, *Acipenser ruthenus*, a small fish living in the Volga; and *A. guldenstadtii*, a Russian sturgeon, and *A. stellatus*, or starry sturgeon, both living in the Caspian Sea and ascending the Volga, Kura, and Ural Rivers in spring. Temporary stations for the propagation of *A. ruthenus* were established and operated in the Volga in 1913, 1914, and 1915; one station for the propagation of *A. guldenstadtii* was erected on the Ural in 1915, and another on the Kura in 1914, for handling both the starry and the Russian sturgeons.

There are not at hand the exact data on the work accomplished as regards the number of eggs hatched and fry planted, but the figures for *A. ruthenus* run into tens of thousands and for *A. stellatus* and *A. guldenstadtii* into several hundreds of thousands. Most of the fry were planted several days after hatching, but a considerable number of fry of the Russian sturgeon were reared for several months, and some specimens were carried in an aquarium for five or six months, until they became too large for their quarters.

There have been some interesting developments in sturgeon propagation in Russia in the past few years, and I will try to describe the methods employed.

Two of the most important deductions from the investigations made during the experimental work are that sturgeon eggs become ripe and suitable for impregnation only when the male and female fish are kept together in the same pond or reservoir and that the spawning act takes place probably only at night. These two observations explain why it has always been very difficult to get ripe eggs from sturgeons caught during daytime or kept in ponds or inclosures with the male and female fish in separate compartments.

In our experiments, specimens of *A. ruthenus* have been held in large ponds, and their eggs have become ripe. Russian sturgeon have been retained in a reservoir about 32 feet long, 11 feet wide, and 6 feet deep, supplied with a current of water pumped directly from the Ural River. One night these fish spawned, and two days later there were found in the mud at the bottom of the pond thousands of eggs. Some of these fish hatched into healthy fry, but, as is always the case under natural conditions, most of them had not been fertilized, and therefore they perished.

With regard to artificial propagation of sturgeon, as elaborated by Russian fish-culturists in the latest work, the methods have been as follows: As the eggs flow from the female sturgeon they have a tendency to become united into a glutinous mass, which must at once be prevented. We received good results by stripping the eggs into a wire screen, washing them thoroughly with river water, and then putting them in a tin pan and fertilizing them with milt diluted with water. Several minutes later, before the eggs had become sticky, we again washed them thoroughly with river water, which at this time in the Ural and Kura Rivers is very turbid and of a yellow color, because of the enormous quantity of clay and sand in suspension. By such use of muddy river water analogous to the employment of swamp muck or of starch for overcoming the adhesiveness of pike-perch eggs in the United States, we counteracted the stickiness of the sturgeon eggs, which thereafter lose that quality and become easy to handle in any fish-hatching apparatus. We obtained quite good results in using two very different kinds of apparatus, namely, the Williamson trough and the Chase jar; but in both cases we preferred to employ not running water, which is always a little muddy, but filtered water without circulation and with constant aeration.

After three or four days of development the eggs hatched, and thousands of fry were obtained. For the first four or five days the young do not require any external food, having a sufficient quantity of nourishment in their yolk sac; but after that period we introduced into the troughs and jars living food consisting of the smallest fresh-water crustaceans (*Daphnia*, *Bosmina*, etc.) collected in small, warm waters with fine-meshed nets. The fry soon begin to search for these crustaceans. When they become larger and accustomed to take food, we begin to feed with chopped earthworms, of which young sturgeon are very fond. Fed in this way sturgeon grow very rapidly, attaining during the first month a length of about 1½ inches and during five months 10 to 11 inches. Fry of two to three months have already begun to closely resemble the adults and are very pretty fish.



# SOME PLANTS OF IMPORTANCE IN POND FISH CULTURE

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By EMMELINE MOORE, PH. D.

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Appendix IV to the Report of the U. S. Commissioner of Fisheries for 1919



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# SOME PLANTS OF IMPORTANCE IN PONDFISH CULTURE.

By EMMELINE MOORE, *Ph. D.*

Contribution from the U. S. Fisheries Biological Station, Fairport, Iowa.

## INTRODUCTION.

It is a matter of importance in the production of pondfish to control the growth of aquatic vegetation. This can not profitably be done until it is known what plants enter directly into the fish dietary or contribute indirectly to the support of the various animal forms upon which fish feed.

There is little precise knowledge of the natural food of the advanced fry and young fingerlings of our ponds and streams. Nearly all of the examinations of the food content of fishes refer to the advanced fingerling stages or to adults. The importance from an economic standpoint of securing information about the natural forage of very young fish is seen at once. So far as we know, only a small percentage of the fry reach maturity, and by more or less vague explanations the failure has been referable to our lack of knowledge of the food relations in their environment.

This investigation, conducted at the U. S. Fisheries Biological Laboratory, Fairport, Iowa, refers primarily to the aquatic vegetation in the food of fish which are reared in ponds and considers the problem from the following standpoints: What plants contribute directly to the food of the advanced fry and fingerlings? What plants contribute indirectly to their food by providing forage for the various animal forms upon which fish feed? The investigation covers the period of the summer months during two seasons, June 20 to August 31, 1917 and 1918.

The data presented illustrate the dependence of the young fish on food, mostly animals, which in turn feed on plants. The determination of these plants, which are the basic source of the food supply in the ponds, forms the chief contribution of this paper. Numerous examinations have been made of the food content of young fish, in which the direct use of plants by them is revealed. The results have been formulated into tables (p. 14) which supplement the data already at hand in the researches of Forbes (1880), Pearse (1918), Reighard (1915), and others, and indicate plant values among the flowering plants, the filamentous algæ, and various microscopic plants.

The method pursued has been to study the plant population and, correlatively, the contents of the digestive tract in various species of

young fish. An inventory (Table 1) was taken of the plant population in certain ponds,<sup>a</sup> covering all forms, the larger rooted aquatics, the floating forms, including the filamentous algæ, and the plankton. Simultaneously with the inventory an examination was made of the food found in the digestive tracts of the young fish taken from the ponds at regular intervals. By this means it has been possible not only to identify the food but to determine the character of the forage grounds of the fish and to consider the various plants and the animal associations of importance in the economy of the pond.

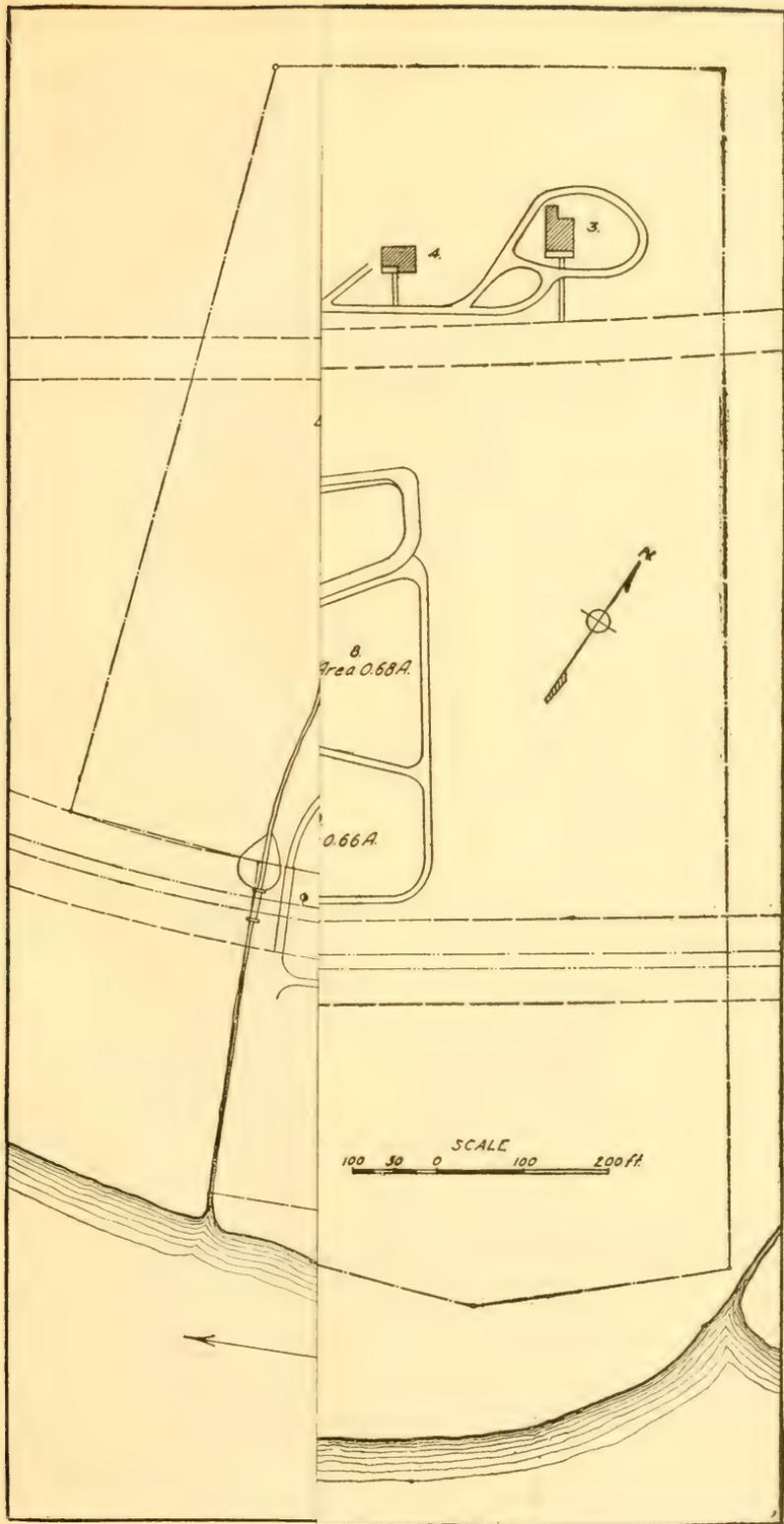
Collections of fish were made at weekly intervals and, if not examined at once in their fresh condition, were kept in an alcohol-formalin preserving fluid until needed. In examining the food the method of Pearse (1918) was employed, that is, the food content of the digestive tract was pressed out upon a glass slide, moistened, and examined under the dissecting and compound microscopes. All figures in the tables referring to food content represent volumetric percentage estimates. Measurements in lengths are given in millimeters and exclude the caudal fin.

A brief and general description of the ponds under investigation will assist in making the interpretation. The accompanying map from an earlier publication of the Bureau shows clearly the position and arrangement of the ponds at the Fairport station. They are grouped in six series, A, B, C, D, E, and F, respectively, the ponds in each series being numbered independently. The investigations here recorded were concerned only with series B and D, the former composed of six small, the latter of nine somewhat larger dirt ponds. The areas of the specific ponds studied, that is, 16B and 1, 2, 3, 8, and 9D, vary from 0.22 to 0.85 acre. Water is supplied to each through inlet pipes connected with a large reservoir, which in turn is supplied from the Mississippi River. The depth varies from about 6 inches near the inlet pipes to 7 or 8 feet at the outlet. Plants common to the ponds of the region have been introduced; marsh plants such as cat-tails, *Sagittaria*, *Bidens*, and *Eleocharis* occupy the shallower portions; sedges bind the borders of the deeper portions; and floating and rooted aquatics flourish within the pond area. Various aquatic insects and other animal forms have found their way into the ponds, and practically natural conditions prevail.

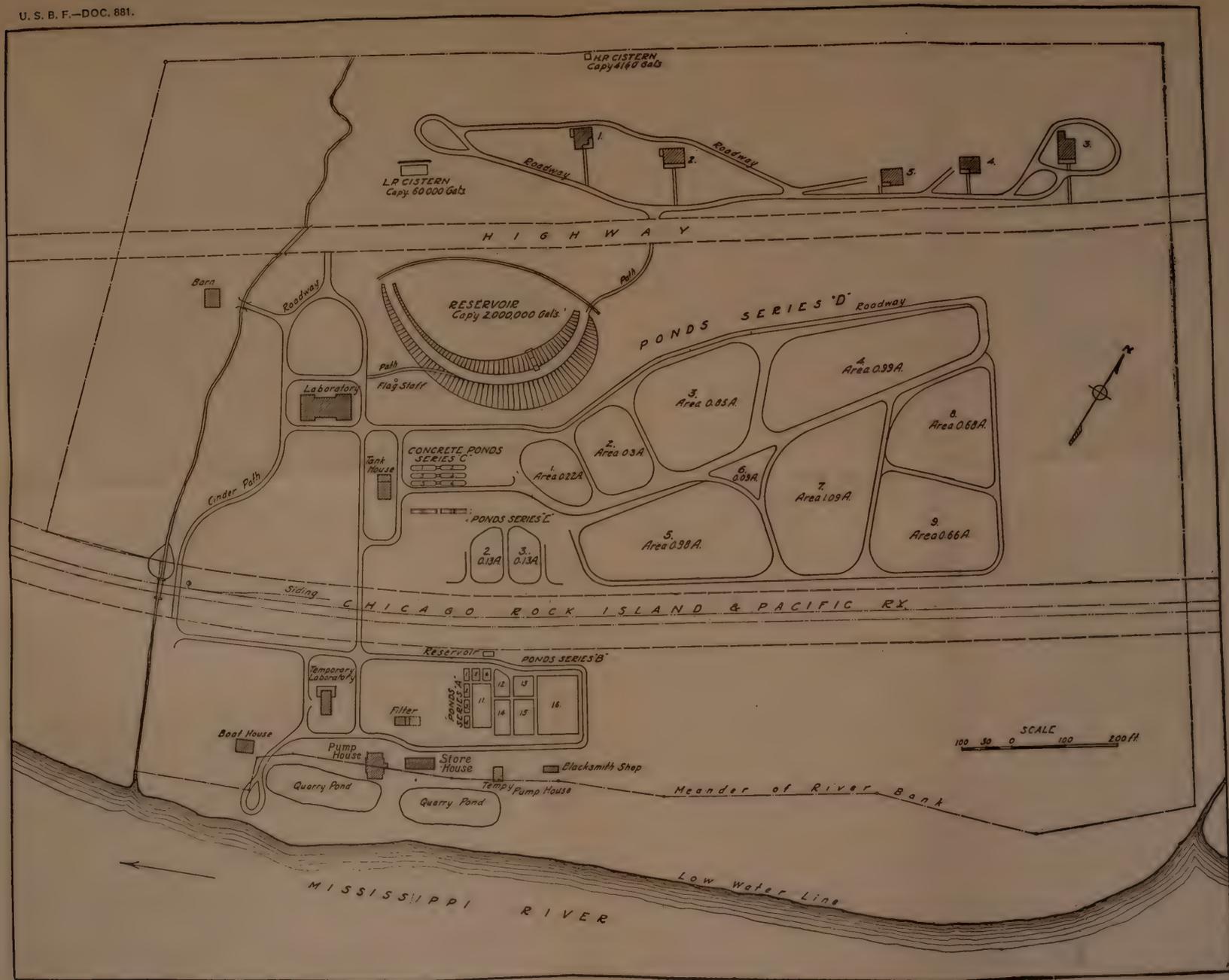
#### BASS, CHIRONOMID, AND ALGAL RELATIONS.

It is shown in Table 2 that the chironomid larvæ are among the most important single items of food taken by the young of the largemouth black bass during the summer. The larvæ of a certain species of the chironomids removed from the digestive tract were identifiable and later checked up with specimens taken from the ponds. These proved to be *Orthocladus nivorius* Fitch., a species common in the ponds and the one upon which the bass chiefly fed. The body walls of this larva are thin and transparent, and when lightly crushed under a cover glass the food content can be readily determined with the microscope. It was this identification of the alga in the crushed specimens taken from the bass that gave the clue to the chain of food relations subsequently to be described.

<sup>a</sup> See accompanying map showing topography of the ponds under investigation.









Previous to the identification of this chironomid in the fishponds the inventory of the plants had disclosed the interesting association of the larval stage of this insect with the alga, *Mougeotia genuflexa*. The alga was exceedingly abundant and produced a most remarkable and beautiful formation. This formation, or algal mat, as it may be called, was composed of delicate, light-green filaments of gossamer-like threads which were interwoven intricately in the form of loose-meshed rolls suspended near the surface of the water. The author's attention was attracted by a large number of elliptically-shaped bags, or cases, lightly held in the meshes of the algal mat. These proved to be the larval cases of the chironomid in question. While foraging for food the larvæ move in and out of their cases, retaining their hold, meanwhile, by their caudal hooks. In feeding they draw toward them filaments from the loose meshes of *Mougeotia*, or they forage directly from the outer walls of their cases, to which this alga is applied in the construction of the case, renewing the filaments as fast as they become depleted. The larvæ continue to feed upon this alga as long as the supply lasts, which is generally only until the middle of July, for by that time this species of alga, which flourishes during the early part of the season, has passed the stage when floating mats are readily formed. Thereafter it becomes scattered through the partial disintegration or breaking up of the filaments. It is at this time that the characteristic "knees" or swellings in the cells occur which give to this form of *Mougeotia* its specific name, *genuflexa*. It is while engaged in these feeding operations that the larvæ fall prey to the bass.

Several hundred larvæ of *Orthocladius nivorius* were examined to determine to what extent other algæ contributed to their food supply. The determination is a simple matter. The larvæ are lightly crushed under the cover glass by a slow, forward movement of the thumb, a slight pressure being sufficient to push out the contents of the digestive tube. The material is teased out under the microscope, and the problem becomes one of identification of the algæ. Almost without exception larvæ taken from the mats of *Mougeotia* showed a forage value of 100 per cent of this alga. From larvæ taken at random in pond 3D, from habitats in which other algæ were the chief constituents and *Mougeotia* appeared only as a small factor in the heterogeneous assortment, this alga again formed the bulk of the food. Specimens of *O. nivorius* were hatched in a watch glass to which had been added a variety of algæ as well as *Mougeotia*, and it is interesting to note that the young selected the latter invariably. It is not surprising, for *Mougeotia* is one of the most delicate of the filamentous forms and possesses a brittleness which apparently recommends it to the larvæ, for when observed in their feeding operations they were seen to snap off filaments in one-cell and two-cell lengths with great rapidity. This preference for *Mougeotia* was observed in the very earliest stages of larval growth, and it continued to be shown to pupation.

Later broods of *Orthocladius nivorius*, of which there appeared to be three during the summer, found their natural forage among other algæ which succeeded *Mougeotia genuflexa*, such as *Mougeotia sphaerocarpa*, *Spirogyra nitida*, *S. majuscula*, *Cedogonium*, *Hydrodictyon reticulatum*, Lyngbya, and various microscopic forms present in the algal mats.

## IMPORTANCE OF ALGAL MATS AS FORAGE.

The larva of the chironomid, *Orthocladius nivoriundus*, forms an important item in the dietary of the largemouth black bass. In turn the alga *Mougeotia* and other filamentous types supply forage for the chironomids. Thus these common pond plants contribute in a material way to the support of the bass.

Nearly all of the aforementioned algae are commonly distributed in ponds. Where they do not occur and the region is within their range, they can easily be introduced into the ponds by transferring a roll or wad of the alga before it dries out. If the alga is to be transferred by mail it should be rolled in a wet cloth, wrapped in thick paper, and dispatched at once.

Unfortunately the notion exists that algal mats serve no useful purpose, and wasteful practices prevail in the seining operations. Without discrimination they are raked out, thrown upon the bank, and left to decompose, regardless of kind or function in the economy of the pond. The author's observations thus far on the value of algal mats, which may be called locally "moss," "moss blanket," or "water moss," lead to the conclusion that discrimination must be exercised if the ponds are to be properly stocked with useful forage plants. For help in such discrimination the species which commonly produce the algal mats, or "moss," floating on the surface of ponds, are given as follows: *Cladophora crispata*, *Hydrodictyon reticulatum*, *Pithophora odogonia* var. *vaucherioides*, *Ædogonium martenicense*, *Rhizoclonium hieroglyphicum*, and *Spirogyra* species. Generally not one form alone produces the mat or blanket but a combination, as *Cladophora* and *Pithophora*; *Hydrodictyon*, *Ædogonium*, and *Cladophora*, etc.

Blankets in which *Cladophora*, *Pithophora*, and *Rhizoclonium* are the prominent forms appear to be least desirable, though the subject warrants further investigation. This blanket complex reproduces and forms a coarse, thick mat which readily covers a pond and shuts out the light. Under control, however, this mat may be regarded as useful. It should be conserved near the edges only.

## FIELD CHARACTERS OF VARIOUS ALGAL MATS.

The following field characters will assist in discriminating the different kinds of algal mats or blankets:

*Mougeotia genuflexa* when abundant forms a loose, filmy, floating aggregation of delicate, light-green, gossamerlike threads lightly suspended near the surface of the water and easily wafted about by the wind. It is as difficult to scoop up in the hand as a floating spider web would be. This alga does not accumulate in sufficient quantity to become detrimental, since its filaments are so delicate and form so loose a mesh that light is not appreciably shut out by it.

*Mougeotia sphaerocarpa* is also a delicate alga, though a little less so than *M. genuflexa*, and its growth habit is different. It has a light yellow-green frothy look and floats on the surface of the water as a thin film. It is found in the sheltered places usually, though it may spread over a small pond as a surface film when undisturbed by the wind. The frothy appearance is due to the very active photosynthetic capacity of the alga, the oxygen bubbles being confined,

meanwhile, in the meshes of the filaments. This alga compares favorably with *M. genulfæa* as a food producer. It appears in abundance in the ponds later in the season than the foregoing species and has been observed repeatedly in the examination of the larval food of *Orthocladius*, *Pseudochironomus*, and *Stratiomyia*.

*Spirogyra* species are generally a vivid green. They more often form a part of an algal complex, though they may occur nearly pure in round mats of varying size. They can be identified easily by the slimy, silky feel of the single threads or filaments. When held out of the water the single threads drip and curl up on drying. *Spirogyra weberi* may develop in a pure stand enveloped in a mass of transparent jelly.

*Cedogonium martinicense* often forms the upper layer on the mat of *Cladophora*. Upon aging, it fades to a pale yellowish color and acquires a soft cottony feel. Chironomids are active feeders upon it.

*C. sp.<sup>a</sup>* does not form a mat but occurs as an epiphyte on the larger aquatics and on the coarser filamentous alga. The slender naias (*Naias flexilis*) and the water-weed (*Elodea canadensis*) may become completely swathed in it by midsummer. It is an extremely small form of *Cedogonium* which in the aggregate takes on an olive-green look. It has the characteristic cottony feel. All things considered, it doubtless affords forage to a greater number of pond herbivores than any other alga of the ponds. Chironomids, snails (*Planorbis* and *Succinea*), and the blunt-nosed minnows, as indicated by their food contents, show a preference for this alga.

*Pithophora adogonia* var. *vaucheriaoides* consists of short filaments which on aging look and feel like coarse, dark hair. It is generally to be found with *Cladophora* and in the mat-forming stage occupies the stratum beneath it or becomes interwoven with it.

*Cladophora crispata* forms the coarsest and thickest algal mats in our ponds. The mats, or portions of them, have a coarse, heavy look and a harsh feel. When the mat is lifted out of the water it feels tough and gives one the impression of handling wet, coarse, brown paper or coarse loosely-woven cloth.

*Hydrodictyon reticulatum*, or water-net, is easily distinguished when floated out on the hand by means of the characteristic four to five sided meshes. It may form in sufficient abundance to produce a heavy mat covering the surface of small ponds.

These "rough and ready" field characters should assist the uninitiated in discriminating the most common and widely distributed representatives of the mat-forming algae of our pond waters. It is recognized of course that the microscope, together with keys and illustrations, is the only sure method of identification.

#### BOSMINA AND VOLVOX ASSOCIATION.

The plankton studies in pond 2D showed a conspicuous association of the small cladoceran, *Bosmina longirostris*, and the green alga, *Volvox*, species *perglobator* and *spermatosphæra*. The association of these organisms, *Bosmina* and *Volvox*, is important in terms of fish food. The *Bosmina* afford a direct means of subsistence to the young bass; and the *Volvox*, through their contribution to the food supply of the *Bosmina*, an indirect one.

<sup>a</sup> A valuable forage species unidentified to date but probably near *howardii*.

By reference to Table 2, it is seen that the young bass find in the small *Bosmina* a favorite natural food. It was selected by them from a varied and abundant zooplankton consisting of cladocerans, copepods, and rotifers. In the smallest fry examined the *Bosmina* content reached 100 per cent. For example, in the examination several specimens under the average of 12.2 mm. measured 10 mm. and 11 mm., and in all cases, the smaller the fry taken from the environment of *Volvox*, the larger the percentage of *Bosmina* in the food content, indicating that this is not only the earliest but the preferred natural food of the young bass.

It was found that *Bosmina* occupied the upper stratum of water in the open areas as well as the more sheltered weedy portions of the ponds. Their presence is indicated to the naked eye by the appearance, as it were, of a fine sprinkling of dust particles continually gyrating in the surface film of water. They occur in the greatest numbers just below the surface, and in this location they are accessible to the fry as they rise to feed.

The *Volvox* accumulated also in the upper stratum of water. The pulse of this alga coincided with that of *Bosmina*, but declined before any distinct diminution of *Bosmina* was noted. Further observational studies disclosed the direct dependence of *Bosmina* upon *Volvox* for subsistence.

Plankton catches from the upper stratum were taken repeatedly, and the feeding habits of *Bosmina* observed under the compound microscope. It was rarely possible to identify the food once taken into the digestive tract, because in most cases the mandibles grind the food particles beyond recognition. Occasionally, however, particles slip by whole, and when these could be seen through the transparent body walls the animal was lightly crushed under a cover glass to make the identification more sure. Bits of broken cœobia of *Volvox* were identified, and these graded into the ground material characteristic of the digestive tract. In most cases the feeding habits were observed directly by watching the maneuvers of the living animal. *Volvox* was in the reproductive stage, and organisms with antherozoids, or sperms, were exceedingly abundant. The *Bosmina* in their feeding operations attached themselves to a bundle of ripe antherozoids, and by a rapid movement of the legs, characteristic of all cladocerans, winnowed the sperms within the body walls, from whence they were wafted into the mouth. This continued until the bundle of antherozoids was appreciably diminished, and the *Bosmina* whirled off to other feeding grounds, in which the constituents were often too small to identify as they were wafted into the body. *Volvox*, however, continued to remain a source of nutriment until its decline.

This interdependence of the organisms, *Bosmina* and *Volvox*, was observed in pond 1D also, but the plankton pulse was not manifested by so large a quantity of *Bosmina* in this pond.

#### SCAPHOLEBERIS AND MOUGEOTIA ASSOCIATION.

It was found that *Scapholeberis mucronata*, a larger cladoceran, succeeded the *Bosmina* in the food of the older fry, and investigation followed to determine its food relations among the algæ of the ponds.

Plankton catches showed a larger percentage of *Scapholeberis* in pond 1D than in all others. Attention was then concentrated upon this pond. Plankton studies were made from various regions in the pond to determine the specific plant habitat of the cladoceran. This proved to be the scum or film produced by the alga, *Mougeotia sphaerocarpa*, in the quieter portions of the pond. In these regions the algal complex teemed with *Scapholeberis*, the feeding grounds being conspicuously localized in the region of the *Mougeotia* filaments.

The examination of the food content in the digestive tracts of *Scapholeberis* revealed a miscellaneous diet of small unicellular and palmelloid algæ which abounded in the *Mougeotia* complex. The most common forms were small diatoms, and such green algæ as *Sphaerocystis*, *Oöcystis*, *Celastrum*, and *Schizochlamys*.

The association of this cladoceran with the *Mougeotia* complex adds another point in favor of the introduction and cultivation of *Mougeotia* to supply a natural forage in fishponds.

The *Scapholeberis* pulse in pond 1D attained its maximum in late July and early August. At that time it supplied a fair percentage of the food of the largemouth black bass (Table 2) and a high percentage of the food of the bluegill (Table 3).

Ponds 1D and 2D have differed in the contribution they made to the food supply of the young fish in the matter of quantity as well as variety. This was particularly true of the *Bosmina* pulse which occurred in both ponds simultaneously but to a lesser degree in pond 1D. Birge and Juday (1911) state: "The answer to the question of why different bodies of water differ so widely in productivity is wholly beyond our knowledge." In these ponds, however, a partial explanation may be sought in the difference in kind and quantity of living plants as well as in the accumulations of débris during succeeding seasons.

In physical features the ponds are similar. They are equally deep, and they are surrounded by a similar vegetation. They have been treated alike, that is, they have been wintered full, not dry. Such draining as has been necessary to conduct the seining operations has been temporary only. Physiologically, however, they are more or less distinct because of the dissimilar character of the vegetation in them. Pond 1D has been richly stocked with floating algæ which at times have covered the surface. Few of the larger rooted aquatics are present. Pond 2D has no algal mats or blankets, but fully one-tenth of the surface area has been covered by the large-rooted aquatic, *Potamogeton illinoensis*, interspersed in places with the nonrooted *Ceratophyllum*, or hornwort. In these ponds are present, apparently, the requisite conditions to produce a conspicuous plankton pulse of great economic value in terms of the natural forage of fish fry by supplying in quantity organisms which are preferred by the fry during the early days of feeding.

#### DAPHNIA AND APHANIZOMENON ASSOCIATION.

Data in the tables show that a high percentage of food is supplied by the daphnids. They are recognized herbivores in the ponds, and it remains to explain their particular plant preferences and associations.

A remarkable illustration of such an association was presented during the present season in the studies connected with pond 9D, in which *Daphnia pulex*, one of the largest of the daphnids, was produced in enormous quantity by natural means. The blue-green alga, *Aphanizomenon flos-aquae*, contributed directly to its support and proved to be the most desirable food of a heavy, natural culture of *Daphnia pulex*.

The author's first observation of this association in the pond occurred on June 21, 1918. At this time a "bloom" of the *Aphanizomenon* was approaching its maximum. It was so abundant that the water appeared blue-green and oily. A few hand strokes of the dip net would bring up a quart of it in concentrated form. The individual colonies are ordinarily microscopic, but during the acceleration of growth in "bloom" production the colonies are considerably augmented and become readily distinguishable. They appear as flocculent masses, 7 to 16 mm. long and less than half as wide. They are delicate and tissue-like and assume the form of flattened spindle-shaped masses lightly suspended in the water at all depths, from the surface to the bottom of the pond. Practically a pure stand had developed, for there were few representatives of other floating algae present. The station records noted the presence of the algae in May. From that time until June 21, the date of the author's first observation, multiplication must have taken place with great rapidity, and it continued to do so until the maximum was reached in the interval of July 24 to 30, when the algae could be rolled up from the bottom like mush.

This conspicuous growth of algae in the pond was attended by one equally remarkable in the number of *Daphnia* produced. The *Daphnia* swarmed among the algae, forming practically a pure culture of *Daphnia pulex*. A rough estimate by volume, obtained by the gravity method, showed approximately 75 cc. per cubic meter. Accurate determinations were difficult because of the accompanying algal debris in the concentrations. When the algal maximum was attained the *Daphnia* pulse had already begun to decline. Cypris, copepods, and rotifers increased in the zooplankton and *Clathrocystis*, *Volvox*, and *Pleodorina* in the phytoplankton.

The daphnids fed continuously upon the *Aphanizomenon*. The entire process of feeding could be observed easily by placing them in a watch glass or in a hollow glass slide and observing them with the compound microscope. The flocculent masses of the algae were wafted into the open walls of the body and fed forward toward the mouth by the action of the legs in the manner so aptly described by Birge (1918). During the feeding operations the *Daphnia* were offered a mixed plankton, but invariably they retained only the *Aphanizomenon* in the food current streaming toward the mouth. Observations on the feeding habits were continued from time to time during a period of five weeks, and it was easily seen that the abundant natural forage provided in *Aphanizomenon* was one of the determining factors in the high productivity of *Daphnia pulex*.

By reference to Tables 4 and 5 it is seen that *Daphnia* formed a high percentage of the food content in the orange-spotted sunfish and catfish with which the pond was stocked. Data are not at hand for the very young catfish since it was desirable not to disturb the ponds

by seining during the breeding period, but the large size of the fingerlings (Table 5) at the date recorded seems worthy of note and readily explainable in terms of an abundance of desirable natural food.

The succession of causes, physical and physiological, which have led to the remarkable acceleration of growth in the alga, *Aphanizomenon*, and the accompanying culture of daphnids is not easy to explain; yet it is desirable to record the method of treatment of the pond which has produced this extraordinary development. The pond covers an area of 0.66 acre and is free from floating plants. In the shallow portions there are submerged aquatics such as Naias and *Potamogeton pusillus*; and around the edge, a little of the blanket-forming alga, *Cladophora crispata*. In general it is an open pond free from the larger aquatics or their accumulations. It could easily have become "seeded down" by spores of *Aphanizomenon* through inlet waters from the supply reservoir which in turn receives the river water. This alga is common in the supply waters and is distributed in season to the ponds. *Daphnia pulex* are also common in the ponds. A contributing cause of the great "wave" of *Daphnia* is possibly due to the fact that the pond has been wintered dry during successive seasons, the freezing and drying processes affecting the winter eggs of the daphnids beneficially.

#### MAYFLIES IN THE FOOD OF BASS.

Reference to Table 2 indicates the importance of mayfly larvæ in the food of the young largemouth black bass. The mayflies are herbivores. The researches of Needham (1905), Morgan (1913), and Clemens (1917), on the life histories of these insects have shown that they subsist on a variety of plants in our lakes and streams, the familiar articles of diet being diatoms, unicellular and filamentous algae, and the larger aquatic plants, the latter generally in a partial state of disorganization. Unfortunately, time has not permitted investigation of the plant associations of this group of insects in small ponds. From the few records of examination, however, it may be forecasted that an important habitat preference of some species of the larvæ is among the larger potamogetons.

#### THE DIRECT FUNCTION OF PLANTS IN FISHPONDS.

The tables show a forage value of plants which can not be regarded as merely accidental. By reference to Table 7 it becomes evident that the young of the buffalofish favor an admixture of animal and plant substance. The absence of grit in the digestive tract and the presence of plant materials, such as the staminate flowers of *Elodea*, for example, which are found only at or near the surface of the ponds, illustrate the wide range of their feeding habits. The high percentage in the food content of the flagellate plants, *Pandorina*, *Eudorina*, and *Pleodorina*, is suggestive of the value of the small things among the pond plants.

The most conspicuous function of plants in the fishpond is found in their indirect relations, in their contribution to the forage of myriads of animal forms upon which fish feed. This paper has emphasized this function of plants in its consideration of animal-

plant associations, and it is through a more complete understanding of such associations that the method of rationing the ponds to increase their productivity by natural means can be approached.

## SUMMARY.

1. Chironomid larvæ are among the most important single items in the dietary of young bass.

2. The identification of the food content and plant associations of the chironomids indicates the importance of cultivating certain algal forms in the ponds to provide adequate forage requirements.

3. Mat-forming algæ of certain types provide valuable forage areas for chironomids and cladocerans.

4. The *Bosmina-Volvox* association is of special importance in providing the first forage materials for the bass fry and the young bluegill.

5. The *Scapholeberis-Mougeotia* association is important in providing a later food for the advanced fry stage.

6. The *Daphnia-Aphanizomenon* association develops a heavy culture of daphnia.

7. Plants are of importance directly in supplying a high percentage of food to the advanced fry of the buffalofish.

8. The blunt-nosed minnow in a pond habitat subsists mainly upon plants.

9. The rationing of ponds for a continuous and abundant supply of natural forage must depend upon a more precise knowledge of the animal and plant associations.

## TABLES.

[NOTE.—All figures in the tables referring to food content represent volumetric percentage estimates. Measurements in lengths are given in millimeters and exclude the caudal fin.]

TABLE 1.—INVENTORY OF AQUATIC PLANTS IN CERTAIN PONDS OF SERIES B AND D, FAIRPORT, IOWA.<sup>a</sup>

[P means present; A means present in abundance.]

Aquatic plants.	June, 1917.					June, 1918.
	Pond 1D.	Pond 2D.	Pond 3D.	Pond 8D.	Pond 16B.	Pond 9D.
Flagellates: <i>Euglena sanguinea</i> .....		P			P	P
Blue-green algæ:						
<i>Aphanizomenon flos-aquæ</i> .....			P	P	P	A
<i>Microcystis</i> .....				P		A
<i>Clathrocystis</i> .....				P		
<i>Cœlosphaerium</i> .....		P	P	P		
<i>Merismopedium</i> .....				P		
<i>Oscillatoria</i> .....	P		P			
<i>Lynghya martensiana</i> .....				P		
<i>Anabaena circinalis</i> .....						P
<i>Anabaena flos-aquæ</i> .....		A			P	P
<i>Rivularia natans</i> .....			P	P	P	
Diatoms:						
<i>Navicula</i> .....	A	P	P	P	P	P
<i>Synedra</i> .....	P	P	P	A	P	A
<i>Pleurosigma</i> .....				P		
<i>Cocconeis</i> .....	P	P	A	A		A
<i>Melosira</i> .....		P		P	P	P
<i>Tabellaria fenestrata</i> .....	A	A				
<i>Fragilaria</i> .....		P	P			
<i>Gomphonema</i> .....		A				
<i>Amphora</i> .....	P					

<sup>a</sup> Inventory not exhaustive but sufficiently detailed to serve as a working basis.

TABLE 1.—INVENTORY OF AQUATIC PLANTS IN CERTAIN PONDS OF SERIES B AND D, FAIRPORT, IOWA—Continued.

Aquatic plants.	June, 1917.					June, 1918.
	Pond 1D.	Pond 2D.	Pond 3D.	Pond 8D.	Pond 16B.	Pond 9D.
<b>Green algae:</b>						
<i>Cosmarium pyramidatum</i> .....	P		P	P	P	A
<i>C. undulatum</i> .....	P	P	P	P	P	P
<i>C. notibile</i> .....						P
<i>Closterium moniliferum</i> .....	P		P	P		
<i>C. lanceolatum</i> .....			P	P	A	A
<i>C. lunula</i> .....				P		
<i>Staurastrum polymorphum</i> .....		P	P	P	P	P
<i>Selenastrum</i> .....		P			P	
<i>Zygnema</i> sp.....		P	P			
<i>Spirogyra communis</i> .....	P	P	P			
<i>S. porticallis</i> .....		P	P			
<i>S. varians</i> .....			A	P		
<i>S. decima</i> .....			P			
<i>S. nitida</i> .....	P	P				
<i>S. crassa</i> .....	A	P	A		P	
<i>S. tenuissima</i> .....	P	P	A			
<i>S. gravilleana</i> .....				P		
<i>Mougeotia genuflexa</i> .....			A			
<i>M. laetevirens</i> .....			A			
<i>M. sphaerocarpa</i> .....	A					
<i>Chlamydomonas</i> .....				P		
<i>Pandorina morum</i> .....		P		P	A	P
<i>Pleodorina californica</i> .....				A	A	P
<i>Eudorina elegans</i> .....	P	P	P	P	P	
<i>Volvox perglobator</i> .....			P	P	P	P
<i>Volvox sphaerocarpus</i> .....						
<i>Palmella</i> .....		P	P			
<i>Botryococcus</i> .....			P			
<i>Ineffigiata</i> .....				P		
<i>Tetraspora</i> .....		P				
<i>Anchistrodesmus</i> .....		P				
<i>Scenedesmus</i> .....		P				P
<i>Hydrodictyon reticulatum</i> .....			P	A		
<i>Pediastrum duplex</i> .....	P	P	P	P	P	
<i>Ulothrix</i> .....			P		P	
<i>Edogonium rivulare</i> .....	A	A		P		
<i>Ed. sp.</i> .....	A	A	A			A
<i>Ed. martenicense</i> .....	A		P			
<i>Cladophora crispata</i> .....	A	P	A		P	P
<i>Rhizoclonium hieroglyphicum</i> .....			A			
<i>Pithophora oedogonium</i> var. <i>vaucherioides</i> .....	A	P	A			P
<i>Chara</i> .....			P			
<b>Flowering plants:</b>						
<i>Typha latifolia</i> .....	P	P	P	P		P
<i>Sparganium americanum</i> .....	P	P				
<i>Potamogeton illinoensis</i> .....		A	P			
<i>P. pectinatus</i> .....			P		A	
<i>P. pusillus</i> .....			A	P		P
<i>Najas flexilis</i> .....	P	A	A	A		A
<i>Sagittaria latifolia</i> .....		P	P	P	P	
<i>Elodea canadensis</i> .....	P	A	A	A		P
<i>Vallisneria spiralis</i> .....		P	P			
<i>Lemna minor</i> .....	P			P		
<i>Heteranthera dubia</i> .....			A		P	
<i>Ceratophyllum demersum</i> .....	P	A				
<i>Nymphaea advena</i> .....					P	
<i>Castalia odorata</i> .....			A		P	
<i>Ranunculus aquatilis</i> .....	A	A	A			
<i>Mriophyllum spicatum</i> .....			P			



TABLE 3.—FOOD CONTENT OF BLUEGILL (*LEPOMIS PALLIDUS*), ADVANCED FRY AND FINGERLINGS, IN CERTAIN PONDS AT FAIRPORT, IOWA.

Date.	Pond.	Specimens.	Average length.	Animals.									
				Cladocerans.			Adult copepods.	Nauplii.	Cypris.	Chironomid larvæ. <sup>a</sup>	Damselfly larvæ.	Mayfly larvæ.	
				Bosmina.	Scapholeberis mucronata.	Miscellaneous forms.							
1918.				No.	Mm.								
July 25.....	2D.....	10	12.4	66.9		11.1	28.4	31.1	10	0.6	11		
Do.....	1D.....	18	18.9	9.4	17.2					.8	9.2		
Aug. 1.....	2D.....	25	13.4	43.6		19	9	6.1		.6	13.8		
Do.....	2D.....	17	15.6	49.9		12.4	12.4			.6	15.2		
Aug. 8.....	1D.....	5	36.9	4.5		52	12.6					2	5

Date.	Animals—Contd.				Plants.								
	Beetle larvæ.	Water mites.	Rhizopods.	Unidentified.	Unicellular algal.	Anabæna.	Diatoms.	Volvex.	Desmids.	Mougeotia.	Spirogyra.	Cædogonium.	Spores.
1918.													
July 25.....								1		13	0.3	0.3	
Do.....	1.4					0.3				5	.6		
Aug. 1.....		0.6	0.2	0.4		1.4		0.6		1		1.2	2.9
Do.....			3.2										
Aug. 8.....													

<sup>a</sup> Chiefly *Tanytus decoloratus* Mall and *Pseudochironomus richardsoni* Mall.

TABLE 4.—FOOD CONTENT OF ORANGE-SPOTTED SUNFISH (*LEPOMIS HUMILIS*), ADVANCED FRY AND FINGERLINGS, IN POND 9D, FAIRPORT, IOWA.

Date.	Specimens.	Average length.	Animals.								Plants.				
			Cladocerans.			Diaptomus.	Miscellaneous copepods.	Cypris.	Chironomid larvæ.	Notonectids.	Beetle larvæ.	Unidentified.	Hyalella.	Cædogonium sp.	Plant debris.
			Daphnia pulex. <sup>a</sup>	Clydorus.	Miscellaneous forms.										
1918.															
July 15.....	2	30.5	19.5					10	80.5						
Do.....	1	71	10						30	50					
July 18.....	5	18.6	39	6	9	15			25	6					
July 25.....	12	25.6	31.9	18.4	12	19.5			16.1						
July 26.....	16	22.5	52	6	1.5	27.3			6.5	3.1	0.6	0.9	0.6		
Aug. 2.....	19	23.3	27.1	20.4		18.4	25.6		4.2		1.2				
Aug. 8.....	10	42.5	6	5.1		3	14.5	12	57.5		.4			2	

<sup>a</sup> *Daphnia* and *Aphanizomenon* association.

TABLE 5.—FOOD CONTENT OF CHANNEL-CAT (*ICTALURUS PUNCTATUS*), FINGERLINGS, IN POND 9D, FAIRPORT, IOWA.

Date.	Specimens.	Average length.	Animals.							
			Daphnids.	Chydorus.	Copepods.	Cypris.	Chironomid larvae and pupae.	Damselfly larvae.	Notonectids.	Beetle larvae.
1918.	No.	Mm.								
July 25.....	2	51.5	37.5		20	2.5	30			12.5
Aug. 2.....	6	54.1	39.2	13.3	12.5	4.2	29.3			12.3
Aug. 16.....	6	58.3	4.2	17.5	5.8	12.2	59.3	3.3	2.5	

Date.	Animals—Contd.				Plants.				
	Hydrilla.	Leeches.	Grit, debris, etc.	Clathrocystis.	Diatoms.	Volvox.	Closterium sp. Cosmarium sp.	Ædogonium sp.	Eloëea.
1918.									
July 25.....			12.5				1.2		
Aug. 2.....	7.5	15.8	13.3					1.66	
Aug. 16.....			5.8	3.3	0.83		1.7		0.33

TABLE 6.—FOOD CONTENT OF BLUNT-NOSED MINNOW (*PIMEPHALES NOTATUS*) IN CERTAIN PONDS AT FAIRPORT, IOWA.

Date.	Pond.	Specimens.	Average length.	Animals.						Plants.	
				Daphnids.	Chironomid larvae.	Anurea cochlearis.	Statoblasts of pectinella.	Insect debris.	Grit.	Phacus.	Euglena.
1918.		No.	Mm.								
July 26.....	9D	1	49	5							
Aug. 7.....	9D	2	46.5			17.5	7.5		47.5		
Aug. 8.....	8D	2	45.1	6.7		4.4	.55	1.1	4.4	3.9	
Aug. 15.....	8D	4	46.2	1.3	5				27.5	1.75	0.75

Date.	Plants—Continued.										
	Chroococcus.	Oscillatoria.	Lyngbya.	Anabena.	Spirulina.	Diatoms.	Schizochlamys.	Closterium sp. Cosmarium sp.	Ædogonium sp.	Najas flexilis.	Eloëea.
1918.											
July 26.....						5		10	80		
Aug. 7.....								20			
Aug. 8.....	4.4	1.1	28.9	1.5	7.2	3.3	5	2.8		3.3	15.5
Aug. 15.....			55	5	5	1.25		2.5			

TABLE 7.—FOOD CONTENT OF BUFFALOFISH (*ICTIOBUS RUBILUS* AND *I. CYPRINELLA*), ADVANCED FRY AND FINGERLINGS, IN POND 16B, FAIRPORT, IOWA.<sup>a</sup>

Date.	Specimens.	Average length.	Animals.						Plants.			
			Arceia.	Difflugia.	Cladocerans.	Rotifers.	Statoblasts of Plumatolla.	Insect eggs.	Chironomid larvae.	Blue-green algae.	Ceratium.	Diatoms.
1917.	No.	Mm.										
July 12.....	7	12			5	20.2			1.2	0.6		5.5
July 24.....	20	19.9	3.1	15.2	7	3.6		1.3	3.1	3.1		3
Aug. 24.....	15	29.6	6.2	25.8	6.8	12.2	0.1		1.1	6.4	2	3.2

Date.	Plants—Continued.											
	Euglena.	Volvox.	Pleodorina.	Eudorina.	Pandorina.	Pediastrum.	Scenedesmus.	Desmids.	Cedogonium sp.	Staminate fls. of Elodea.	Grit.	Debris.
1917.												
July 12.....	7.1		5.1	15.4	30.6	1		8	0.1		0.1	
July 24.....	.1		15	2	3			4.2	1.5	19.8	9	6
Aug. 24.....		0.1	31.3				0.1	2.8	.2	.3	1.2	

<sup>a</sup> Fry hatched in jars May 17 to 22, 1917, and transferred to pond May 25, 1917.

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# SOME CONSIDERATIONS CONCERNING THE SALTING OF FISH

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Appendix V to the Report of the U. S. Commissioner of Fisheries for 1919



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# SOME CONSIDERATIONS CONCERNING THE SALTING OF FISH.<sup>a</sup>

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Contribution from the Fishery Products Laboratory, Washington, D. C.

## INTRODUCTION.

### THE NEED FOR EXPERIMENTAL WORK.

Although fish have been preserved with salt since prehistoric times, little experimental work has been done with the view of improving the existing methods. The fisherman who salts his own catches of fish or who cooperates with his neighbors in salting fish has neither the time nor the money to experiment that he may improve his product or save labor and waste products. With a few exceptions, the fishing industry has not attracted large capital for extensive operations. It has not been exploited, therefore, as has the meat-packing industry.

Much work has been done in the hatching of fish eggs, stocking streams and lakes, and increasing the aquatic life of this country generally. But until recently little had been done to conserve the fish after being taken or to utilize as food fish which had hitherto been neglected. Little of the river herring, sea trout, Spanish mackerel, kingfish, sea bass, scup, and drumfish in our southern waters had been utilized until within recent years, when refrigerator cars and cold-storage plants came into use.

It required the stimulus of the enormous demand for food caused by the great world war to awaken an interest in fish salting and to arouse a demand for better methods. It became apparent that if the methods of salting fish could be improved so that fish might be salted with safety during hot weather in any warm climate the food-fish supply of the United States would be greatly augmented.

<sup>a</sup> This work was undertaken in cooperation with the National Research Council, Council of National Defense, and was at first conducted in the laboratories of Johns Hopkins University, where the author had the benefit of the advice and direction of Prof. B. E. Livingston, department of plant physiology, and Prof. E. V. McCollum, School of Hygiene and Public Health. He is also indebted to Prof. J. J. Abel, of the department of pharmacology of the same university, for the use of his laboratory for the conduct of part of this work.

The results achieved, the conclusions reached, and the recommendations made in this paper have their origin in experiments done on a small scale and are not to be taken as having been proved by commercial practice.

There is a lamentable lack of control over the salt-fish product produced in any plant. In some places the standard of quality is a white, colorless fish. Yet in those localities it is doubtful whether the fish salters understand the factors controlling whiteness. In other localities a very hard, rigid fish is desired. In such regions there is a great demand for Turks Island salt, for it is quite generally understood that this salt produces a hard fish, although very few understand why. Before this experimental work had been followed two weeks the experimenter learned that the qualities of the finished product, such as color and hardness, could be controlled entirely. This alone made the work worth while.

It has long been known that it is exceedingly difficult to salt fish in the ordinary way during hot weather, and few attempt it. Apparently no one had tried to find out why fish spoil so quickly while being salted during the summer.

For centuries fish have been cured either in brine or in dry salt without the addition of brine. There has been much discussion concerning the value of the two methods. It was, therefore, worth while to determine the relative merits of the two methods of applying salt to fish, even though no information relevant to the problem under consideration should be obtained.

The inexactness of the present methods has been pointed out to show the need for such experimental work as is reported in this paper. Correct interpretations of experimental work should lead to more exact procedure in salting fish. A more uniform product should be obtained. The results of the experimental work should explain the reason for some of the methods in use to-day. The consideration of the scientific aspect of fish salting should bring forth a spirit of research for better salt fish. There should be a demand for high standards for salted fish. At present in some parts of the country the salt-fish buyers have practically no standards for estimating the quality of the salt-fish product. This is in part because of the difficulty in estimating differences in quality of salt fish.

At the present time (summer of 1919) the price of salt river herring is very low. This is chiefly because the quality of salted herring sold during the past few years has been so poor. The salt river herring on the market has a very strong "wild-game" taste. If certain precautions were taken, this could be entirely avoided. The resultant product would then be of much better quality than that to which the public is accustomed. It is doubtful if a better price could be obtained for salt river herring under present conditions. If higher standards were demanded, however, it should sell for a higher price.

In North Carolina and Virginia the buying public has become so accustomed to purchasing very hard, dry fish that soft fish in brine will not sell, although it may be better in quality. There is little ground for the argument that dry, hard fish is of greater culinary value. On the other hand, without investigation it would seem reasonable that a wet, soft fish would be more palatable when cooked than a fish "as hard as a board."

Most fish salters are aware of the fact that they must not store their fish in hot places during the summer months; yet no attempt has been made to determine the best conditions for storing salted fish. Fish have been stored both dry ("tight packed," packed in layers

with solar salt between layers of fish) and in brine (pickle); yet no investigation has been carried out to show which of these two methods is the better. The "tight-pack" method is almost universally used in the South, whereas in the North fish, with the exception of cod, haddock, cusk, and pollock, are just as universally stored in brine.

Much may be done to improve both the methods of salting and of storing fish. If better methods were used, salted fish, even the "common herring," would regain its place in public favor. The fish salter would gain immensely thereby, for as the quality improves so will the demand. It is hoped that this work may be the beginning of a movement looking toward a better salted-fish product; that it may encourage the fish salter to control his product and produce a fish of the best possible quality. A proper understanding of the factors affecting the product will surely lead toward the improvement of methods.

#### PRESENT COMMERCIAL METHODS OF SALTING FISH.

The methods of salting fish in use to-day vary greatly in different localities. The writer found, in going from one fish-salting plant to another, that many fish salters were not familiar with all of the methods of salting fish. It is wise, therefore, to give a brief description of the methods in use in various parts of the country. This will make clear the reasons for the procedure followed in the experimental work. There may also be a better understanding of these different methods, and if they are correctly understood the fundamental principles of salting fish will be clear to the reader.

In this work no mention is made of the mechanical details of cleaning, hauling, lifting, or drying fish. Attention is given to only the important points which affect the quality of the finished product. The writer has visited five fish-salting centers and has observed the methods employed. The procedure followed in salting fish in these places will be described briefly. No attempt has been made to include all of the different processes or the procedure for all varieties of fish. The description merely includes the most important methods and the general procedure.

#### GLOUCESTER, MASS.

In Gloucester the business of salting fish is very extensive. It is characterized by greater organization and larger companies than elsewhere. The reason for the organization is to be found in the large number of fish caught in that vicinity and in the continuity of the catches. Fish are brought into Gloucester in large quantities every working-day of the year. Employees may, therefore, be hired for the entire year and the plants worked on a larger scale than elsewhere.

The cod, haddock, cusk, and pollock are caught together and are salted in the same general way. When they are unloaded from the vessels, the fish are sorted as to kind and size. During the cold months these fish are salted either in kenches (regular piles or layers of fish) or butts (very large barrels, of about 300 gallons capacity). In the warmer months all are salted in butts, as the fish would spoil

if they were not covered with pickle during the "striking" or salting process. The fish are thrown "face up" (cut surface, flesh side up) into the butts and sprinkled with salt as they are thrown in. Great stress is placed upon the even distribution of the salt. Between 6 and 7 bushels are used to each butt of fish. Turks Island salt is ordinarily used. Each butt yields approximately 500 pounds of dried cod. The rule holds: The warmer the weather the more salt used.

The fish are piled high above the top of the butt. The last few layers, those exposed, are piled with the backs up. A pile of salt is placed upon the top of the fish. By the day following the salting, the fish have settled below the top of the butt and the pile of salt has almost disappeared. Five or six more pecks of salt are then added to strengthen the pickle. Ordinarily the fish are allowed to remain in the butts from 10 days to 3 weeks. Only 3 days are required for the salt to penetrate through the fish, the remainder of the time being required for the fish to "strike through," or harden. After 3 days the flesh of the fish is still quite soft, but during the next 18 days it gradually becomes harder. If there is a large supply of fish on hand and if the demand is slack the fish are left in the butt much longer than 3 weeks. However, if allowed to remain there for too long a time the salted fish become yellow. This happens in the space of 2 months or less in hot weather, but in cold weather the fish may be left in the butts almost indefinitely. The amount of salt added (6 or 7 bushels) is far in excess of the amount actually taken up by the fish and dissolved in the pickle. This excess salt is used later in making more pickle.

After the fish are "struck" they are taken out of the butts, the slime is washed off, and the fish are piled in kenches about 4 feet high, face up, with the exception of the last few layers, which are piled face down in order to keep the top layers clean (free from dust). Weights are placed on top of the kenches to compress the fish and to squeeze out the pickle. Since the object of the kenching is to allow the fish to drain and partially dry, they are piled on racks about 8 inches above the floor. This enables the pickle to run out from under the piles of fish. The length of time during which the fish are left in the kenches depends mainly upon the weather and upon the amount of fish already upon the flakes. (See below.) During warm weather the fish are likely to spoil, so they are watched very closely and are repiled whenever there is danger of spoilage. The more often the fish are repiled the less time they must remain on the flakes; but the fish salters usually do not repile them more than once, since it requires a great deal of time. However, if the season is a rainy one, and they do not dry rapidly upon the flakes, the fish are rekenched several times.

After the fish are somewhat dry they are placed upon flakes for further drying. A flake is a rack (a lattice bed about 8 feet wide) built in the open, about 30 inches above a floor. The drying yard is known as the flake yard and is often located on a roof. The degree to which the fish are dried depends upon the trade. If the fish are to be sold in the southern States, they must be drier than if they are to be sold in the immediate vicinity. The length of time the fish must remain upon the flakes to dry to the required degree depends entirely upon the weather. The lower the humidity, the less time is

required for drying. The higher the velocity of the wind, the more rapidly the fish dry. When there is a driving wind two or three lots may be dried in a single day. When the weather is poor, however, it may take a week or more to dry a single lot. If the sun is hot, great care is taken to prevent the fish from becoming sunburned. Canvas is placed a few feet above the flake, and this prevents the direct-burning action of the sun. When the day is too hot, the fish are not placed upon the flake. If rain is imminent, they are collected and put under waterproof boxes on the flakes.

After drying, the fish are sorted as to quality and size. A first-quality fish should be uniformly white, have no bloodstains, possess a "sweet" smell, and be one of the thicker fish. After the fish are sorted they are hauled to the packing room. Before packing they are sprinkled with salt containing 0.4 per cent boracic acid, the amount of this mixture applied depending upon the climate of the region where the fish will be sold; the warmer the climate, the more of it used. This sprinkling of the dried fish with boracic-acid mixture is peculiar to this class of fish. No other salt fish is piled in kenches or dried on flakes. If the fish is for export, it is tied in bundles and packed in boxes or drums.

Although the method of cleaning, the cut appearance of the various fishes, and the amount of salt used all differ, mackerel, whiting, alewives, and herring are usually salted by the same general method in Gloucester. The exact procedure followed in salting one particular fish varies with the season and the trade, however.

The cleaned (cut) or round (uncut) fish are dipped in salt, the fineness of the salt and the quantity used depending upon the variety of the fish and the season of the year. The dipped fish are packed in layers in barrels or butts, salt is scattered over each layer, and, as in the case of cod, a small pile of salt is placed on top of the fish. The fish are then allowed to make their own pickle, and within 24 hours enough has been formed to cover them. The pile of salt on top of the fish is replenished on the second day.

Ample time is allowed for the fish to become thoroughly "struck," or salted, before they are touched again. This period is usually at least 30 days. The fish are then repacked tightly in barrels. In most cases a small amount of salt is placed over the top. The barrel is then headed and a bunghole bored in it, after which it is rolled on its side and filled with 100° brine (saturated salt solution).

#### REEDVILLE, VA.

Along the Chesapeake Bay, in the vicinity of Reedville, Va., there are about 40 fish-salting plants. Almost the only fish salted on a large scale is the alewife, or river herring. There is little organization among the fish salters of this region, due, in part, to the very short season. At Irvington the plants often operate no longer than six days. At Reedville the plants operate for about three weeks; however, the rush season lasts only a week.

The packers in this vicinity salt fish in a way distinctly different from that used in any other section of the country, with the exception of Havre de Grace, where for the most part, a similar method is used. The washed, cut river herring are dumped into large vats filled

one-sixth full with 100° pickle (saturated salt solution). As the fish are placed in the tanks salt is scattered over each layer. Each day the fish are roused (stirred up) with large paddles and more salt is added, usually in sufficient quantity to make the pickle saturated (100°); but the procedure varies in the different plants. Some fish salters (those in the vicinity of Irvington) keep their brine at 70 per cent saturation (70°). Even if the brine used at the start is saturated, by the following morning, when the fish are stirred for the first time, the pickle is not stronger than 60°. If a very large excess of salt is added when the fish are put in, this lowering of the concentration of the salt solution may be obviated to a considerable extent; but, as the fish are immersed loosely in a large excess of pickle, there is a tendency for the salt to sink to the bottom of the vat. As a result the pickle on top is always below saturation, whereas the bottom layers are saturated, or very nearly so.

At the end of from 7 to 10 days the fish are scooped out of the vats and hauled to a draining floor, where they are placed loosely in piles about 18 inches deep. They are allowed to drain and dry for three or four days. Then the salted river herring are packed tightly in layers in barrels, and a quart of Turks Island salt is scattered between each two layers of fish. No brine is added to these barrels, as the fish are sold dry. It is to be noted that in this region brine is added to the fish when they are salted, and after salting they are sold dry; whereas in Gloucester the alewives are salted with dry salt, without the addition of brine, and are sold in brine (pickle).

#### EDENTON, N. C.

Most of the fish salted in this region are river herring, or alewives. Most of the fishermen salt their own catches of fish. The fish-salting plants are, therefore, small, even smaller than those in the vicinity of Reedville. The season here is also short, usually lasting about six weeks.

In this region greater care is taken to wash the cut (cleaned) fish more perfectly. As a result, the salt river herring produced is of a little better quality than that produced elsewhere. The fish are mixed with salt with shovels and are shoveled into butts without any particular packing. They are allowed to remain in the butts from 8 to 12 days, after which they are piled on the floor to dry and drain for three or four days, in the same way that they are handled at Reedville. They are then packed tightly in barrels. About a quart of Turks Island salt is scattered over each layer of fish; no brine is added.

#### HAVRE DE GRACE, MD.

In Havre de Grace practically the identical procedure is followed in salting fish as in Reedville, Va. Aside from one plant, in which some fish are salted by a modified "Scotch" method, there are no important differences from the Reedville method. This modified "Scotch" method involves the salting of the round (uncut) alewives with dry salt. The fish are packed tightly in barrels, covered, and allowed to develop their own pickle. This method is similar to the one followed at Boothbay Harbor. However, at Boothbay Harbor

the fish are "gibbed" or "pipped." That is to say, the gills are cut out, and the viscera, with the exception of the roe or milt, are pulled out. The fish are sold in brine.

#### BOOTHBAY HARBOR, ME.

Herring is the principal fish packed in Boothbay Harbor. Most of the fish are Scotch-cured here. In this process the pipped fish are mixed with fine salt by hand without being washed. They are then carefully packed in barrels. Salt is sprinkled over each layer. A day or so later the barrels are filled up with herring of the same day's pack. After 9 or 10 days the barrel is drained of the old pickle, and the fish are washed with it without unpacking. The barrel is then completely filled with fish and filled through the bung-hole with 100°, or full-strength, brine. The peculiarity of this method is that the fish are not washed before being salted. Therefore, every bit of blood in the cut fish either remains in the fish or goes into the pickle.

#### SUMMARY.

As stated previously, no effort has been made to include all the variations of the different methods of salting fish. Neither has any attempt been made to discuss any detail other than the mode of applying the salt to the fish. From the above description it is seen that all the methods include but three general modes of application of salt to fish: 1. The fish are immersed in a solution of salt which is kept saturated, or nearly so, by the addition of salt from day to day. 2. The fish are packed in water-tight containers with dry salt and are allowed to develop their own pickle. 3. The fish are packed in piles (kenches), and the pickle is permitted to run off the fish as it is formed.

The last-mentioned method is used only in cold weather, in an emergency when there are no containers at hand. Such is often the case on ships fortunate enough to make extraordinarily large catches. As it is practical only in cold weather, the method is not available for much commercial fish salting, and therefore no experimental work with it has been attempted.

The brine method of salting fish is chiefly used along the Chesapeake Bay, in the Reedville (Va.), and Havre de Grace (Md.) regions. This method has the big disadvantage of requiring more labor than the dry-salt method. Some salt must be added nearly every day, and the pickle must be watched closely to prevent it from becoming too weak. The fish must be roused (stirred up) every day. This is done with large paddles of various sizes and shapes and requires the expenditure of considerable energy. The fish produced by this method are much softer and contain more water than those produced by the dry-salt method. They appear similar to partially "struck," dry-salted fish. However, the fish are more plump and seem more like fresh fish than the dry-salted product.

The dry-salt method involves no rousing after salting and necessitates but one addition of salt, provided the fish are properly salted in the beginning. Usually the fish salted by this method are tightly packed in barrels or butts and not disturbed. This prevents the salt from falling to the bottom, as is the case when the brine-salted fish

are roused. Fewer scales are knocked off, and the fish have a wrinkled, shrunken appearance. If a lot of dry-salted fish is mixed with a lot of brine-salted fish, the fish can easily be separated, so marked is the difference in their appearance.

#### STORAGE OF SALTED FISH.

There are three general methods of storage: 1, the brine; 2, dry, with salt; 3, dry, with boracic acid. The quality of the fish on the retail market depends to a considerable extent upon the temperature and method of storage. No experimental work on storage was done.

The fish are kept in their own pickle or put in fresh saturated brine, or packed dry. If the pickle formed by the fish is dirty in appearance, it is discarded and fresh pickle (salt solution) is added. New brine is always added if the salt fish are likely to be stored in a place which is not cool. Fish dealers say that the "blood pickle" is likely to "sour" if kept in a warm place.

If the fish are packed dry, as are the cod in Massachusetts and the alewives in the South, they are packed either with salt or with boracic acid. The cod is sprinkled with salt containing 0.4 per cent boracic acid before packing. A considerable quantity of coarse salt is thrown over each layer of alewives as they are packed in the barrels.

In all cases the salted fish must be kept at a low temperature if they are to be stored for any length of time. The fish salted in Massachusetts and Maine are held in cold storage until the time of shipment. In North Carolina and Virginia the fish are held in "cool storage." Fish stored exposed to the air are very likely to "rust." Rusting is due to the oxidation of the fish oil and gives the fish a dark-brown color. Packing in brine prevents this to a large extent.

#### PURPOSE OF EXPERIMENTAL WORK.

This work was instituted in order to work out, if possible, a method of salting fish applicable in warm climates. At present none of the methods known are applicable for commercial purposes in a climate where the temperature averages above 70° F. Great care must be taken if the mean temperature rises above 60° F. The logical way to work out any new method is to study the existing methods first. This study should show whether some method in use to-day can be so improved that it may be used at a higher temperature. If, after the present procedures have been given a trial and their shortcomings discovered, no existing method can be adapted for warm climates, then the need for a new method will be shown.

#### FACTORS INFLUENCING THE SALTING OF FISH.

At the beginning it was evident that, if the various methods were to be fairly judged, the influence of the factors affecting the salting of fish would have to be known. Then, if all known methods were found incapable of being modified for use at higher temperatures, the relative values of the various factors would have been found, and improvements in the present methods might be suggested without further work. There would also be a basis of knowl-

edge with which a new method could be worked out. Besides, this plan of procedure would give data of great value. The application of correct interpretations of these data would lead to improved methods and a more uniform product. The relative importance of the factors influencing the salting of any fish being then known, the fish salter should be able to produce any desired product by modifying his conditions.

It has always been known that the relative freshness of a fish has an influence upon the quality of the salted fish. Everyone is aware of the fact that if fish are stale great care must be exercised in salting them in order to obtain a desirable product. There are no data in the literature which show how stale a fish may be and yet be salted satisfactorily. This result depends upon the efficiency of the method.

Any method that may be used to salt fish at high temperatures may also be used to salt stale fish. Since there is so little control of the present method of salting, little valuable data on this process could be obtained unless the available methods of salting fish were standardized so that uniform procedure would be followed in all cases.

Commercial fish salters are often very careless in allowing their fish to become stale before they salt them. The writer found it necessary to obtain the maximum temperature of salting perfectly fresh fish. Evidently the thoroughness of cleaning and washing the fish has an influence on the temperature at which they can be salted and also on the quality of the product. It is a well-known fact that unbled animals have a "wild-game" taste. The chief difference between the taste of domestic ducks and wild ducks is due to the fact that wild ducks are shot and not properly bled, whereas domesticated ducks are carefully bled. Fish salters are well aware of the fact that more care must be taken in the salting of round or uncut fish than in curing cut fish. Blood, milt, and roe are substances which decompose readily. Is it not possible that the presence of these substances in fish lower the maximum temperature at which they can be salted?

In the description of methods it was mentioned that there are three ways of applying salt to fish. The kench method of dry salting can be used in only cold weather. Prior to these experiments no one had shown which of the other two methods was the better during hot weather. In Massachusetts the dry-salt method is used the year around; yet in Virginia the fish salters are firm advocates of the brine method.

The resistance of the skin to the penetration of salt is another factor of importance in salting fish. Almost every fish salter will inform you that the salt penetrates more rapidly through the cut surface of the fish than through the skin. Would it not, then, be feasible to skin the fish before salting in warm weather?

Different modes of procedure are followed when various kinds of fish are salted. This in itself is evidence that the species of the fish is an important factor to be considered when working out any method of salting fish. The amount of fat in the different species of fish varies greatly—from about 0.09 per cent in cod to about 16.2 per cent in fat mackerel. The fat in a fatty fish might alter the

permeability of a fish to salt. The fat of different fishes varies widely in chemical composition and physical constants. Some fats may spoil more readily than others and thus affect the keeping qualities of the fish. Fish of different species vary in chemical composition. Everyone knows that some fish soften and spoil much more readily than others. Fish of the same and different species vary greatly in size. The surface exposed to the salt depends upon the size and shape.

#### MODE OF PROCEDURE IN EXPERIMENTAL WORK.

The chemical changes which fat undergoes during salting and storage were not studied, so that any points presented on this subject are merely casual observations which the experimenter noted during his work. The writer used but four species of fish in this work; naturally, therefore, it is not certain that the work applies to all varieties of fish. Most of the work was done with the squeeteague (*Cynoscion regalis*) and the alewives (*Pomolobus astivalis* and *pseudoharengus*). No marked differences were observed in the changes taking place during the salting of these fish. The writer ventures the opinion that the rules observed as to the protein decomposition (flesh decomposition) will apply to nearly every species of fish; but he doubts whether any observations concerning the chemical changes occurring in the fat of one species will hold good for all others, for the various fat constants of the oil of different species vary considerably. The rate of oxidation of these fats would vary nearly as much as the composition, because certain fish oils are much less saturated than others and would oxidize much more readily.

With the exception of the chemical changes taking place in the fat and the fact that the species studied were few in number, the writer believes that he has covered in this paper all of the most important factors influencing the salting of fish. The two factors not studied in detail embrace such a large amount of work that they were considered as separate problems.

Few important chemical investigations concerning the salting of fish have been carried out. Previously the problem had been considered mainly from the bacteriological standpoint. Various investigations concerning bacteriological problems had been attempted, but no methods of estimating the rate of salting, the rate of protein decomposition, or the freshness of fish were to be found in the literature. The investigator had, therefore, to work out and standardize methods applicable for his purpose. This in itself was no small task. The writer does not claim that the methods used are perfect or that other procedures could not be used to better advantage but rather admits that they may be improved upon. However, the procedure was uniform, and the results obtained checked satisfactorily in most cases. They must, therefore, be accepted as relative if not exact.

It seems obvious that the more rapidly salt penetrates the flesh of the fish the sooner decomposition of the tissue will stop. This statement is based on the assumption that decomposition of the tissue ceases when the fish is thoroughly salted. But this is not exactly the case. Decomposition is not stopped; it proceeds almost

infinitely more slowly. The decomposition products are also changed in nature, but no toxic compounds are developed. Later the salted fish may spoil because of unfavorable storage conditions, but it is not likely that the spoiled fish will produce harmful results if eaten. In order, therefore, to learn how fast salt penetrates a fish, a method was required which would enable the experimenter to determine the rate of penetration. This should enable him to judge, at least from one standpoint, the value of different salts.

The rate of penetration of salt into fish was followed by cutting sections of the fish at different depths from the surface. These sections were ashed and the amount of chlorine in them determined. The amount of chlorine in the dry salt fish was then calculated. This was done from day to day, and thus the increase in salt content of the inner sections was determined. The rate of penetration of any salt into fish is not an absolutely accurate criterion for judging the quality of that salt, for certain impurities in the salt might have a preservative action surpassing that of the salt.

Then it was necessary for the experimenter to learn the best method of cleaning fish preparatory for salting and to judge the necessity of absolute freshness. The rate of penetration does not afford a means of judging between two methods of application of the salt. It was necessary, therefore, to choose some means of estimating the decomposition of the flesh of fish and to adapt it for use with salt fish. A wide choice was not permissible, for a very large number of determinations must be run simultaneously and quickly. The apparatus required had to be simple and easily transported, as it was necessary to take the laboratory to the fish, as it were, in order to obtain fresh fish. The estimation of the rate of amino-acid formation was chosen as an indicator of the rate of protein decomposition. The reasons for this choice will be explained further on.

A limited amount of histological work was carried on in order to determine if possible the difference between the effect on the cell structure of the salted fish of pure sodium chloride and of sodium chloride adulterated with other chlorides. A complete record was kept of the macroscopic changes of each lot of fish. All the ordinary qualities were observed, such as color, odor, hardness, brittleness, taste, and general appearance. For the sake of brevity only the most notable changes are recorded in this paper. All edible samples of salted fish were cooked at the end of the experiments and their palatability noted. In these culinary experiments the fish were cooked in such a way that their flavor was in no way disguised.

The writer presents in this paper only those conclusions that seem to him to have been proved beyond doubt. The results may be accepted as facts for the river herring and the squeteague. It is very probable that they hold for other fish, but further work must be done to prove this point beyond doubt. In no case are the figures absolutely exact; but there is little doubt that they are relative to each other and that they may be compared with confidence. The writer hopes that this research will create such an interest in the chemistry of fish salting that other researches of a similar nature will be instituted.

## EXPERIMENTAL.

### I. INFLUENCE OF IMPURITIES IN SALT IN SALTING FISH.

#### INTRODUCTION.

Nearly every fish salter is a firm advocate of the use of some brand of commercial salt. A few fish salters realize that the foreign solar salts produce fish of a quality different from the domestic vacuum pan salts, but nearly all of these fishermen think that the difference in the product is caused by the variation in the size of the salt grains. Very few think that the impurities in the salt affect the hardness, whiteness, and other properties of the salted fish. Only a few salters understand the real meanings of the trade names by which the salt is sold. Many believe that "ground alum" refers to the quality of the salt sold under that name and would be surprised to learn that this name refers merely to the fineness of the salt.

Fishermen say: "That grade of salt rots fish." The action of the salt on fish is not clearly understood by all fish salters and salt dealers. This work on the influence of impurities is worth while, even if it merely explains the effects of the common impurities in salt. This will give the fish salter some criterion for judging the value of the various salts.

#### COMMERCIAL SOURCES OF SALT.

The greater proportion of the salt used in this country previous to the war was solar salt prepared in Europe or in the West Indies. Most of this European salt is made by evaporation of sea water along the coast or on islands in the Mediterranean Sea. The chief reason for the use of this salt is the cheapness of transportation facilities from those parts of the world to the Atlantic seaboard, where most of the European salt used in America is consumed. A great deal more material is exported from the United States to Mediterranean ports than is imported from these ports. Steamers are very anxious to bring cargoes from the Mediterranean Sea to the Atlantic ports, and therefore they are willing to transport the salt to our shores for a very small price.

However, during the war this supply was almost cut off. The price of salt in the United States rose to a very high figure, and the greater proportion of the salt used was domestic. Fish salters who had previously been prejudiced against the use of American salt were forced to use it, and many of them became convinced that it was equal in quality, if not superior, to foreign solar salts.

## METHODS OF MANUFACTURE.

Domestic salt is prepared by one of the following processes: Steam evaporation, vacuum evaporation, direct-heat evaporation, or solar evaporation.

Most of the salt produced in the eastern part of America, close to the regions where fish are salted, is manufactured by steam evaporation. The product produced by this method, in jacketed kettles, grainers, and vacuum pans, is a fine-grained salt. For some reason there is much prejudice against the use of fine-grained salt for fish salting. Because of this prejudice very little salt produced in this way was used by fishermen previous to the war. During the war, when the supply of coarse-grained salt was limited, a large proportion of the fish salters began the use of fine-grained salt partially to replace the coarse-grained salts.

The salts produced by direct-heat evaporation are usually coarser grained than those produced by steam evaporation. To-day this process is seldom used except where it is possible to utilize waste heat, and since such a small amount is prepared in this way, this method of production is not considered an important factor in the salt supply.

Unfortunately for the fish trade, nearly all of the domestic solar salt is produced in the arid regions of the West. The only place in the East where this method of evaporation is practiced is in the vicinity of Syracuse, N. Y. Because of the very high freight rates eastward across the continent, the cost of the western solar salt on the Atlantic coast is almost prohibitive.

Pure salt is pure sodium chloride. There is no brand of commercial salt on the market that is 100 per cent pure. There are, however, salts on the market which are 99.95 per cent pure. Most of the American salts are of greater purity than the foreign salts; however, there are a few British salts of great purity. The limited analytical data available to the author indicate that British salts, with the exception of Turks Island are, on the whole, of much greater purity than French, Spanish, and Italian salts. The reason for this probably is to be found in the method of manufacture. The southern European salts are mainly solar salts, whereas the British salts, because of the climate, must be prepared in some other way.

The ordinary procedure in the preparation of solar salts is to allow sea water at high tide to run, or be pumped, into low-lying lands, forming ponds. The outlet to the sea is then closed, and evaporation is allowed to proceed. As the brine becomes more concentrated and more nearly saturated it is run into other ponds. Finally, when the saturation point has been reached the brine is run into crystallizing ponds. Here the usual procedure is to allow evaporation to proceed until the brine becomes high in magnesium chloride and low in sodium chloride. Usually when a concentration of 32° B. is reached the mother liquor is drained off and discarded. From the above brief description of the process it will be seen that solar salt is likely to be impure. Since sea water is high in calcium and magnesium chlorides, it is likely that solar salt will be high in these constituents if it is crystallized but once.

## ANALYSES OF COMMERCIAL SALTS.

The following are analyses of various typical commercial brands of salt:

ANALYSES OF VARIOUS SALTS USED FOR CURING FISH.<sup>a</sup>

Determinations.	Italian salt, Tra-pani. <sup>b</sup>	Spanish salt, Iviza. <sup>b</sup>	Domestic salt, Diamond Flake. <sup>c</sup>
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Sodium chloride.....	95.82	98.05	99.78
Calcium chloride.....	.32	.49	.....
Calcium sulphate.....	.....	.....	.37
Magnesium chloride.....	1.19	.....	.00
Magnesium sulphate.....	1.75	.80	.00
Sand.....	.15	.06	.00

<sup>a</sup> The sulphates were all calculated as magnesium sulphate and the calcium as chloride, except in the case of Diamond Flake salt, where no magnesium was found. In this case the sulphate was calculated as calcium sulphate.

<sup>b</sup> These results were calculated to a moisture-free basis from the data in the table, page 18, Bitting, A. W., Bureau of Chemistry Bulletin No. 133.

<sup>c</sup> Analyst, J. F. Stepl.

ANALYSES OF SAMPLES OF SALT.<sup>a</sup>

[Per cent on moisture-free basis.]

	Domestic salts.			Imported salts.				
	California: 29606-H, Leslie bulk salt from barrels, Leslie Salt Refining Co. <sup>b</sup>	New York: 11309-H, solar rock salt bulk, Solar Salt Co., Syracuse. <sup>c</sup>	West Virginia: MD-16102, Liverpool Salt Co., Hartford. <sup>d</sup>	England.		France: P-7917, Bonaire Salt Exp. Co. <sup>g</sup>	Spain: P-8657, Pella Empresado Navagaoe, Lisbon. <sup>h</sup>	Bahama Islands. P-7853, D. F. & H. F. Har- riott, Turks Estate, Turks Island. <sup>i</sup>
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
<b>RADICALS.</b>								
Arsenate (AsO <sub>4</sub> )	None.			Slight trace.	Trace.	Trace.	None.	None.
Tetraborate (B <sub>4</sub> O <sub>7</sub> )	0.021		0.00	0.89	Trace.	Trace.	Trace.	Trace.
Sulphate (SO <sub>4</sub> )		1.365					1.727	0.405
Carbonate (CO <sub>3</sub> )						1.692		
Bicarbonate (HCO <sub>3</sub> )								
Chloride (Cl)	60.70	59.51		59.81	60.63	58.51	013	60.16
Iron (Fe)			.007					59.44
Calcium (Ca)	.025	.568	1.33	.39	.000	.764	.471	.45
Strontium (Sr)			.81				.008	
Barium (Ba)			.67					
Magnesium (Mg)	.000	.000	.29	.02	Trace.	.090	.306	.47
Sodium (Na, calculated)	39.34	38.56		38.73	39.34	37.71	38.02	37.97
Silica sand, etc. (SiO <sub>2</sub> )	.008	.09		.02	.015	1.312	.086	.13
Total	100.09	100.09		99.89	100.02	100.08	100.06	100.18

<sup>a</sup> Analyses supplied by and published by permission of the U. S. Bureau of Chemistry.

<sup>b</sup> Collected Sept. 5, 1914; analyst, W. F. Baughman.

<sup>c</sup> Collected Sept. 8, 1914; analyst, W. F. Baughman.

<sup>d</sup> Collected from Grainer May, 1913; analyst, W. F. Baughman. This salt is not supposed to be used for food purposes.

<sup>e</sup> Collected Feb. 4, 1916; analyst, C. H. Badger.

<sup>f</sup> Collected Oct. 6, 1914; analyst, R. H. Kellner.

<sup>g</sup> Collected Dec. 1, 1915; analyst, W. F. Baughman.

<sup>h</sup> Collected July 11, 1917; analysis, W. F. Baughman and R. H. Kellner.

<sup>i</sup> Collected Nov. 1, 1915; analyst, C. H. Badger.

<sup>j</sup> Collected Nov. 10, 1915; analyst, W. F. Baughman.

## ANALYSES OF SAMPLES OF SALT—Continued.

	Domestic salts.			Imported salts.				
	California: 23000-H, Leslie bulk salt from barrels, Leslie Salt Refining Co.	New York: 11309-H, solar rock bulk, Solar Salt Co., Syracuse.	West Virginia: MD-16102, Liverpool Salt Co., Hartford.	England—  P-8036, Ash- ton Higgin & Co., Liver- pool.	CN-2084, Chas. Moore & Co., Liver- pool.	France: P-7917, Bonaire Salt Exp. Co.	Spain: P-8657, Pels Empexado Nagagaco, Lisbon.	Bahama Islands.  P-7853, D. F. Alfred Slofts Estate, Turks Island.
COMBINATIONS.								
Sodium chloride (NaCl).....	Per cent. 100.01	Per cent. 98.02	Per cent. 92.70	Per cent. 98.45	Per cent. 99.96	Per cent. 95.86	Per cent. 96.63	Per cent. 96.52
Sodium bicarbonate (NaHCO <sub>3</sub> ).....			1.13	.08	.043	.35	.018	
Magnesium chloride (MgCl <sub>2</sub> ).....			3.68	.05		.16	.967	1.20
Magnesium sulphate (MgSO <sub>4</sub> ).....		.08				2.40	.737	.80
Calcium chloride (CaCl <sub>2</sub> ).....	.045	1.93	1.46					
Calcium sulphate (CaSO <sub>4</sub> ).....	.030						1.602	1.53
Strontium chloride (SrCl <sub>2</sub> ).....								
Strontium sulphate (SrSO <sub>4</sub> ).....			1.02				.017	
Barium chloride (BaCl <sub>2</sub> ).....			.01					
Ferric oxide (Fe <sub>2</sub> O <sub>3</sub> ).....		.06		.02	.015	1.312	.086	.13
Silica sand, etc. (SiO <sub>2</sub> ).....	.008							
Total.....	100.09	100.09	100.00	99.85	100.02	100.08	100.06	100.18
Moisture.....	.159	1.12	5.66	.84	.139	1.39	4.475	4.19
Remarks.....	Fine crys- tals.			Fine crys- tals.		Coarse crys- tals.	Coarse crys- tals.	Coarse crys- tals.
								Large crys- talline lumps.

a By difference.

These analyses are given in order to show the large amounts of impurities contained in some salts and to point out that it is possible to purchase on the market salts that are very nearly pure. It is to be noted that the chief impurities are calcium, magnesium, and sulphates. It is not known in just what chemical combination these occur in the salt, but this makes no difference. The analyses are given on a moisture-free basis in order that they shall be relative to each other. Further, the amount of moisture contained in salt is of little importance to the fish salter; except that, of course, damp salt contains less salt per ton than dry salt and, therefore, is more expensive if it is purchased at the same price.

#### INFLUENCE OF IMPURITIES ON RATE OF PENETRATION OF SALT.

##### INTRODUCTION.

*Former work on rate of penetration.*—Bitting (1911), of the Bureau of Chemistry, tried some experiments to show the effect of fineness of salt upon the rate of penetration of salt into codfish. Bitting's data show that in various coarse and fine salts there was little difference in the rate of extraction of water from the tissues or in the rate of penetration of salt into the fish. However, in his work no consideration was given the chemical composition of the salt. To make the work comparative, a single salt ground to different degrees of fineness would have to be used in salting all of the experimental lots of fish. Bitting used various domestic and foreign salts which were of different degrees of fineness, but which varied widely in chemical composition. It is stated that the cod used were small in size, but no information was given regarding the uniformity of size, which is a very important factor, as salt will penetrate to the center of a thick fish much less readily than it will penetrate a thinner fish. Nor does Bitting give any information as to his method of obtaining a 50-gram sample from a fish. Before the experiments could be repeated the exact size of the fish used would have to be known and also the exact method of sampling. The writer doubts that any method of sampling a fish other than sampling a section of given thickness a definite distance from the skin or flesh side of the fish would be accurate enough to show differences in the penetrating powers of different salts.

*Importance of rate of penetration.*—A consideration of the cause of souring had suggested that the souring is a decomposition of the inner meat of the fish before the brine strikes through and stops the decay. Various writers had observed an antagonism between the bivalent metals and monovalent metals in their passage through membrane. This suggested that the small amounts of calcium and magnesium, which exist in commercial salt as impurities, might exert a pronounced retardation on the penetration of the sodium chloride into the fish. An attempt was, therefore, made to measure the influence of these metals on the penetration of the sodium chloride into fish. If it were found that these impurities in salt caused the salt to penetrate more slowly, then the use of purer salt would lessen the danger of spoilage, for the fish would strike through more rapidly and less time would be allowed for decay of the inner portion.

An attempt was, therefore, made to measure the rate of penetration of pure salt into fish as compared with the rate of penetration of mixtures of sodium chloride with the common impurities in salt; that is calcium, magnesium, and sulphate.

#### METHOD.

It was fortunate that the writer began his experiments on the rate of penetration of salt with chemically pure sodium chloride, for this led to the discovery that the impurities in salt were largely responsible for the physical characteristics of the salted fish. The fish chosen for this work was the squeteague or weakfish (*Cynoscion regalis*), which could be obtained in a nearly fresh condition almost all the year around in Baltimore, where the experimenter was working. This fish is of medium fatness and was obtained on the market in quantity at any desired uniform size. It had been planned to try any improvement that might be worked out on the alewife or river herring. The squeteague was more similar to the river herring than any other fish that could be purchased throughout a long season.

After considering many possible methods of determining the rate of penetration of salt into fish it was decided to determine the per cent of chlorine in different sections of the fish from day to day. The layer from one-half to 1 cm. in depth was found by experience to give the most uniform results.

Thus far the work has been applied to but one fish, the squeteague. The writer does not claim that the results of the work on this one fish can be applied without change to all varieties of fish. Different results might be obtained if a fat fish, such as the mackerel, had been used. Clark and Almy (1918) give the fat content of a composite sample of weakfish, on May 1, as 2.34 per cent (fresh basis); on September 25 a similar composite sample contained 0.52 per cent. However, they observed also that different squeteague in the same school and various schools differ greatly in their fat content.

Fish in good condition and of as nearly uniform size as possible were obtained from wholesale fish dealers of Baltimore. After cutting the length of the belly, eviscerating, and removing the heads, they were salted with dry salt of known composition. The salt used was Baker's analyzed, chemically pure sodium chloride, or mixtures of this with other salts of the same grain size. This salt was just a little smaller grained than ground alum, or packer's salt, which is so widely used in the fish-salting industry. The salts were thoroughly mixed, so that all portions were of uniform composition. The fish were rolled in salt, and salt was sprinkled over each layer of fish, as is the practice of the trade. For every three parts, by weight, one part of salt was added when first salted.

After the fish had been in salt 24 hours one part, by weight, of salt was added for every 15 parts of fish. Later, at the end of six days, 1 part, by weight, of salt was added for every 30 parts of fish. The fish were placed belly down in 2-gallon stone jars. The above procedure was carried out in order to duplicate, if possible, the method of salting fish in use at Gloucester.

In the different experiments the temperature of salting was kept as near 68° F. as possible by surrounding the jars with running

water near this temperature. The temperature did not vary more than 2.7° from the average. The fish were sampled at about 48-hour intervals. In sampling, a transverse section, about 3 inches in width, was cut from a fish. A layer, 0.5 cm. in depth, was cut from the outside of the fish, which had been exposed to the brine. A second layer, underlying first layer 0.5 cm. thick, was then cut for a second sample. These samples were then dried at 100° C. and ground up. The percentage of chlorine was then determined by first carefully ashing the fish in silica dishes and afterwards titrating the chlorides with tenth-normal silver nitrate, using potassium chromate as indicator. The inner section (one-half to 1 cm. in depth) was found to be of the most uniform composition. Analysis of different fish from a single lot showed that this layer did not vary more than 1 per cent in chlorine.

## DISCUSSION.

The results of the work which has been completed are given in Tables 1 to 4 and are shown graphically in the curves, figures 1 to 4. The work shown in Tables 2, 3, and 4 was all done at the same time with fish of the same relative freshness, and the temperatures of the brines were kept uniform. The work reported in Table 1 was done at a different time with a different lot of fish of somewhat larger size and heavier scale. As a result, the data in Table 1 are not comparable with those given in the other tables.

The results of the analyses of the dry fish samples are shown in Tables 1, 2, 3, and 4. The figures in all cases refer to the per cent of chlorine in dry fish. In Table 1 the analyses of sections of fish salted with a salt so prepared as to contain 1 per cent of calcium chloride and analyses of sections of similar squeteague salted with pure salt at the same time under identical conditions are presented.

TABLE 1.—RETARDATION OF PENETRATION OF SALT INTO FISH DUE TO 1 PER CENT OF CALCIUM CHLORIDE IMPURITY, EXPRESSED IN TERMS OF PER CENT OF CHLORINE IN DRY SAMPLE, AT 62.5° F.

Analysis of salt used.	Section of fish.	Per cent chlorine after—			
		1 day.	4 days.	7 days.	10 days.
Pure sodium chloride.....	Outer a.....	9.8	16.2	19.6	19.5
Do.....	Inner b.....	2.6	11.0	16.0	18.7
1 per cent calcium chloride, 99 per cent sodium chloride.....	Outer a.....	8.7	10.8	15.2	16.6
Do.....	Inner b.....	2.5	7.9	14.1	14.4

a 0 to  $\frac{1}{2}$  cm.

b  $\frac{1}{2}$  to 1 cm.

It is to be noted that the sections, both inner and outer, of the fish salted with pure salt ran higher in chlorine content than those salted with salt containing 1 per cent of calcium chloride.

In Table 2 data are presented which were obtained from the salting of another lot of squeteague with pure salt and from a similar lot salted with salt so prepared that it contained 1 per cent of magnesium chloride impurity.

TABLE 2.—RETARDATION OF PENETRATION OF SALT INTO FISH <sup>a</sup> DUE TO 1 PER CENT OF MAGNESIUM CHLORIDE IMPURITY, EXPRESSED IN PER CENT OF CHLORINE IN DRY SAMPLE, AT 68° F.

Analysis of salt used.	Per cent chlorine after—			
	1 day.	3 days.	6 days.	9 days.
Pure sodium chloride.....	9.8	16.0	19.7	22.4
1 per cent magnesium chloride, 99 per cent sodium chloride.....	6.5	15.7	18.7	19.0

<sup>a</sup> Inner section of fish,  $\frac{1}{2}$  to 1 cm.

In this case, also, the chlorine content of the inner sections of fish salted with pure salt is higher than that of similar sections of fish salted with the salt containing 1 per cent of magnesium chloride.

Table 3 shows that an increase in the amount of magnesium chloride to 4.7 per cent caused a further retardation.

TABLE 3.—RETARDATION OF PENETRATION OF SALT INTO FISH DUE TO 4.7 PER CENT OF MAGNESIUM CHLORIDE IMPURITY, EXPRESSED IN PER CENT OF CHLORINE IN DRY SAMPLE, AT 68° F.

Analysis of salt used.	Section of fish.	Per cent chlorine after—			
		1 day.	3 days.	6 days.	9 days.
Pure sodium chloride.....	Outer <i>a</i> .....	14.6	19.0	22.7	22.7
Do.....	Inner <i>b</i> .....	9.8	16.0	19.7	22.4
4.7 per cent magnesium chloride, 95.4 per cent sodium chloride.	Outer <i>a</i> .....	10.1	17.1	17.8	18.1
Do.....	Inner <i>b</i> .....	5.9	12.7	17.1	18.1

*a* 0 to  $\frac{1}{2}$  cm.

*b*  $\frac{1}{2}$  to 1 cm.

Table 4 shows that the presence of the sulphate ion in solution caused a greater retardation than the consequent lowering of the concentration of the chlorine ion should cause.

TABLE 4.—RETARDATION OF PENETRATION OF SALT INTO FISH <sup>a</sup> DUE TO 10 PER CENT OF SODIUM SULPHATE IMPURITY, EXPRESSED IN PER CENT OF CHLORINE IN DRY SAMPLE, AT 68° F.

Analysis of salt used.	Per cent chlorine after—			
	1 day.	3 days.	6 days.	9 days.
Pure sodium chloride.....	9.8	16.0	19.7	22.4
10 per cent sodium sulphate, 90 per cent sodium chloride.....	7.1	10.5	15.3	17.1

<sup>a</sup> Inner section of fish,  $\frac{1}{2}$  to 1 cm.

Further than a retardation of the rate of penetration of the sodium chloride, calcium chloride and magnesium chloride had noticeable effects on the physical appearance of the salted fish. Both the calcium chloride and magnesium chloride as impurities in salt made a much harder fish than pure sodium chloride. Calcium chloride, apparently, was most active in this regard. Pure sodium chloride, when used dry for salting fish, produces a soft, yellow-meated fish which will bend when held in the hand. Five per cent of calcium

chloride as impurity is sufficient to produce a very stiff, hard fish. One per cent of calcium chloride produced a softer fish, but yet one which was much harder than that produced by pure sodium chloride. Four and seven-tenths per cent of magnesium chloride, as impurity, produced a fairly hard, stiff fish, with a very bright, shiny appearance.

Both calcium chloride and magnesium chloride, as impurities in salt, caused a very noticeable whitening. This whitening could easily

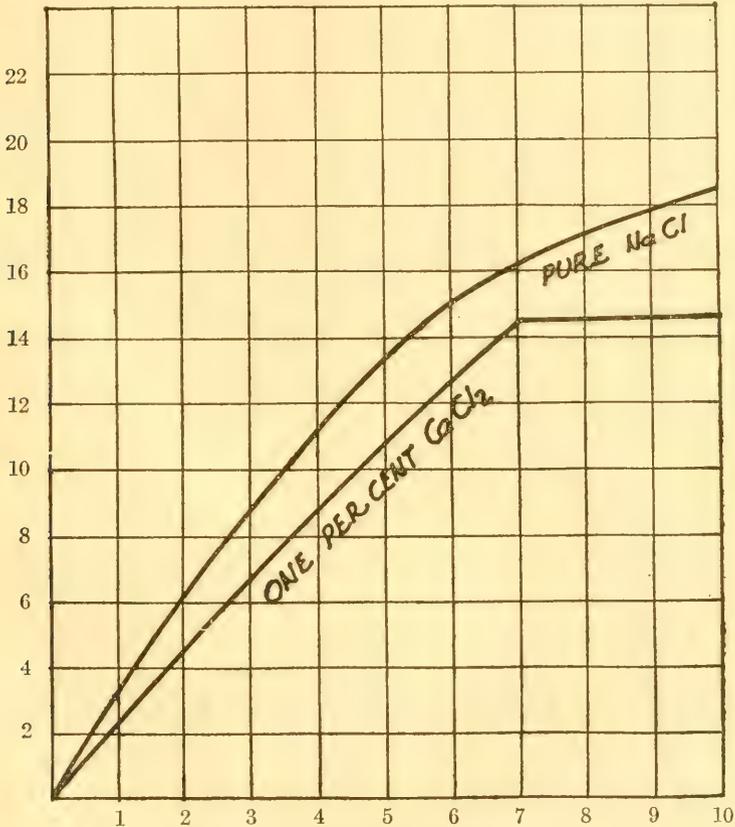


FIG. 1.—Curves show retardation of penetration of salt due to 1 per cent of calcium chloride impurity (section  $\frac{1}{2}$  to 1 cm. depth). Figures at left indicate per cent of chlorine in dry fish; at bottom, time in days.

be followed, as it was first observed in the outer portions of the fish and moved toward the center until at the end of from 10 to 13 days the fish was uniformly white throughout. Calcium chloride was most active in this regard.

Figures 1 to 4 illustrate graphically the data presented in the tables. In each case the time in days is plotted along the ordinate (horizontal line). The percentage of chlorine in the dry fish is plotted along the abscissa (vertical line).

Figure 1 shows how the percentage of chlorine in fish (the amount of sodium chloride contained in the fish) increases for 10 days. The

salts used were pure sodium chloride in one case and sodium chloride containing 1 per cent of calcium chloride in the other. It will be noted that after seven days the chlorine content of the fish salted with pure salt is nearly 2 per cent higher than that of the fish salted with salt containing 1 per cent of calcium chloride. The chlorine content of the fish salted with pure sodium chloride continues to increase rapidly, whereas the chlorine content of the squeteague salted

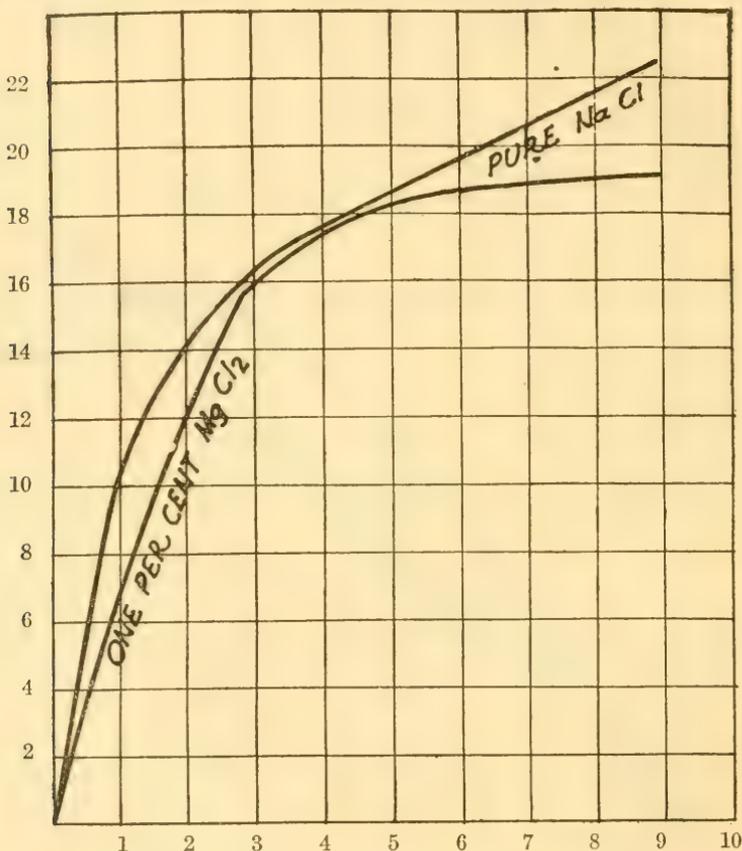


FIG. 2.—Curves show retardation of penetration of salt due to 1 per cent of magnesium chloride impurity (section  $\frac{1}{2}$  to 1 cm. depth). Figures at left indicate per cent of chlorine in dry fish; at bottom, time in days.

with salt containing calcium chloride increases very much more slowly.

Figures 2 and 3 show that the marked slowing up in the penetration of the salt into fish, due to the presence of magnesium chloride, begins in about six days after salting.

Figure 4 shows that the marked slowing up of the penetration of the salt into fish in the case of salt adulterated with 10 per cent of sodium sulphate occurs almost immediately. The amount of impurity used in this case was far in excess of any amount ever found in any commercial salt. It is doubtful whether small amounts of

sulphates found in commercial salts would have any appreciable effect on the penetration of salt in fish.

## SUMMARY.

1. Small amounts of calcium chloride or magnesium chloride, as impurities in salt, retard the penetration of the sodium chloride into the squeteague.

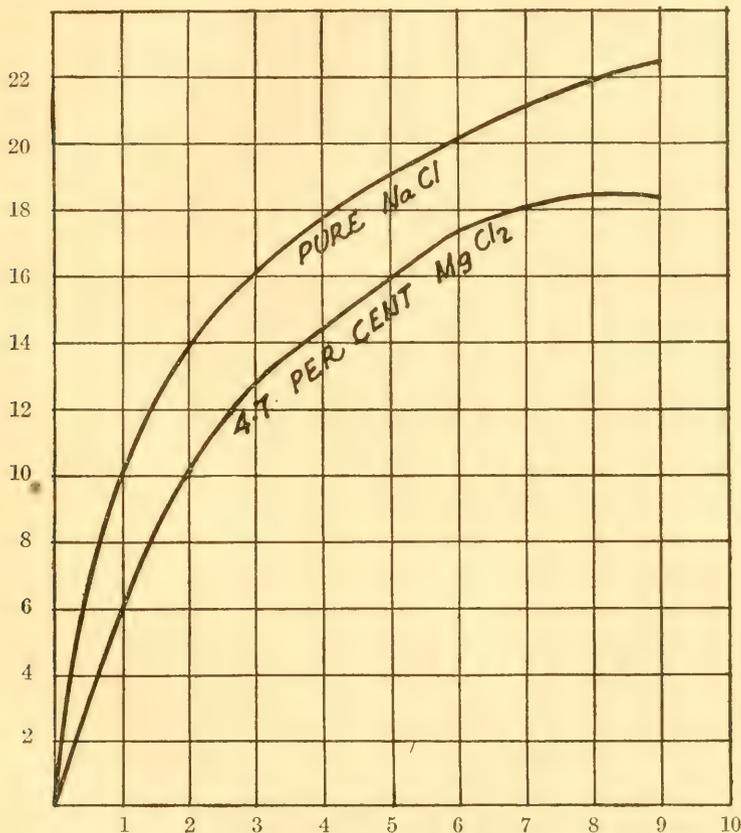


FIG. 3.—Curves show retardation of penetration of salt due to 4.7 per cent of magnesium chloride impurity (section one-half to 1 cm. depth). Figures at left indicate per cent of chlorine in dry fish; at bottom, time in days.

2. The sulphate ion has a similar, though less noticeable, effect.
3. Calcium chloride and magnesium chloride, as impurities in salt, cause a firmer, whiter fish than pure sodium chloride.

INFLUENCE OF IMPURITIES ON RATE OF PROTEIN DECOMPOSITION.<sup>a</sup>

## INTRODUCTION.

When the consideration of obtaining the relative values of different methods of salting fish was first taken up, the rate of penetration of

<sup>a</sup> The analytical work reported in this section of the paper was done by J. F. Steph, temporary assistant, U. S. Bureau of Fisheries.

chlorine into the fish was chosen as a criterion. The writer realized, however, that this alone was hardly a satisfactory criterion. Even if the salt penetrates fish with equal rapidity, it is no proof that the fish are keeping equally well. Different moisture contents would cause unequal keeping qualities; also, some impurities in the salt might have a greater preservative action than sodium chloride.

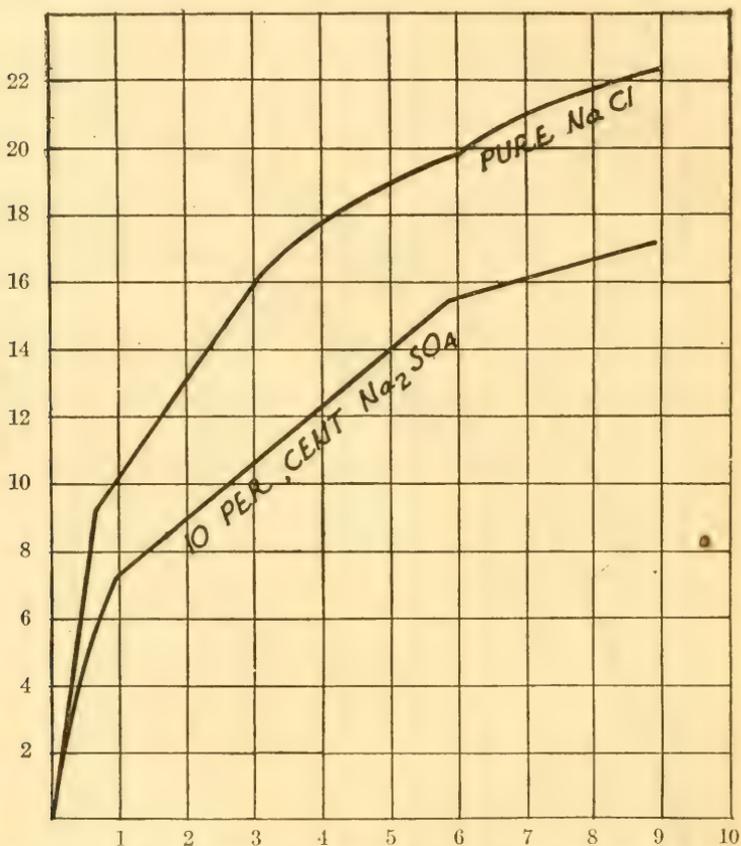


FIG. 4.—Curves show retardation of penetration of salt due to 10 per cent of sodium sulphate impurity (section one-half to 1 cm. depth). Figures at left indicate per cent of chlorine in dry fish; at bottom, time in days.

It was considered essential to have some means of measuring the amount and rate of decomposition of protein in order to judge as to how much decomposition took place while any given lot of fish was being salted. If the amount of decomposition at the end of the salting process were known, the real value of any salting method as a means of preserving fish would be known.

When proteins decompose, they break up, first, into simpler proteins, then into polypeptides, and then into amino acids. It is very difficult to measure accurately the amounts of simpler proteins and polypeptides in fish. However, the total amino-acid content of fish and brine is easily determined.

A number of experimenters have found that the amount of amino acid formed is an index of the total protein decomposition in meat and fish. Hoagland, McBryde, and Powick (1917), working on the decomposition of beef during cold storage, found that the amino-acid content of beef increased relatively more than any other constituent. They found that the amount of amino acid formed varied directly with the length of the storage period. They say:

The increases in amino nitrogen represent an accumulation of the end products of proteolysis and furnish an excellent index of the extent of protein autolysis. They are produced by the combined action of various proteolytic enzymes—protease and erepsin in particular—upon muscle proteins and their cleavage products. \* \* \*

Amino nitrogen showed greater actual and relative changes than any other nitrogenous constituent. This result was to have been expected, since this constituent represents, in a large degree, an accumulation of the end products of proteolysis.

Bradley and Taylor (1917) used the estimation of amino acids by the formol-titration method to measure the rate of digestion of proteins.

Ottolenghi (1913) found that the amino-acid nitrogen content of meat was the best index of decomposition of meats. He used the amino-acid content to trace the ripening of meat to ascertain when active decomposition sets in. He found that only Sørensen's formol-titration method for determining amino-acid nitrogen and the microscopic examination for bacteria were of practical use for his purpose. Other methods were found to require too much time and elaborate manipulation.

#### METHODS.

*Determination of amino-acid nitrogen.*—It was necessary to use a method of estimating amino-acid nitrogen which did not require a complicated apparatus. The procedure had to be short, so that a large number of analyses could be made in a day. The formol-titration method is the only one that fulfills these requirements. Therefore, the amino-acid nitrogen was estimated in all cases by Sørensen's formol-titration method as modified by Benedict and Murlin.

The writer is well aware that this method is open to many objections. There are many slight errors due to the loss of diamino acids by precipitation, the high results given by some amino acids, and the low results given by others, etc. But for use as a measure of decomposition of protein a method does not need necessarily to give the exact amount of amino-acid nitrogen present in the fish or brine. If it gives results which are relative in all cases, it is sufficiently accurate for use where the results are used as an index of decomposition.

The procedure in the determination of amino-acid nitrogen in pickle was as follows: Twenty-five c. c. of brine were measured into a beaker. A quantity of 10 per cent phosphotungstic acid in 2 per cent hydrochloric acid, sufficient to precipitate all the protein, was added. This was allowed to stand overnight. The solution was then filtered and the precipitate washed. One c. c. of a 0.5 per cent solution of phenolphthalein was added and barium hydrate in substance until the solution turned a permanent red. After standing at least half an hour the solution was filtered and the precipitate washed. The solution was then neutralized with half-normal hydrochloric

acid. Enough tenth-normal sodium hydroxide was then added to turn the solution very slightly pink. Then 10 c. c. of neutral 40 per cent formalin were added and the solution titrated with tenth-normal sodium hydroxide. A blank on the formalin was run and this subtracted or added, as the case might be.

When the determination was made on the fish, the procedure was varied as follows: Sections were cut from four fish. These were cut into small pieces and mixed. Twenty-five grams of this mixture were weighed out and then ground in a mortar for 5 minutes. Twenty-five grams of salt were added, and the sample was washed out of the mortar. The sample was then made up to 250 c. c. volume and was allowed to stand on ice overnight; then sufficient was filtered off through a dry filter to obtain a 50 c. c. sample which was treated as in the case of the brine.

Before sampling the salt the residual salt was thoroughly mixed after draining off the brine. A 25-gram sample was then weighed out. After dissolving the salt in water sufficient phosphotungstic acid was added to precipitate the protein and ammonia present. From this point the procedure was the same as for the brine and fish. In every case, after precipitation with phosphotungstic acid, the supernatant liquid was tested to see if enough phosphotungstic acid had been added.

*Salting of fish.*—Great emphasis was placed on uniformity of procedure throughout this experimental work. The experiments concerning protein decomposition as affected by the impurities in salt were carried out on river herring caught in the Albemarle Sound. These fish were purchased from fishermen and were iced as soon as they were brought ashore. This was about  $1\frac{1}{2}$  hours after capture. They were then immediately cleaned thoroughly. The following procedure was followed in salting lots numbered FA-1, FA-4, FA-5, and FA-6. These results are reported in Table 5, page 32.

The heads and all viscera were removed and the fish split along the belly to the vent. They were then soaked in ice water for an hour. The under side of the backbone was scraped free from blood, and all blood was washed out. The fish were then drained free from water, weighed, and salted. The river herring were rolled in salt and packed tightly, belly up, in layers in kits. Some salt was sprinkled over each layer of fish. No brine was added; the fish developed their own pickle. When packed, a weight of salt equal to one-third the weight of the fish was added. The following day a weight of salt equal to one-twelfth the weight of the fish was added.

The salt used was either the commercial brand of salt known as Diamond Flake, or mixtures of this salt with chemically pure salts of similar degrees of fineness. Diamond Flake salt is a fine-grained salt prepared in Michigan, the analysis of which is given on page 18.

Previously, an experiment had been run to determine whether the impurities present in commercial Diamond Flake salt were of sufficient importance to cause a variation in its preservative action on fish from that of chemically pure sodium chloride taken as a standard. The result of this work showed that the differences in the amounts of amino-acid nitrogen formed in these two cases was within the limit of the experimental error.

The kits of salted fish were immediately placed in a large, constant-temperature vat capable of holding seven small kits. The kits were held at a definite constant temperature throughout the salting period. In this case the temperature of lots FA-1, FA-4, FA-5, and FA-6 was held at 79° F.

These large, constant-temperature vats were steel tanks. They were about half filled with water, which was electrically heated. A framework was built around them, and the space between the framework and the vats was filled with sawdust. They were fitted with wood covers and were also covered with paper and oilcloth. This effectually thermally insulated them. Hasselbring thermoregulators operated a relay system which regulated the operation of the heaters. A water motor drove the stirrers, which efficiently kept the vats at a uniform temperature throughout. In this experiment the temperature did not vary more than 1° F. from the average.

*Analysis of fish.*—Samples of the fresh fish were analyzed at the beginning of the experiment. It was found that uniformly cleaned, fresh alewives have practically the same amino-acid content. In the case of the well-cleaned and well-washed alewives this is about 0.02 per cent amino-acid nitrogen (fresh basis). This fact might be utilized in judging freshness of fish.

At the end of the experiment the fish, brine, and salt were weighed and sampled. The samples were analyzed for amino-acid nitrogen, according to the method described. The total weights of amino-acid nitrogen in the brine, residual salt, and fish were calculated. These were added together, and the total weight of amino-acid nitrogen contained in the fresh fish subtracted from their sum. This gave the total weight of amino-acid nitrogen formed. This figure was divided by the original weight of the fish in kilograms. The result is the weight of the amino-acid nitrogen formed per kilogram of fish.

This work is based on the supposition that the greater the decomposition of protein the greater will be the amount of amino-acid nitrogen formed, inasmuch as the chief product of autolysis is amino-acid nitrogen. Where decomposition takes place so rapidly that the chief action is bacterial, amino-acid nitrogen is also formed; but in this case it is merely an intermediate product as the end products of bacterial action are ammonia and nitrogen. In such cases ammoniacal nitrogen ought also to be determined. The experimenter was always limited by lack of time and facilities for elaborate chemical work. This is inevitable unless the investigator has the use of a complete chemical laboratory close to a large continuous supply of fresh fish and has the help of a corps of assistants.

As long as there was but little spoilage of fish in the experiment, the results of the amino-acid determinations from different lots salted under identical conditions checked excellently. But when the spoilage was great enough to cause the formation of foul-smelling gases and was quite evidently of a bacterial nature the amounts of amino-acid formed did not show what was anticipated. Surely, in such cases the ammoniacal nitrogen ought to have been determined.

The results of the analyses and calculations are given in Table 5.

TABLE 5.—EFFECT OF CALCIUM CHLORIDE AND MAGNESIUM CHLORIDE IN SALT ON RATE OF AMINO-ACID FORMATION IN SALTED FISH.<sup>a</sup>

[Lots D refer to samples dry-salted, and lots S to those brine-salted.]

Lot No.	Method of cleaning.	Analysis of salt.	Weight of salt and brine used.	Salting period.		Weight of fresh fish.	Amino-acid nitrogen in fresh fish.	
				Average temperature.	Length.		Per ct.	Grams.
FA-1:D.....	Heads removed; eviscerated; well washed.	<i>Per cent.</i> 5.0 calcium chloride; 0.37 calcium sulphate; 94.78 sodium chloride.	Kgs. c1.66	° F. 79	Days. 7	Grams. 4,000	Per ct. 0.02	Grams. 0.80
FA-4:D.....	do.....	5.0 magnesium chloride; 0.37 calcium sulphate; 94.78 sodium chloride.	c1.25	79	7	3,000	.02	.60
FA-5:D.....	do.....	99.78 sodium chloride, Diamond Flake.	c1.25	79	7	3,000	.02	.60
FA-6:D.....	do.....	do.....	c1.25	79	7	3,000	.02	.60
DA-8:S.....	Heads removed; eviscerated with exception of milk and roe.	do.....	b6, c1	75	9	5,000	.022	1.10
DA-9:S.....	do.....	94.78 sodium chloride; 5.0 sodium sulphate; 0.37 calcium sulphate.	b6, c1	75	9	5,000	.022	1.10

Lot No.	Total amino-acid nitrogen at end in—				Amino-acid nitrogen formed.		Physical condition of salted fish.
	Fish.	Brine.	Salt.	Fish, brine, and salt.	Total.	Per kilogram fresh fish.	
	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	
FA-1:D.....	2.20	0.53	0.07	2.80	2.00	0.500	Good; hard; whitened.
FA-4:D.....	1.17	.52	.05	1.74	1.14	.380	Do.
FA-5:D.....	1.00	.50	.07	1.57	.97	.323	Good; hard; yellow-white.
FA-6:D.....	1.07	.48	.06	1.61	1.01	.336	Do.
DA-8:S.....	2.46	2.09	None.	4.55	3.45	.69	Contained 2 bad fish; total number, 25.
DA-9:S.....	2.82	1.97	None.	4.79	3.69	.74	Contained 3 bad fish; total number, 25.

<sup>a</sup> The fish in this experiment were salted four hours after capture.<sup>b</sup> Brine.<sup>c</sup> Salt.

## DISCUSSION.

*Effect of calcium and magnesium salts.*—It should be noted that the amounts of impurities, calcium, magnesium, and sodium sulphate that were added are great. The combined amounts of calcium and magnesium salts occurring in commercial salts is seldom over 4 per cent. The analyses given on pages 18 and 19 show the composition of various commercial salts.

More amino-acid nitrogen was formed in lot FA-1 than in lots FA-4, FA-5, or FA-6. Lots DA-8 and DA-9 were cleaned in a different manner and were salted in brine instead of dry salt; so these results are not comparable with the results of the lots numbered FA.

Lot FA-1 was salted with salt containing calcium chloride as impurity. This increase in the amount of amino-acid nitrogen formed was about 50 per cent over the weight of amino-acid nitrogen formed when pure salt was used. In other words, there was a half more decomposition of the protein when the salt contained 5 per cent of the calcium chloride than when no calcium chloride was present. Five per cent of calcium chloride is only the equivalent of 1.8 per cent of calcium. This is a greater amount than was contained in any whose analyses are given in the tables of salt analyses.

Salt sample number MD 16102 contained 1.33 per cent calcium. However, it will be noted that the total impurity amounted to 7.3 per cent. Lot FA-4 was salted with salt containing 5 per cent of magnesium chloride. In this case 0.380 gram of amino-acid nitrogen was formed during the salting period. This is 15 per cent more than when pure salt was used (FA-5, FA-6). However, 5 per cent of magnesium chloride is 1.28 per cent of magnesium, which is double the amount of magnesium likely to be found in any commercial salt.

If the salt analyses given previously are consulted, it will be seen that the Trapani salt sample is the only one that contains a very large amount of magnesium and that this amount is less than 3 per cent of total magnesium salts. It seems unlikely, therefore, that the amounts of magnesium salts contained in commercial salts have any appreciable deleterious effect on the fish-curing properties of any salt.

*Effect of sodium sulphate.*—Samples DA-8 and DA-9 were prepared for salting by cutting off the heads and cutting the length of the abdominal cavity. All viscera were removed with the exception of the milt or roe. As the milt and roe were left in the fish, it was impossible to wash the fish thoroughly, or to remove all the blood. For this reason the maximum temperature of salting was greatly lowered, even though all other conditions were identical. These fish were salted in brine. For every gram of fish taken 1 c. c. of brine was used. At the time of salting a considerable excess of solid salt was added. From time to time more solid salt was added. The fish were stirred daily. Sufficient salt was added to keep the pickle saturated at all times. The amount of salt required for this purpose was about one-fifth of a gram of salt for every gram of fish.

The samples were taken at the end of the salting period. They were analyzed, and the calculations were made in the manner previously described. Lot DA-8 was salted with nearly pure salt. The salt used in lot DA-9 contained 5 per cent sodium sulphate as impurity. These lots were salted just above the maximum temperature for fish cleaned in this way (containing roe, milt, and blood). Any differences in the preserving or penetrating powers of the salts used should show up very noticeably under these conditions. Yet there is only a difference of 7 per cent in the amount of amino-acid nitrogen formed. There is a little more decomposition in the case of the salt containing the sodium sulphate, but the difference is slight. There is usually not more than 2 per cent of sulphates contained in commercial salts. Had the amount of sodium sulphate been reduced to 2 per cent it is likely that the difference between the preservative power of the impure salt and the pure salt would have hardly been noticeable.

These results concerning the rate of formation of amino-acid nitrogen check with those on the penetration of chlorides; that is, where there was a slowing up in the rate of penetration of chlorides, there is an increase in the rate of amino-acid formation. The changes are approximately the same, except in the case of the effect of the sulphates. The results obtained from the work on rate of penetration of salt adulterated with sodium sulphate show a marked decrease in the rate of penetration, due to the impurity. The increase in rate of production of amino acids due to the presence of this impurity is very slight. However, the work on the rate of penetration was done with salts containing 10 per cent of sodium sulphate. It may be that this marked retardation takes place only at high concentrations of sodium sulphate, when there is a marked hardening of the tissues.

#### DISCUSSION.

##### PHYSICAL EFFECTS ON FISH.

This work on the preservative action of different salts was done on alewives, whereas the penetration of salts were followed in squeteagues. The hardening and whitening action of calcium and magnesium salts was marked on alewives; but it was less noticeable than in the case of squeteagues. Five per cent of sodium sulphate had practically no whitening action on alewives and very little hardening action. It may be that 10 per cent of sodium sulphate in salt is required to bring out the whitening power. No lot of alewives was salted with salt containing more than 5 per cent of sodium sulphate.

##### A POSSIBLE EXPLANATION OF RESULTS.

The writer believes that the hardening action of calcium and magnesium salts on the tissues of the fish is responsible for the retardation of the penetration of the chlorides. This, in turn, is at least partially responsible for the lesser preservative action of the impure salts. Sodium sulphate evidently acts only when in greater concentrations than it is ordinarily found in commercial salts. Its deleterious action as an impurity is, therefore, not to be feared.

##### PRACTICAL APPLICATION.

When fish are salted at any temperature averaging below 50° F., salts may be chosen that will produce the desired quality of salted fish. When a hard, white fish is desired, salts high in calcium and magnesium salts may wisely be chosen. However, if a soft, pliable fish is desired, pure salts should be used.

When the average temperature of salting is above 50° F., greater care should be used in the selection of salt. This becomes of particular importance when the fish are salted, either round or containing blood, roe, or milt, as these fish are much more likely to spoil than when they are thoroughly cleaned. In this case the smaller the amounts of calcium and magnesium salts present the more desirable the salt. Fish salters working in warm climates should strive to obtain salt containing less than 1 per cent of total calcium and magnesium salts. Sulphates are never present in large enough quantities to lower the effectiveness of the salt as a preservative.

## EFFECT OF FINENESS OF SALT.

The writer considered the fineness of salt as of little importance, save in a physical way. Inasmuch as his time was limited, he conducted no experiments to determine the optimum degree of fineness of salt for use in fish salting. This factor is entirely eliminated when fish are salted by the brine method. When small fish are salted with dry salt, care must be taken not to use too coarse a salt, such as Turks Island. When such a coarse salt is used, great difficulty will be encountered in obtaining a uniform distribution of the salt throughout the barrel or butt of fish. Nearly all of the salt used will be on the outside of the fish. If, however, fine salt be used, a considerable portion of the salt will be inside the abdominal cavity. This abdominal cavity usually is quite moist; so almost immediately a strong pickle will be formed which will begin to penetrate the fish. Fine salt certainly has the advantage of being easier to distribute evenly throughout a container of fish regardless of the size of the fish. However, in the case of cod and other large fish fine salt gives the fish a somewhat different appearance. In such cases, when the weather is cold, appearance should be the first consideration. If such large fish are salted in warm, southern climates, less consideration can be given to the appearance of the product. In such climates the first considerations must be the composition of the salt and its uniform distribution throughout the container of fish.

## SUMMARY.

Calcium and magnesium salts and various sulphates cause a retardation of the penetration of salt into fish. These salts also cause a less perfect preservation of the fish during salting. This was shown by increased amounts of amino acids formed during the salting period. Calcium is most powerful in this regard. Magnesium salts cause a considerable increase in the rate of decomposition during salting, other conditions being the same. But this effect is not nearly so great as that caused by calcium salts. Sulphates do not cause an appreciable increase in the rate of decomposition at the concentrations at which they are present in salt. The fish salter working under adverse conditions in warm climates should use care in the selection of his salts and choose salts that are low in calcium and magnesium.

## II. A COMPARISON OF EFFICIENCY OF BRINE AND DRY SALT FOR SALTING FISH.

## INTRODUCTION.

At present fish are salted either by the use of dry salt or brine and salt. Before improvements in either method could be suggested it was considered essential to know the relative merits of the two methods at various temperatures. The work presented in this section of this paper was undertaken, therefore, with that aim in view.

The dry-salt method involves the packing of fish with salt in a water-tight container. The water and body juices of the fish dissolve sufficient salt to make enough "pickle" to cover the fish. A small pile of salt is usually placed on top of the container to press

down the fish and keep them covered. The fish are not disturbed until the end of the salting period.

In the brine method of salting fish the procedure is as follows: Fish are dumped into a vat containing enough brine nearly to cover them, and a considerable quantity of salt is added along with the fish. Each day more salt is added, and the fish are stirred in the "pickle." The purpose of adding the salt is to maintain the brine as near saturation as possible.

In these experiments these two methods were given a trial. The commercial methods were imitated as closely as possible in order to fairly compare the methods.

#### DETERMINATION OF RATES OF PROTEIN DECOMPOSITION.

##### METHOD.

Ninety pounds of reasonably fresh squeteague (*Cynoscion regalis*) were obtained. The fish had been caught two days previously and had been kept on ice. There were 120 fish in all, making the average weight three-fourths of a pound. They were cut down the belly and eviscerated. The tails and heads were cut off, and the fish were washed in ice water.

After cleaning there remained 23.4 kg. of fish. These were divided into 12 lots. Six lots of 1.3 kg. each and six other lots containing 2.6 kg. each were weighed out. To each of the smaller lots were added 1,300 c. c. of saturated sodium chloride solution and 250 grams of pure, dry sodium chloride. The fish of the larger lots were rubbed in chemically pure dry salt and then packed in glass dishes, cut surface down, and sodium chloride was sprinkled over each layer. The 2.6 kg. of fish just made two layers; 990 grams of salt were used in this way on each lot. The salt used in this experiment was chemically pure "Baker's analyzed" sodium chloride. This salt is a little smaller grained than "ground alum."

One of each of the lots of fish was then placed in a different constant-temperature compartment. The fish were permitted to remain in this constant-temperature apparatus for nine days. The brine-salted lots of fish were stirred daily. The temperature in any one compartment did not vary more than 1° F. from the average. The brines were sampled and analyzed for amino-acid nitrogen on the first, third, fifth, seventh, and ninth days. At the end of the experiment the fish and salt were also analyzed for amino-acid nitrogen. In the case of fish to which the brine had been added not more than 25 grams of salt remained undissolved. The amount of amino-acid nitrogen in this small amount of salt was considered negligible. In all cases, however, there was an excess of undissolved salt at the end of the salting period.

The method of sampling the fish, brine, and salt was described in the first section of this paper. The method of analysis of the samples for amino-acid nitrogen was the formol-titration method, which was described on page 29.

##### DISCUSSION.

Table 6 shows the titration values obtained by the formol titration for amino acids of 25 c. c. of the brines. These figures are given

to show the rate at which the amino acid diffuses out into the brine. They also point out a means of forecasting spoilage of fish.

TABLE 6.—INCREASE IN AMINO-ACID CONTENT OF BRINES.

[Figures refer to c. c. N/10 NaOH amino acid contained in 25 c. c. of brine: Lots D refer to samples dry salted; lots S, to those brine salted.]

Lot.	Brine collected after—					Temperature.
	19 hours.	67 hours.	5 days.	7 days.	9 days.	
	C. c.	C. c.	C. c.	C. c.	C. c.	
2D.....	4.7	5.0	5.1	5.1	6.5	° F.
2S.....	1.3	2.0	2.1	2.7	3.4	63
3D.....	4.7	4.9	5.6	5.4	7.1	63
3S.....	1.4	2.4	2.3	2.7	4.2	70
4D.....	4.4	5.2	5.7	5.9	7.6	70
4S.....	1.4	2.6	2.5	2.7	4.4	75.5
5D.....	4.4	5.1	7.0	7.6	8.5	80
5S.....	1.2	2.7	3.0	4.2	a 5.3	80
6D.....	4.1	4.8	8.7	a 9.6	a 10.1	87
6S.....	1.3	3.4	3.7	a 5.2	a 7.2	87
7D.....	4.4	7.2	a 10.3	a 13.0	a 16.0	93
7S.....	1.1	3.4	a 4.6	a 6.6	a 9.5	93

a Spoilage of fish noted.

Apparently the water contained in the fish diffuses out more rapidly in the case of the dry-salted fish. Above 86° F. sufficient brine to cover the fish was formed from the dry salt in 15 hours. About 30 hours were required for the lots at 70 and 63° F. to form enough brine to cover all the fish. The lots at 75.5 and 80° F. formed sufficient brine to cover the fish in somewhat less time. The gradual increase in the amino-acid content of the brines of the brine-salted fish (S) was probably due to the slow diffusion out of the water containing the amino acids dissolved in it. The immediate rise of the amino-acid titration value to about 4.5 c. c. in the dry-salt method was probably due to the rapid movement outward of the water in the fish.

When the amino-acid titration values rose above 9 c. c. in the dry-salted lots, the fish (D) were found to be spoiled. This was observed in five days at 93° F. and in seven days at 87° F. The lot at 80° F. did not spoil in this case.

In the case of those fish salted in brine (S) when the formol-titration value rose to 5 c. c. N/10 alkali, the fish were observed to be spoiled. This was noted at five days for those at 93° F.; at seven days for those at 87° F.; and at nine days for those at 80° F.

TABLE 7.—VOLUMES OF BRINE FORMED DURING SALTING.

[Lots D refer to samples dry salted; lots S, to those brine salted.]

Lot.	Weight of fish.	Volume.	Lot.	Weight of fish.	Volume.
2D.....	Kg. 2.6	C. c. 770	5D.....	Kg. 2.6	C. c. 780
2S.....	1.3	1,580	5S.....	1.3	1,625
3D.....	2.6	815	6D.....	2.6	850
3S.....	1.3	1,610	6S.....	1.3	1,670
4D.....	2.6	820	7D.....	2.6	680
4S.....	1.3	1,670	7S.....	1.3	1,620

The figures in Table 6, together with the volumes of the brine given in Table 7, were used to calculate the total amounts of amino-acid nitrogen formed in the brines. These figures are given in Table 8.

TABLE 8.—TOTAL AMOUNT OF AMINO-ACID NITROGEN FORMED IN BRINES.

[Lots D refer to samples dry salted; lots S, to those brine salted.]

Lot.	Total amount amino nitrogen after—					Temperature.
	19 hours.	67 hours.	5 days.	7 days.	9 days.	
	Grams.	Grams.	Grams.	Grams.	Grams.	° F.
2D.....	0.203	0.215	0.220	0.220	0.311	63
2S.....	.115	.168	.176	.238	.304	63
3D.....	.217	.224	.254	.250	.328	70
3S.....	.130	.215	.205	.247	.380	70
4D.....	.201	.238	.259	.270	.349	75.5
4S.....	.133	.242	.233	.298	.412	75.5
5D.....	.192	.222	.310	.367	.412	80
5S.....	.112	.246	.273	.392	.498	80
6D.....	.197	.230	.414	.565	.532	87
6S.....	.126	.317	.345	.488	.677	87
7D.....	.168	.273	.332	.459	.614	93
7S.....	.104	.310	.417	.602	.867	93

In order to make the figures in Table 8 comparable, the total amounts of amino-acid nitrogen formed were divided by the weights of fish salted in the different lots. These figures are presented in Table 9.

TABLE 9.—AMOUNT OF AMINO-ACID NITROGEN FORMED IN BRINE PER KILOGRAM OF FISH.

[Lots D refer to samples dry salted; lots S, to those brine salted.]

Lot.	Amino-acid nitrogen per kilogram of fish after—					Temperature.
	19 hours.	67 hours.	5 days.	7 days.	9 days.	
	Grams.	Grams.	Grams.	Grams.	Grams.	° F.
2D.....	0.078	0.083	0.085	0.085	0.119	63
2S.....	.089	.129	.135	.183	.234	63
3D.....	.084	.086	.098	.097	.126	70
3S.....	.100	.165	.158	.190	.292	70
4D.....	.077	.092	.099	.104	.134	75.5
4S.....	.102	.186	.179	.228	.316	75.5
5D.....	.074	.086	.119	.141	.158	80
5S.....	.086	.189	.210	.300	.383	80
6D.....	.076	.089	.159	.195	.208	87
6S.....	.097	.244	.265	.377	.510	87
7D.....	.065	.105	.151	.193	.236	93
7S.....	.080	.238	.320	.465	.666	93

At the end of the experiment samples from each lot were cooked. All the fish salted at 87 and 93° F. were spoiled. About 20 per cent of the fish salted in brine at 80° F. were spoiled. None of the fish salted by the dry-salt method at this temperature (80° F.) were spoiled. Fish salted with dry salt at 80° F. were eaten both by Prof. B. P. Livingston and the writer and were pronounced satisfactory. All fish salted at lower temperatures were in good condition. The results of the cooking trials check with the amount of decomposition, as shown by the total amount of amino acids formed in Table 10.

A composite sample of the fresh squeteague gave on analysis 0.022 per cent amino-acid nitrogen. This figure was found to be fairly constant for squeteagues but was higher when the samples had been iced for a long period.

In Table 10 the various amounts of amino-acid nitrogen formed in the brine, fish, and salt are given; also the total amino-acid nitrogen formed and the total amount of amino-acid nitrogen formed per kilogram of fish is given.

TABLE 10.—TOTAL AMINO-ACID NITROGEN FORMED DURING SALTING PERIOD.<sup>a</sup>

[Lots D refer to samples dry salted; lots S, to those brine salted.]

Lot.	Amount of salt used.	Amount of brine used.	Average temperature of salting period.	Weight of fresh fish.	Amino-acid nitrogen in fresh fish.	
	Grams.	C. c.	° F.	Grams.	Pcr cent.	Grams.
2)D.....	990		63	2,600	0.022	0.572
2)S.....	250	1,300	63	1,300	.022	.286
3)D.....	990		70	2,600	.022	.572
3)S.....	250	1,300	70	1,300	.022	.286
4)D.....	990		75.5	2,600	.022	.572
4)S.....	250	1,300	75.5	1,300	.022	.286
5)D.....	990		80	2,600	.022	.572
5)S.....	250	1,300	80	1,300	.022	.286
6)D.....	990		87	2,600	.022	.512
6)S.....	250	1,300	87	1,300	.022	.286
7)D.....	990		93	2,600	.022	.572
7)S.....	250	1,300	93	1,300	.022	.286

Lot.	Total amino-acid nitrogen at end in—				Amino-acid nitrogen formed.			Physical condition of salted fish.
	Fish.	Brine.	Salt.	Fish, brine, and salt.	Total.	Per kilogram fresh fish.	Increase over dry-salt method.	
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Per cent.	
2)D.....	0.660	0.311	0.056	1.027	0.455	0.175		Good.
2)S.....	.333	.304	.000	.637	.351	.270	54	Do.
3)D.....	.675	.328	.065	1.068	.496	.190		Do.
3)S.....	.285	.380	.000	.665	.379	.292	54	Do.
4)D.....	.783	.349	.053	1.185	.613	.236		Fair.
4)S.....	.332	.412	.000	.744	.458	.352	49	Do.
5)D.....	b. 934	.412	.078	1.424	.854	.328		Do.
5)S.....	b. 451	.498	.000	.949	.663	.510	55	Spoiled.
6)D.....	b1. 276	.532	.068	1.896	1.324	.510		Do.
6)S.....	b. 594	.677	.000	1.271	.985	.756	48	Do.
7)D.....	b1. 492	.614	.096	2.202	1.630	.628		Do.
7)S.....	b. 610	.867	.000	1.477	1.191	.916	45	Do.

<sup>a</sup> In this experiment the fish were cleaned after two days' icing by removing the heads, eviscerating, and washing carefully, and were salted for nine days.

<sup>b</sup> Number is slightly high because of the accidental discard of the sample by one of the writer's coworkers. The result given is from sample taken three days after the fish had been removed from the constant-temperature compartments. The fish were kept at 64.5° F. during those three days. However, any slight error would be the same for all samples.

These figures show that the total amounts of amino-acid nitrogen formed are much greater in the case of the brine-salted fish. The increase varies from 48 to 55 per cent. This seems to prove that

the brine-salt method is not as efficient in preserving fish as the dry-salt method.

The writer wishes to point out the value of the amino-acid content of fish and brine as a criterion in estimating and detecting spoilage. Any two lots of the same fish may be compared and their relative freshness determined. This may be used for either fresh or salted fish. If the fish have been salted by the same process, this may be done quite easily by determining amino-acid nitrogen in the brines.

It also seems probable that the increase in amino-acid content could be used to forecast spoilage of fish during the salting period. A rapid rise in the amino-acid content of the brine would warn the salter that his fish were in danger of spoiling, and the salter could remove them to cold storage or use stronger brine.

#### RATE OF PENETRATION OF SALT.

In addition to following the formation of amino-acid nitrogen in fish salted by these two ways, the rate of penetration of chlorides into squeteagues was followed. This was accomplished in the same manner as the determination of the rates of penetration of different salts described on page 22.

#### METHOD.

The general procedure in these experiments was as follows: Fish of a uniform size (3.5 cm. thickness) were salted with pure sodium chloride by the two methods described on page 36. These two jars of fish were placed in a constant-temperature compartment and sampled at the end of 1, 4, 7, and 10 days. The temperature of the fish did not vary more than 1.44° from the average of 69.44° F. The samples were dried and ashed and the chlorine determined by titration with a silver-nitrate solution. The results are given in Table 11.

TABLE 11.—PENETRATION OF SALT INTO SQUETEAGUE, EXPRESSED IN TERMS OF PER CENT OF CHLORINE IN DRY SAMPLE, AT 70° F.

Method of salting.	Section of fish.	Per cent chlorine after—			
		1 day.	4 days.	7 days.	10 days.
Dry salted.....	Outer <i>a</i> .....	9.8	16.2	19.6	19.5
Do.....	Inner <i>b</i> .....	2.6	11.0	16.0	18.7
Brine salted.....	Outer <i>a</i> .....	8.4	15.3	17.3	17.8
Do.....	Inner <i>b</i> .....	1.8	8.3	12.2	15.7

*a* 0 to  $\frac{1}{2}$  cm.

*b*  $\frac{1}{2}$  to 1 cm.

#### DISCUSSION.

The percentage of salt in both sections is higher throughout in the case of the dry-salted fish than in the brine-salted fish. This shows that the salt penetrated more rapidly in the case of the dry-salt method. More data could be given which verify the results of this experiment.

This work agrees with the results obtained by the estimation of the rate of amino-acid formation. For, when the salt penetrates

more rapidly, as in the case of the dry-salt method, less amino acids are formed than when the salt penetrates more slowly. However, the retardation of the rate of penetration is less marked. This suggests the possibility that small differences in salt content of fish may be responsible for much greater differences in the rate of decomposition of the fish.

Figure 5 illustrates graphically the data given in Table 11. It should be noted that the difference in chlorine content gradually increases.

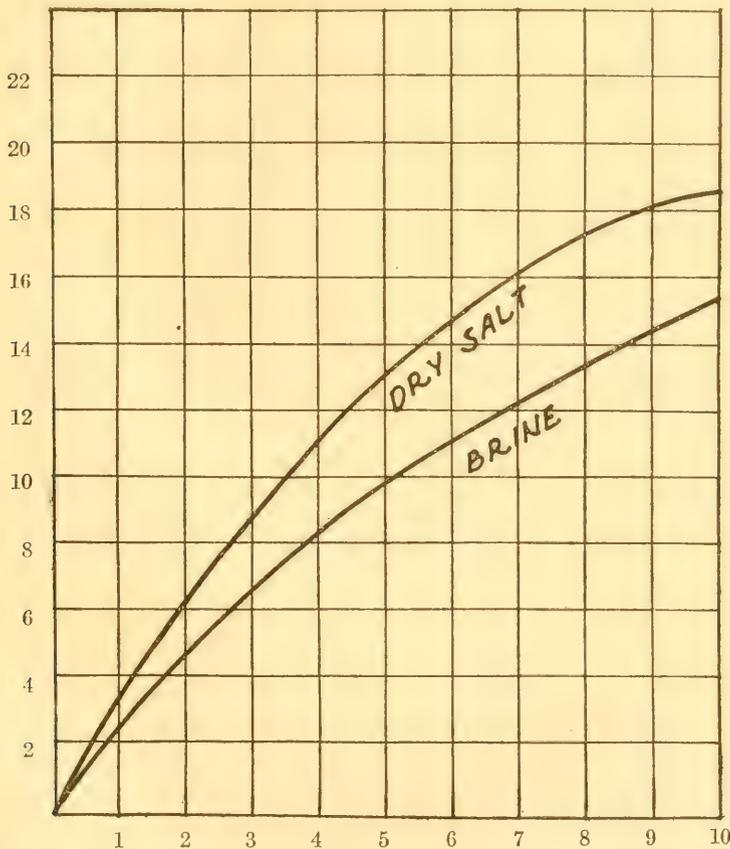


FIG. 5.—Curves show comparative rates of penetration of salt into fish when dry salted and when brine salted (section one-half to 1 cm. depth). Figures at left indicate per cent of chlorine in dry fish; at bottom, time in days.

#### DISCUSSION.

##### PHYSICAL DIFFERENCES BETWEEN THE PRODUCTS OF THE TWO METHODS.

Dry-salted fish are invariably harder than brine-salted fish. This is probably due to the difference in moisture content. Brine-salted fish are about 7 per cent higher in moisture than dry-salted fish at the end of a salting period of 10 days. Dealers who "tight pack" their fish state that dry-salted fish require very little draining, whereas the brine-salted fish must be drained and dried for at least four days.

Dry-salted fish have a shriveled appearance, due to their drier condition. They are also brighter in appearance, as a less number of scales have been knocked off.

#### HYPOTHESIS TO ACCOUNT FOR RESULTS.

There are three important means of preserving foodstuffs, namely: 1. By destruction of bacteria and enzymes, which is accomplished by sterilization with heat. 2. By desiccation, or removal of water; bacteria do not thrive, nor are enzymes active in the absence of water. 3. By the addition of a preservative, which inhibits the growth of bacteria and the action of enzymes.

When fish are preserved by salting, we make use of the two last-mentioned means of preservation. The salt not only penetrates the fish but also dissolves and removes water. In some way dry salt removed more water from fish than brine. In the case of the dry-salt method the salt content of the fish is greater. The lesser decomposition taking place during dry salting than during brine salting is evidently due to these two facts.

It is not clearly understood just why the salt penetrates more rapidly when the dry-salt method is used. After stirring a vat of fish which are being brine-salted, the concentration of the upper layers of pickle immediately begins to decrease. It decreases most rapidly just after the fish are put in. In large vats of fish, the pickle sometimes becomes as weak as 60° (60 per cent saturation), even though there may be solid salt in the vat. Of course, this diluted brine is not so active as saturated brine. Also, it may happen that, although the pickle appears saturated according to the hydrometer reading, that in contact with the fish is not saturated, for water continually comes out of the fish and dilutes the brine in the vicinity of the fish. It would be well to try an experiment comparing the brine-salting method with the dry-salt method and have both brines stirred continually. The writer believes that both methods would show up equally well in such a test.

#### DRY-SALT METHOD MORE ECONOMICAL.

The dry-salt method involves a little more work at the beginning of the salting period; for more labor is involved in thoroughly distributing the salt throughout a large quantity of fish than is required to make up a brine and put the fish and salt into it. But after packing the fish into butts with dry salt, no further labor is required; whereas, brine-salted fish must be "roused" (stirred up), and salt must be added every day during the salting period. "Rousing" is an operation that requires considerable time and labor, and since the fish must be roused eight or nine times, the total labor expended in this process is large. There is no reason, therefore, for the brining of fish in order to save labor, as in the long run this process is not economical in respect to labor.

At present the used pickle from both processes is thrown away. It is the custom to save the surplus salt used in the dry-salt method. A great deal more pickle is left at the end in the brine method. This involves a greater loss of salt, when it is discarded, than when the smaller amount of dry-salt pickle is thrown away. The dry-salt

method is, therefore, more economical in regard to salt, as well as to labor.

#### SUMMARY.

1. The formation of amino-acid nitrogen was followed in the brine during the salting of fish by two methods—salting by use of dry salts and salting by use of brine.

2. The total amount of amino-acid nitrogen formed during salting was calculated.

3. More amino acid was formed by the brine method of salting.

4. The estimation of the amino-acid nitrogen content of fish and brine was suggested as a means of detecting and also forecasting spoilage.

5. The rate of penetration of salt into the squeteague when salted with dry salt and when salted with brine was determined. Salt applied dry goes into the fish more rapidly.

6. Samples of the fish salted by the two methods under consideration were cooked. It was found that all of the fish salted with dry salt at 80° F. were edible. Those salted with brine were unfit for consumption.

7. The dry-salt method was found to be more economical both of labor and salt.

These results show that the dry-salt method of salting fish, as practiced commercially, is much more efficient in preserving fish than the brine method. The dry-salt method is also the more economical of the two.

### III. INFLUENCE OF METHOD OF CLEANING FISH FOR SALTING.

#### INTRODUCTION.

##### IMPORTANCE OF METHOD OF CLEANING.

It has always been known that the method of cleaning a fish preparatory for salting has an important influence on the quality of the product. From the first the writer noted that the salt penetrated more rapidly through the cut flesh of fish than through a surface covered with skin. This was first noticed while following the penetration into the fish of salt containing calcium chloride. The calcium chloride produced a marked whitening of the tissue. This was observed to proceed more rapidly on the cut side of the fish than on the side covered with skin.

The common practice in rating the quality of a salted herring or alewife is to break the fish open so that the backbone is exposed. The odor of the dark red or brown spots is then observed. The experienced fish salter knows that these spots are the first parts of the fish to spoil. They are caused by the coagulation and partial decomposition of the blood. Most fish salters seem to realize that the blood is the most unstable substance contained in fish, for they rate the efficiency of different procedures in fish salting by the amount of blood that the processes "draw out." They are well aware of the fact that round fish can not be salted at as high a temperature as cut fish. Numerous fishermen have advised the writer that very little

trouble would be encountered in salting any fish if care would be taken to scrape the blood away from the backbone and then wash all the blood out of the fish.

These and other similar observations showed the importance of the mode of cleaning as a factor in fish salting. A series of experiments was, therefore, carried out for the purpose of learning which method of preparing fish for salting was the best.

#### COMMERCIAL METHODS OF CLEANING.

*Uncut fish.*—Large quantities of herring and alewives are annually salted round, or without cutting. Some of these are washed, but other fish salters do not wash their round fish.

*Pipping.*—When herring are salted by the Scotch method, they are pipped or gibbed. This involves the cutting of the fish at the throat so that the gills and viscera are all removed, with the exception of the milt and roe. The head is not cut off. When fish are cut in this way it is difficult to remove the blood contained in the abdominal cavity.

*Beheading.*—"Headless roe" fish are prepared by partially cutting off the head of a roe fish, usually river herring; then the head is pulled off in such a way that the viscera, with the exception of the roe, are pulled out. Little blood may be washed out from fish cleaned in this manner. In some cases this procedure is altered by cutting the fish down the belly in addition to beheading.

*Cutting.*—The greater proportion of the river herring are salted after the heads and bellies have been cut off. In most cases this is done by the cutter in one operation.

*Cutting and scraping.*—In some vicinities small quantities of river herring are salted after being cleaned perfectly. The heads and bellies are cut off, and then the abdominal cavity is scraped until all the blood under the backbone and all the membranes are removed. Fish cleaned in this way are usually consumed locally.

*Splitting.*—Larger fish, such as the mackerel, cod, haddock, cusk, and the like, are usually eviscerated and split. This is considered essential for proper salting.

#### EFFECT OF CLEANING ON PROTEIN DECOMPOSITION.

##### METHOD.

The work on cleaning was done on the river herring. Two hundred and fifty pounds of river herring were purchased from a local Albemarle Sound fisherman. These fish were iced as soon as they were received from the boat, which was about two hours after their capture. The fish were divided into 8 lots: 2 lots of 1,000 grams each were salted round; 2 other lots were pipped; 2 lots were cleaned by cutting off the heads, cutting the fish the length of the belly, and removing the entrails, with the exception of the milt and roe; and 2 lots were cleaned by cutting and scraping. The heads and viscera were removed, including the milt and roe. These fish were then washed, and blood and membranes were scraped out of the abdominal cavity. Great care was taken in this case to remove all visible

blood, including that underneath the backbone. All the lots were then weighed out. Exactly 1,000 grams of cleaned fish were taken in each case. They were salted in dry Diamond Flake salt, which is a fine, pure, granulated salt. Three and a third kilograms of salt were used on each lot during the first packing. The following day 833 grams of salt were added to each lot of fish.

One lot cleaned in each way was placed in each of two constant-temperature compartments, which have been previously described. One of these constant-temperature compartments was regulated for 79° F. The other was set for 88° F. Both these temperatures, it will be noted, are very high for salting fish. The results of these experiments are given in Table 12.

TABLE 12.—DEVELOPMENT OF AMINO-ACID NITROGEN IN FISH CLEANED IN VARIOUS WAYS.<sup>a</sup>

Experiment No.	Method of cleaning.				Average temperature of salting period.	Weight of fresh fish.	Amino-acid nitrogen in fresh fish (4 hours).	
					° F.	Grams.	Per cent.	Grams.
BA-1.....	No cleaning; salted round.....				79	1,000	0.029	2.90
BA-2.....	Pipped.....				79	1,000	.027	2.70
BA-3.....	Head cut off; abdominal cavity split open; viscera removed, with exception of milt and roe.				79	1,000	.022	2.20
BA-4.....	Cleaned perfectly; milt and roe removed..				79	1,000	.020	2.00
BA-5.....	No cleaning; salted round.....				88	1,000	.029	2.90
BA-6.....	Pipped.....				88	1,000	.027	2.70
BA-7.....	Head cut off; abdominal cavity split open; viscera removed, with exception of milt and roe.				88	1,000	.022	2.20
BA-8.....	Cleaned perfectly; milt and roe removed...				88	1,000	.020	2.00

Experiment No.	Total amino-acid nitrogen at end in—				Amino-acid nitrogen formed.		Physical condition of fish.
	Fish.	Brine.	Salt.	Fish, brine, and salt.	Total.	Per kilogram fresh fish.	
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	
BA-1.....	7.88	2.52	0.22	10.62	7.72	0.77	Badly spoiled; bloated.
BA-2.....	6.66	2.09	.29	9.04	6.34	.63	Spoiled.
BA-3.....	6.80	2.06	.19	9.05	6.85	.68	Do.
BA-4.....	3.83	1.70	.13	5.66	3.66	.37	Excellent condition.
BA-5.....	10.70	3.08	.35	14.13	11.23	1.12	Badly spoiled; bloated.
BA-6.....	7.75	2.40	.20	10.35	7.65	.76	Badly spoiled.
BA-7.....	7.72	2.45	.22	10.39	8.19	.82	Do.
BA-8.....	4.60	1.95	.14	6.69	4.69	.47	Excellent condition.

<sup>a</sup> In this experiment the fish were dry salted for nine days, four hours after capture, with 4.166 kilograms of Diamond Flake salt (99.78 per cent NaCl).

#### DISCUSSION.

The remarkable thing about this experiment is that all the fish salted were entirely spoiled except those cleaned perfectly. Even the lot of perfectly cleaned fish which was salted at a temperature of 88° F. throughout the salting period was found to be in perfect condition at the end. These fish were cooked and sampled by six persons. All pronounced them to be far superior to the commercial salt-fish product. One critic went so far as to say that they were on a par with the fresh river herring.

The results of the chemical analyses for amino-acid nitrogen in the various samples verifies these observations. Both perfectly cleaned

lots ran very low in amino acids. This shows definitely that there was very little protein decomposition.

The results given in Table 12 show that round fish spoil very easily when salted. This is a very poor way to salt fish unless the weather is very cold. On comparing BA-2 with BA-3, and BA-6 with BA-7, the writer is forced to the conclusion that it makes very little difference whether the fish are cut the length of the belly or not. It may be that those cut open, BA-3 and BA-7, were infected with bacteria during the process. At these high temperatures bacteria seem to thrive even in the presence of the salt. This was evidenced by the bloating of all the round fish, due to the accumulation of gas in the belly. This also took place in some of the pipped fish.

The writer wishes to point out that the only difference between lots BA-3 and BA-4 and between lots BA-7 and BA-8 was that BA-3 and BA-7 contained milt, roe, and blood. These substances were, then, alone responsible for the spoilage. No other factor could be the cause, as the procedure in handling was the same in every respect. The question then arises as to which caused the spoilage—the blood, roe, or milt.

Previously a similar experiment had been attempted, except that the work was carried out in a commercial plant and was merely qualitative. This experiment was not quite so successful, for at a lower temperature, 80° F., some of the fish spoiled. However, the majority were in excellent condition. Upon examination, the spoiled fish revealed that the work of removal of blood before salting had been carelessly done, for blood was found under the backbone, above the vent, in every spoiled fish. None of the good fish showed traces of blood. Unfortunately, no attempt was made to salt milt and roe at high tem-

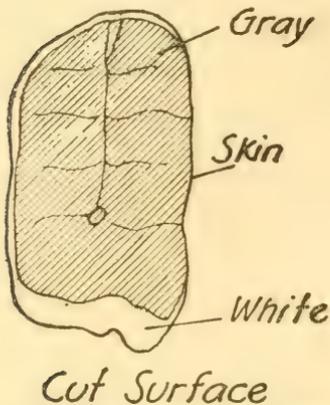


FIG. 6.—Whitening of fish after 1 day in brine.

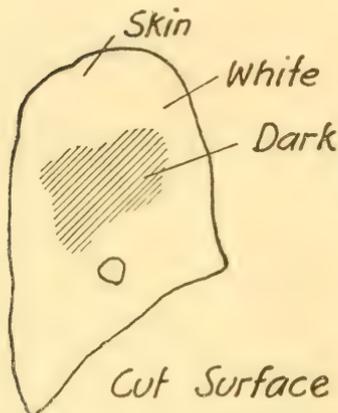


FIG. 8.—Whitening of fish after 10 days in brine.

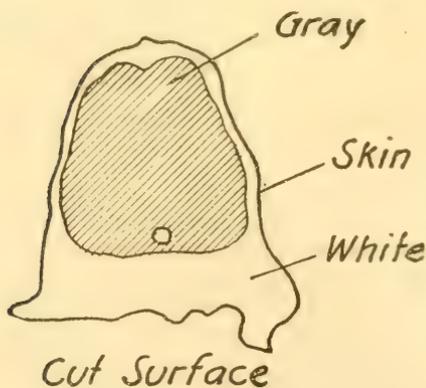


FIG. 7.—Whitening of fish after 6 days in brine.

peratures. Such experiments would show whether these substances are partially responsible for the spoilage. However, both the milt and roe must be removed if all of the blood be taken out of the fish. This is, therefore, a point of secondary importance.

## ACTION OF THE SKIN.

## METHOD.

The skin of fish is known to be a membrane which is more or less impermeable to the passage of dissolved salts. In the work on penetration of different salts it was noted that the penetration of salt into the fish took place much more rapidly through the cut flesh than through fish covered with skin. In the experiments on the penetration of salts containing calcium salts as impurity the passage of the salt into the fish could be followed very easily, for as the salt passed into the fish the fish became very white. This gave an easy way of estimating the rate of penetration of the salt into the different parts of the fish. The fish were cut on different days. The depth of the whitening was measured and the cross sections were drawn to scale. The diagrams are given to show how much more rapid the penetration of the salt is through the cut surface than through the skin surface.

Figure 6 shows the appearance of a cross section of a squeteague after it had been in salt for one day. The whitening had penetrated 5 mm. on the cut surface, but the whitened condition was found only 1 mm. under the skin. Figure 7 shows a cross section of the fish after it had been salted for six days. At this time the line between the light and dark portions of the section was not so distinct. Figure 8 shows a section of the fish near the end of the salting period, which was 10 days. There is yet a portion of the fish which was not white. This shows that the fish as yet was not salted uniformly throughout. The fish became entirely white throughout on the thirteenth day.

In order to gain a more accurate idea of the retardation of the penetration of the skin by the salt, some experiments were tried to determine the relative rate of penetration of salt into skinned and unskinned fish. In these experiments both skinned and unskinned squeteagues were salted in dry salt by the ordinary procedure, as described previously. The salt used contained 1 per cent of calcium chloride. This is about the purity of the average salt used for the salting of fish.

The penetration of the chlorides into the fish was determined by analyzing different sections of the fish from day to day. The procedure followed has been described in the first part of this paper. The results of the analyses of the sections from one-half centimeter to 1 cm. in depth are given in Table 13.

TABLE 13.—COMPARATIVE RATE OF PENETRATION OF CHLORIDES <sup>a</sup> INTO SKINNED AND UNSKINNED FISH,<sup>b</sup> EXPRESSED IN PER CENT OF CHLORINE IN DRY FISH.

Mode of cleaning.	Per cent chlorine after—			
	22 hours.	4 days.	7 days.	13 days.
Skinned.....	9.7	19.8	20.2	20.3
Unskinned.....	1.7	11.9	18.9	20.3

<sup>a</sup> Analysis of salt used, 99 per cent sodium chloride, 1 per cent calcium chloride.

<sup>b</sup> Inner section of fish,  $\frac{1}{2}$  to 1 cm.

## DISCUSSION.

These data show that salt penetrates skinned fish at approximately double the speed it enters unskinned fish. Therefore, skinned fish may be salted in about one-half the time required for unskinned fish. Of course, it is not practical to skin most fish before salting; but these results show the great advantage gained in splitting a fish wherever this procedure may be followed. In hot climates the length of the salting period, the period of danger, may be cut in two.

St. Johns River shad are successfully salted in Florida by the present methods. Attempts at salting St. Johns River alewives have repeatedly failed. The reason for the successful salting of the shad may be because the shad are split and washed before salting. The alewives are salted without splitting. Due to this splitting, the salting period of the shad may be shorter than the salting period for the alewives.

## PRACTICAL APPLICATIONS.

This work on the methods of cleaning proves beyond doubt that the chief cause of spoilage of fish during salting in hot weather is the decomposition of the blood contained in the fish. This seems to show that the problem of salting fish in warm climates is in reality a very simple one.

What must be done, then, in order to salt the alewives of the Florida rivers successfully during warm weather? The only change from the North Carolina method necessary is that greater care must be taken to remove every bit of blood and viscera. This can be accomplished if the roe and buckroe are removed in the cleaning operation. These may be canned profitably. After cleaning, the under side of the backbone should be scraped so that all the blood and membranes in the abdominal cavity are removed. A 20-penny nail is an instrument that can be conveniently used for scraping the backbone. The head of the nail may be ground thinner on an emery wheel. This operation sharpens the head so that it cuts out the membranes without much pressure. A single operator can easily scrape out a thousand fish in an hour. After scraping the fish they should be soaked in cold water for at least one-half hour. This dissolves practically every trace of the blood. It is good practice to wash the fish in a false-bottomed wheelbarrow with a powerful stream of water. After soaking the fish they should be packed in dry salt.

The above method of cleaning fish pays, even though the salting is done in a climate where this procedure is not essential; for extra washing and cleaning produces fish of much finer quality than those produced by the old methods. The up-to-date canner is using every possible precaution to avoid the presence of blood in his canned fish, so as to produce an entirely white fish. The well-washed fish when salted does not undergo a discoloration due to the presence of blood. The strong taste of salted river herring is eliminated in the washing.

Perfectly cleaned fish, salted at high temperatures, should bring a better price than the old dirty-looking product produced in the North. The public would soon learn of their improved quality.

All large fish salted in warm weather should be split, and care should be taken to remove the blood. This should be less difficult in

the case of the split fish, for the blood would be almost entirely exposed to view. The splitting would also greatly decrease the length of the salting period, due to the more rapid penetration of the salt.

#### SUMMARY.

River herring, cleaned by various methods, were salted at very high temperatures. All save those from which all roe, milt, and blood had been removed spoiled. Perfectly cleaned river herring were salted at a temperature of 88° F. It was concluded, therefore, that the chief cause of spoilage of fish during salting is the decomposition of the blood remaining in the fish. The rate of penetration of salts into skinned fish was compared with the rate of penetration of salt into fish before skinning. It was found that salt penetrates skinned fish at about double the speed it enters unskinned fish. This proves the great value of splitting fish preparatory to salting. These results are of great value in a practical way, for they show that if proper care be taken in the cleaning of fish, it is probable that they may be salted in any hot weather anywhere in the United States. With only an hour's extra work per thousand of river herring, these fish may be prepared for salting in hot weather. The salt-fish product prepared by this extra care in cleaning is of much better quality than the commercial salt fish.

#### IV. INFLUENCE OF FRESHNESS IN SALTING FISH.

##### INTRODUCTION.

Staleness in fish is undesirable. However, more or less staleness is always unavoidable. It seems reasonable to suppose that during colder weather staler fish may be salted than during hot weather. Few data in the literature concerning the limits of freshness are of value, for there are no standard methods of judging staleness. Most writers on the subject have used various physical criteria to estimate the relative freshness of stale fish. Some of the physical qualities that have been used as criteria are: 1. The presence, or absence, of a reddish discoloration on the ventral aspect of the backbone. 2. The odor. 3. The manner in which the flesh separates from the backbone. 4. The appearance of the abdominal walls.

The use of such criteria leaves too much to the judgment of the investigator. In other words, the personal equation plays too prominent a part. There are really but two ways of fairly stating the degree of freshness of any fish. The first and most accurate way is to give the number of hours since the fish was caught and the temperature at which it has stood for that time; the other is to state its chemical analysis. The per cents of amino-acid nitrogen and of ammoniacal nitrogen are particularly indicative of the condition of the fish.

In experiments previously described the number of hours the fish had been out of the water before they were salted has been given wherever possible. Since it was impossible to obtain live fish, standard freshness was considered as a fish transported in a boat at atmospheric temperature for two hours. Then the fish were iced and

cleaned, and after being iced for two hours were salted. There was, of course, the error caused by the difference in temperatures of different days. However, since at no time was the atmospheric temperature above 80° F., little decomposition took place in the two hours.

Since fish spoil so quickly during hot weather, an attempt was made to find out how fresh they must be in order successfully to salt them at various temperatures. This should show whether the cause of spoilage during salting in hot weather was through the use of stale fish.

Insufficient work has been accomplished to obtain any very definite data concerning the necessary freshness of fish for salting. Unfortunately, the work was carried out at too high temperatures, and all of the stale lots of fish spoiled.

#### METHOD.

Eighty pounds of glut herring (*Pomolobus astivalis*) were obtained after they had been out of the water for four hours. During this time they had been kept at approximately 60° F. They were divided into five lots and kept at 64° F. One lot was immediately cleaned, washed, and dry salted according to the usual method. After 16 hours a second lot was cleaned, washed, and salted; and after 24 hours a third lot was cleaned, washed, and salted. The first three lots were cleaned by beheading and eviscerating the fish, without removing the milt and roe. After 33 hours the two remaining lots were cleaned and salted. One of these lots was cleaned in the same manner as that of the first three. The other was cleaned more perfectly. The milt and roe were taken out, and the blood was scraped out from under the backbone. These fish were given an extra washing.

The five lots of fish were allowed to stand 15 days (from day of catch) before the analyses were made. For this reason the amounts of amino acids found were higher than in comparative lots which were analyzed at the end of nine days. The total amounts of amino-acid nitrogen formed were computed as before. The results are given in Table 14.

TABLE 14.—DEVELOPMENT OF AMINO-ACID NITROGEN IN FRESH AND STALE FISH AT 64° F.<sup>a</sup>

Experiment No.	Time between capture and salting.	Method of cleaning.	Amino-acid nitrogen in fresh fish.		
			Weight of fresh fish.	Per cent.	Grams.
Z-1.....	4	Head and viscera removed, with the exception of the milt and roe; washed once in ice water.	6,000	0.022	1.32
Z-2.....	20	.....do.....	6,000	.022	1.32
Z-3.....	28	.....do.....	6,000	.022	1.32
Z-4.....	35	.....do.....	5,500	.022	1.21
Z-5.....	35	Head, blood, and all viscera removed; washed twice in ice water.	5,500	.020	1.10

<sup>a</sup> In this experiment the fish were dry salted for 15 days with 2,200 grams of chemically pure sodium chloride.

TABLE 14.—DEVELOPMENT OF AMINO-ACID NITROGEN IN FRESH AND STALE FISH AT 64° F.—Continued.

Experiment No.	Total amino-acid at end in—				Amino-acid formed.		Physical condition of fish.
	Fish.	Brine.	Salt.	Fish, brine, and salt.	Total.	Per kilogram fresh fish.	
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	
Z-1.....	5.06	1.19	0.51	6.76	5.44	0.91	Good.
Z-2.....	7.28	1.51	.43	9.22	7.90	1.32	Tainted.
Z-3.....	7.86	1.53	.44	9.83	8.51	1.42	Spoiled.
Z-4.....	8.54	1.60	.40	10.54	9.33	1.70	Badly spoiled.
Z-5.....	4.54	1.51	.30	6.35	5.25	.95	Tainted.

## DISCUSSION.

Sixty-four degrees Fahrenheit is very close to the maximum temperature for salting fish containing blood, milt, and roe. For this reason all the stale fish spoiled. However, a comparison of the results obtained in lots Z-4 and Z-5 shows quite plainly that the roe, milt, and blood are the first portions of a fish to spoil at lower temperatures. This suggests a method of dealing with all stale fish. Evidently much staler fish may be salted if they are perfectly cleaned than if they contain blood, milt, or roe.

Two other experiments at higher temperatures were tried which verify these results. The other experiments were conducted at 75 and 79° F., respectively, which temperatures were so high that all the fish spoiled. These experiments were almost exact duplicates of the experiments reported in Table 14; hence they will not be described in detail. The fish were cleaned and salted at 4, 10, 14, and 28 hour intervals. Four lots of fish were kept at 75° and four at 79° during this period. The 4, 10, and 14 hour lots were only partially cleaned, the roe, milt, and blood being left in and the fish washed but once. The 28-hour lots were cleaned perfectly, the roe and milt being removed and the blood scraped out. Lot Z-5 was treated in the same way. All of these lots were salted in brine. The results of the calculations of the total amounts of amino-acid nitrogen formed are given in Table 15.

TABLE 15.—DEVELOPMENT OF AMINO-ACID NITROGEN IN FRESH AND STALE FISH AT 75 AND 79° F.<sup>a</sup>

Experiment No.	Time between capture and salting.	Method of cleaning.	Average temperature of salting period.	Weight of fresh fish.	Amino-acid nitrogen in fresh fish (4 hours).	
			° F.	Grams.	Per cent.	Grams.
DA-8.....	4	Head and viscera removed with exception of milt and roe. Washed once in ice water.	75	5,000	0.022	1.10
DA-11.....	10	do.....	75	5,000	.022	1.10
DA-12.....	14	do.....	75	5,000	.022	1.10
DA-14.....	28	Head and all viscera removed. Blood washed out.	75	5,000	.020	1.00
DA-1.....	4	Head and viscera removed with exception of milt and roe. Washed once in ice water.	79	5,000	.022	1.10
DA-4.....	10	do.....	79	5,000	.022	1.10
DA-5.....	14	do.....	79	5,000	.022	1.10
DA-7.....	28	Head and viscera removed. Blood washed out.	79	5,000	.020	1.00

<sup>a</sup> In this experiment the fish were salted for nine days in 5 liters of brine prepared from Diamond Flake salt (NaCl 99.73 per cent) and 1 kilogram of this salt.

TABLE 15.—DEVELOPMENT OF AMINO-ACID NITROGEN IN FRESH AND STALE FISH AT 75 AND 79° F.—Continued.

Experiment No.	Total amino-acid nitrogen at end in—			Amino-acid nitrogen formed.		Physical condition of fish.
	Fish.	Brine.	Fish, brine, and salt.	Total.	Per kilo-gram fresh fish.	
	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	
DA-8.....	2.46	2.09	4.55	3.45	0.69	Tainted.
DA-11.....	3.50	2.11	5.61	4.51	.90	Spoiled.
DA-12.....	3.36	2.45	5.81	4.71	.94	Do.
DA-14.....	2.15	2.51	4.66	3.66	.73	Tainted.
DA-1.....	3.00	2.00	5.00	3.90	.78	Spoiled.
DA-4.....	3.43	2.56	5.99	4.89	.98	Do.
DA-5.....	3.64	2.71	6.35	5.25	1.05	Badly spoiled.
DA-7.....	3.34	2.94	6.28	5.28	1.06	Spoiled.

Comparisons of the analyses of lot DA-12 with the analyses of lot DA-14 and of DA-5 with DA-7 show that thorough cleaning permits the salting of staler fish, for there was no more decomposition in the case of the thoroughly cleaned 28-hour fish than in the case of the 14-hour fish containing milt, blood, and roe. A comparison of DA-8 with DA-11 plainly indicates that at high temperatures great care must be taken to obtain absolutely fresh fish for salting. Evidently there is a temperature somewhere between 50 and 60° F., above which fish can not be kept for any length of time without spoiling.

## GENERAL CONCLUSIONS.

I. *Influence of impurities in salt in salting fish.*—Calcium and magnesium salts and sulphates, as impurities in salt, retard the penetration of salt into fish. Salts containing these impurities, therefore, cause fish to spoil during salting at a lower temperature than salts not containing such impurities. Of these three impurities, calcium is the only one present in commercial salts in large enough quantities to have an appreciable effect on the quality of the salt.

II. *A comparison of the efficiency of brine and dry salt for salting fish.*—Fish packed in dry salt, without any addition of brine, may be kept at a higher temperature than fish salted in brine, for less decomposition takes place if no brine be added. The dry-salt method is the more economical method of the two.

III. *Influence of method of cleaning fish for salting.*—The removal of all blood and viscera, including roe and milt, is absolutely essential for the salting of fish at high temperatures. Blood spoils at a temperature at least 25° F. lower than the spoilage temperature of the flesh of fish.

IV. *Influence of freshness in salting fish.*—During warm weather freshness of fish is essential to successful salting. However, much staler fish may be salted if all blood, roe, and milt are removed in cleaning.

### RELATIVE IMPORTANCE OF FACTORS.

The predominant factor in controlling the qualities of the salt-fish product and the maximum temperature of salting is the thorough cleaning of the fish, so as to effect the removal of all viscera and blood. If fish are perfectly cleaned, it appears possible to obtain a white, sweet-tasting salt fish at any American summer temperature. If the fish are not perfectly cleaned, it is impossible to salt them at any temperature averaging above 70° F. by any known method of salting, regardless of the kind of salt used or the mode of application of the salt.

The factor of second importance is freshness. When the temperature of the fish is above 70° F., the fish must be salted the same day that they are caught, if they are to be successfully cured. At lower temperatures this factor is of less importance, until at 32° F. this factor is practically eliminated. That is to say, at this temperature fish may be kept for long periods and yet be salted successfully.

Next in line of importance comes the method of application of salt. Fish iced for two days (see p. 36) may be salted at about 4° higher temperature by the application of dry salt rather than brine. Fine salt must be used for small fish.

Of next importance is the composition of the salt. This factor may be easily controlled by the purchase of salt of known purity. This affects the physical qualities of the salt fish. Commercial salts high in calcium lower the maximum temperature at which fish may be salted by any known method.

## PRACTICAL APPLICATIONS OF RESULTS.

The probability that fresh fish may be salted without danger of spoilage in any climate in the United States is of considerable importance. The only requirements for salting fish at high summer temperatures are:

1. All viscera and blood must be removed in cleaning.
2. All large fish must be split.
3. The fish must be salted in a reasonably fresh condition.
4. No brine should be added in salting.
5. Salts low in calcium must be chosen.

These requirements do not involve great changes in the methods of salting now employed. In reality they merely require more perfect cleaning and greater care in the selection of salt. The fish of our southern waters that are as yet not utilized may be salted without any difficult changes in the present methods, and thus a great saving may be effected.

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# FROGS: THEIR NATURAL HISTORY AND UTILIZATION

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Appendix VI to the Report of the U. S. Commissioner of Fisheries for 1919



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BULLFROG (*RANA CATESBEIANA*). DESIRABLE SPECIES; ADULT, NATURAL SIZE.

# FROGS: THEIR NATURAL HISTORY AND UTILIZATION.

By A. H. WRIGHT, *Cornell University.*

## INTRODUCTION.

From time to time since Seth Green's day efforts have been made by our best fish-culturists to raise frogs; but in all this period no definite successful mode of procedure has been evolved. Some of these workers became<sup>a</sup> "skeptical" and from "personal study and experience" were made "unbelievers." Others wrote about frog culture in an effort to supply information when they had nothing to give. Still others gave what little they had of value and commented:<sup>b</sup> "We are just as glad as you are that this bullfrog story is finished." Finally, the most serious group<sup>c</sup> announced complete success in "their preliminary experiments," and their efforts were sincerely appreciated by both the public and the culturists; but these experiments were abandoned.

Several writers have taken advantage of the public's intense desire for knowledge on this subject and have perpetrated all sorts of hoaxes and fakes on the credulity of their readers. Periodically some newspapers write of mythical "frog farms" for space fillers. Magazines occasionally accept similar articles, which should never have seen the light, and at present one must needs be on guard against the half-digested, hastily issued, worthless literature which would lead the uninitiated to believe the problem is entirely solved and that frog culture is wholly feasible. Too frequently the public seems to be fed on prettily written, fanciful speculation, and, as a consequence, frog culture receives much undeserved ridicule.

Notwithstanding all this deception and lack of definite procedure and in spite of the fact that little of importance has appeared to encourage it, the public continues to be vitally interested in the possibilities of frog culture. Many a reader of "The Virginian," after the dissertation on the "frawg business," has asked if there is really anything in it. The experiments which were started several years ago at the Pennsylvania State fish hatcheries aroused astonishing and widespread public comment. The commissioner of fisheries of Pennsylvania said:<sup>d</sup>

The interest was confined not to Pennsylvania alone but extended to nearly all parts of the United States. Newspapers, trade papers, and magazines commented on

<sup>a</sup> Mather, Fred: *Modern fish culture in fresh and salt water*, pp. 301, 302. New York, 1900.

<sup>b</sup> Dyche, L. L.: *Ponds, pond fish, and pond-fish culture*, p. 158. State Department of Fish and Game. Kansas. Topeka, 1914.

<sup>c</sup> Report, Department of Fisheries of Pennsylvania from December, 1904, to Nov. 30, 1905, p. 51. Harrisburg, 1906.

<sup>d</sup> *Loc. cit.* pp. 51, 52.

our work in this direction at considerable lengths, and all approvingly. Letters from private citizens were received from nearly every State in the country asking for further information. These were followed by communications from fish commissions and fish-culturists in the same vein.

In former years, at the sessions of the fishery and fish-cultural societies, frog culture was a frequent topic of inquiry, though not of extended discussion. To-day the U. S. Bureau of Fisheries receives countless inquiries and requests for literature, for information, and for possible sources of breeding stock, and this report is written to supply the information which must precede all careful experimental work on frog culture.

The difficulties encountered in many of the preceding efforts have arisen from lack of knowledge of the natural history of our native species of frogs. Such knowledge is an absolutely necessary premise to intelligent, successful endeavor. Often the best of the previous experimenters were not sure whether they had bullfrog or leopard-frog spawn, and thought that possibly the bullfrog bred twice a year when it breeds but once a year, or considered that bullfrog tadpoles transformed the same year they were hatched or in the following spring, neither of which conditions obtains. A careful critical study of most of the previous efforts reveals uncertainties of this sort, one of the most marked of which is the lack of positively identified stock with which to begin. Here, as in every other farming enterprise, it is necessary to have the seed or stock true to name. Fortified with this precaution and equipped with some of the cardinal points in the life history of the species to be raised, the prospective frog culturist stands a far better chance of success than in a blind "hit-or-miss" endeavor.

### COMMERCIAL FROG HUNTING.

#### SOURCE OF SUPPLY.

The market is yet solely reliant upon the natural supply of frogs. Of this industry, previous to 1900, F. M. Chamberlain, of the U. S. Bureau of Fisheries, remarked as follows:<sup>a</sup>

The business of taking frogs for market has greatly increased in recent years. It is now carried on in all sections of the United States and is of economic importance in about 15 States, while in nearly all the remaining States and Territories frogs are taken for local or home consumption [in quantities] of which it is impossible to get a statistical account. The States supplying the largest quantities for the markets are California, Missouri, New York, Arkansas, Maryland, Virginia, Ohio, and Indiana. More frogs are taken in New York than in any other State, but on account of their comparatively small size their value is less than in Missouri and California. The Canadian Province of Ontario also yields a rather large supply of market frogs. As ascertained by inquiries of the U. S. Fish Commission, the annual catch in the United States is but little less than 1,000,000, with a gross value to the hunters of about \$50,000. The yearly cost of frogs and frog legs to the consumers is not less than \$150,000.

The localities in which especially important frog hunting is done are the marshes of the western end of Lake Erie and Lewis and Grand Reservoirs, in Ohio; the marshes of the Sacramento and San Joaquin Rivers, Calif.; the valley of the Kankakee River, Ind.; Oneida Lake, Seneca River, and other waters of northern New York; and the St. Francis River and the sunken lands of the Mississippi River, in Arkansas and Missouri.

\* \* \* The prices received for frogs vary greatly and depend on the condition of the market, the size of the frogs, and the locality. Dressed legs yield the hunters from 12½ to 50 cents a pound, and live frogs from 5 cents to \$4 a dozen. In the Kankakee Valley, Ind., for example, the prices received by the hunters are 75 cents a

<sup>a</sup> A manual of fish-culture based on the methods of the U. S. Commission of Fish and Fisheries. Revised edition, pp. 252, 253. U. S. Commission of Fish and Fisheries. Washington, 1900.

dozen for large frogs, 10 cents a dozen for medium-sized frogs, and 5 cents a dozen for small frogs, while in San Francisco the market price is \$3 to \$4 a dozen.

To the above list of States yielding a considerable supply of frogs in 1900 there should be added Illinois and Minnesota. Of the latter C. H. Townsend writes:<sup>a</sup>

The most valuable product of these fisheries is the frog, the value of the catch in 1899 constituting nearly one-fourth of the entire fishery yield of the State. The species taken is the "meadow frog," which is quite small, the average weight being between 1 and 2 ounces each. \* \* \* Professional frog catchers are said to make from \$5 to \$10 per day during the best of the season. Most of the catch is shipped direct to Chicago.

The frog industry in this State was started about 1895, and has grown in importance. In 1899 over \$5,000 worth were taken in the vicinity of Minneapolis alone. Titchfield was the next greatest frog-producing center in the State that year. In 1900 this industry had shifted from the latter place to Smith Lake, where one dealer purchased over \$5,000 worth during the year.

By the year 1900, then, the following 10 States contributed a large proportion of the market frogs of the country: California, Missouri, New York, Arkansas, Minnesota, Illinois, Maryland, Virginia, Ohio, and Indiana.

In 1908, 250,000 pounds of frogs' legs, with a value of \$42,000, were reported for the whole of the United States.<sup>b</sup> The 13 States which furnished this total were:

States.	Quantity.	Value.	States.	Quantity.	Value.
	<i>Pounds.</i>			<i>Pounds.</i>	
Missouri.....	67,000	\$11,000	Tennessee.....	5,000	\$1,000
Minnesota.....	66,000	7,900	Ohio.....	4,000	600
Louisiana.....	38,000	4,500	Virginia.....	3,000	700
Arkansas.....	27,000	4,900	Iowa.....	2,500	300
Illinois.....	25,000	6,800	Delaware.....	1,900	700
Wisconsin.....	14,000	2,600	Maryland.....	1,000	500
North Carolina.....	3,400	900			

At least 8 of these 13 States are along the Mississippi River, and 6 of them fall wholly within that district. The Mississippi River division contributed 193,000 pounds; the Gulf of Mexico division, 38,000 pounds; the Great Lakes division, 17,000 pounds; and the Atlantic coast division, 11,000 pounds. Thus it is apparent that the Mississippi River States are becoming more important in commercial frog hunting. Before 1900 Missouri and Arkansas were the principal States in this region furnishing frog legs. By 1900 Minnesota and Illinois were added to the list, and by 1908 Louisiana, Wisconsin, Tennessee, and Iowa began to contribute appreciable quotas.

In the previous summation New York does not appear, but in 1915 and 1916 in the Oneida lake region the following is noted:<sup>c</sup>

[One firm conducted] a gross business of about \$15,000 per year in frogs alone. One customer bought between June 1, 1915, and March 1, 1916, \$1,687.50 worth of frogs' legs. When sold per hundred, live weight, large and small, the price ranges from 30 cents to \$1.50 or averages \$1.05. The legs sell per pound, large and small, from 10 to 50 cents, and average 35 cents per pound. An expert can dress between 1,500 and 1,600 frogs per hour, but an average rate is about 1,000 per hour.

<sup>a</sup> Townsend, C. H.: Statistics of the fisheries of the Mississippi River and tributaries. Appendix to Report of the Commissioner, U. S. Commission of Fish and Fisheries for 1901, p. 726. Washington, 1902.

<sup>b</sup> Fisheries of the United States, 1908, pp. 26, 28, 33, et seq. Washington, 1911.

<sup>c</sup> Adams, Chas. C., and Hankinson, T. L.: Notes on Oneida Lake fish and fisheries. Transactions, American Fisheries Society, Vol. XLV, No. 3, June, 1916, p. 163. New York.

## METHODS OF CAPTURE.

There are various methods of capturing frogs. The boy's favorite device is the fish pole, with the line baited with red cloth, worms, grasshoppers, or other insects; and this method is yet frequently employed by the market hunter. A more common method, however, is clubbing. Many of us as boys used to choose a good strong club about walking-stick length. With this instrument we skirted the edges of the swamps, lakes, or marshy creeks in the spring or early summer, traversed the clover or hay fields of the uplands in July about cutting time, or hunted in the wet lowlands a little later. Some of the men and boys occasionally put nails in the end of the club, but this more cruel method avails little. The frogs which were killed were put into a bag or strung on a cord by loops tied about their loins. They were dressed immediately after the trip.

[In Minnesota]<sup>a</sup> frogs are also taken by sticks and gunny sacks. In using sticks the frogs are usually killed and then sold in a dressed condition for food. Gunny sacks in a wet condition are used in their capture by being thrown over the frogs. Frogs are kept alive for market in gunny sacks placed in running water and covered with hay or straw to keep out the frost.

Some expert froggers are very adept at catching them alive by hand. A frog catcher will hold one hand over or in front of the prey to attract its attention and capture the game by a sudden movement of the other hand.

Several methods are based on the migration of the frogs in the fall or spring. In the central New York region in late September, through October, and even in November, frogs are frequently encountered working their way down the hills toward the swamps around or at either end of some of our Finger Lakes. Many reach the swamp in the fall, and many winter in the ravines and enter the swamps in the spring. In many cases State roads or other similar and partial barriers skirt our lakes—that is, steam railroads, electric railways, etc.—and the frog catchers make use of these. A calcium-carbide can or a barrel placed at the swamp end of a culvert may yield numerous frogs which are traveling down the ravines, and the swamps or ditches dug at the base of the hills and at the swamp's border may give good returns.

[In Minnesota]<sup>a</sup> frogs are caught in various ways, but chiefly in pits dug between sloughs and the adjoining high grass. The season for their capture in this manner is usually in the fall, when they are returning to the water. These pits are about 3 feet long, 2 feet wide, and 2 feet deep.

There are many other variations of this pit, posthole, ditch, or excavation method. In Oneida Lake an outgrowth of the pit and can methods is the use of screens.

[This form of capture]<sup>b</sup> is used in the fall when the frogs migrate from the fields and swamps toward the lake for hibernation. This migration is not regular, it takes place mostly at night, particularly during warm rains, after a light frost. Taking advantage of this migrating behavior, cheesecloth screens, about 18 inches high, supported by sticks, are placed along the shore to intercept the migrating frogs. At intervals of two or three rods nail kegs, carbide cans, or posthole-like excavations entrap the frogs which, failing to surmount the screen, wander along it and fall into the traps. The frog catcher has only to collect the frogs from those traps. Late in the season one may find various sized frogs, mice, and other small mammals drowned and frozen in these small wells.

<sup>a</sup> Townsend, C. H.: *Loc. cit.*, p. 726.

<sup>b</sup> Adams, C. C., and Hankinson, T. L.: *Loc. cit.*, pp. 161, 162.

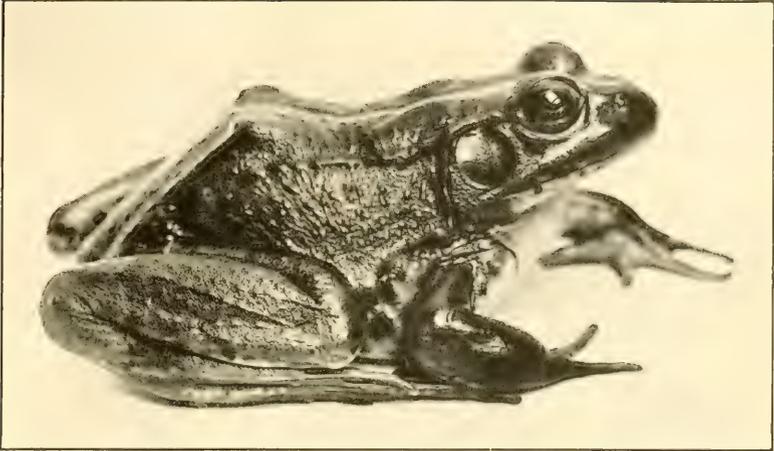


FIG. 1.—GREEN FROG (*RANA CLAMITANS*). DESIRABLE SPECIES; NATURAL SIZE.

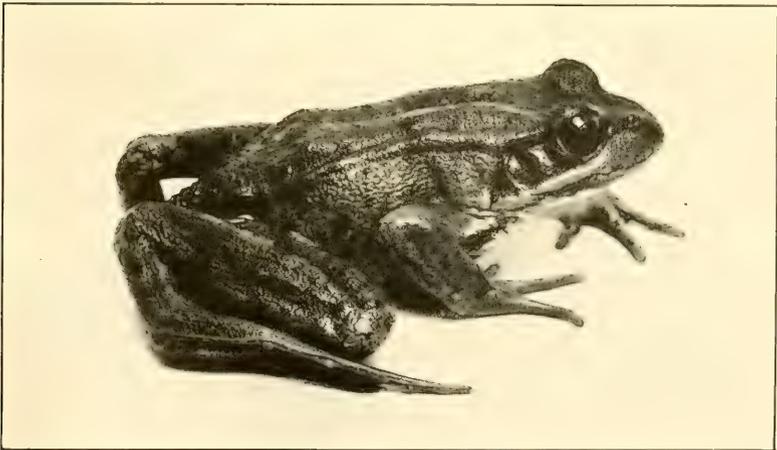


FIG. 2.—"WESTERN BULLFROG" (*RANA AURORA*). DESIRABLE SPECIES; NATURAL SIZE.

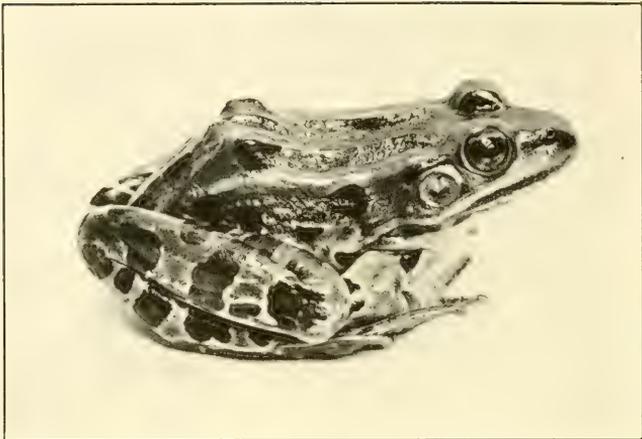


FIG. 1.—LEOPARD FROG (*RANA PAPIENS*). DESIRABLE SPECIES;  
NATURAL SIZE.

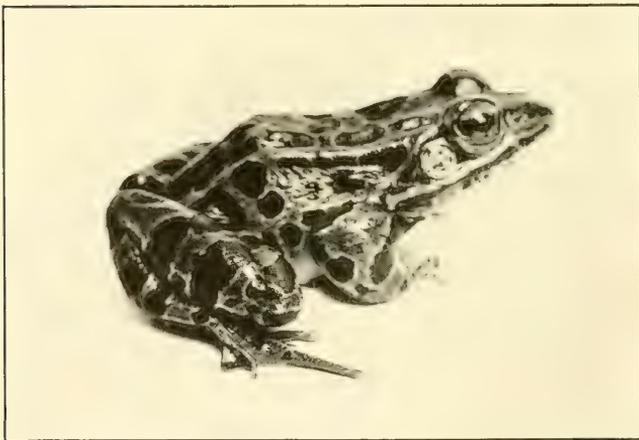


FIG. 2.—PICKEREL FROG (*RANA PALUSTRIS*). DESIRABLE  
SPECIES; NATURAL SIZE.

The screens have to be placed far enough back from the lake shore to avoid water rising too near the surface and thus destroy the traps. On the swampy ground the holes are similarly obliterated by the water. To overcome this difficulty, Mr. A. W. Thierre, of Lower South Bay, has devised a trap of woven wire screen; with a one-half-inch mesh. If this trap was placed at an opening in the screen, which is not the case, it would allow the undersized frogs to escape and to reach the lake and find proper winter quarters, while the screens tend to destroy both the smaller kinds of frogs and immature individuals of the larger species. This wire trap has an inclined surface up which the frogs crawl, and from which they fall into the trap cavity, and from which they seldom escape. Thierre also uses a large minnow box to store his frogs until delivery to the dealers.

By means of the screens and traps a single night's catch may amount to about 500 pounds, from about a half mile of screen in a good locality. As much as \$70 has been paid for a single catch.

In many regions, as in central New York and elsewhere, the professionals come to know where the frogs hibernate and often dig them out of the mud in large numbers. In the Erie Canal, after the water is withdrawn, many frogs are taken from the mud or even from beneath the ice of some of the pools.

A favorite method of capture at night is to use a bull's-eye or any form of bright light. The frogs are dazed and in most cases can be caught by hand or approached near enough for their easy dispatch. Sometimes in the deeper waters and swamps two men are needed for this form of capture, one to row the boat and the other to locate and shoot the prey. The lantern may be on the prow of the boat, carried in the hand, or worn on the head, as with alligator hunters. The rifle and spear and gig are used mainly in Illinois, Arkansas, Missouri, and Tennessee. The spear may be one of several sorts; three-pronged or single, or merely a nail or a straightened fishhook in the end of a pole.

### COMMERCIAL FROGS.

#### DESIRABLE SPECIES (PLS. I, II, AND III).

The six eastern edible species fall into two groups of three each:

Those with more or less uniform dorsal coloration on the back, and with an eardrum larger than the eye in the male, namely, the green frog (*Rana clamitans*), the bullfrog (*R. catesbeiana*), and the southern bullfrog (*R. grylio*).

Those which are blotched or spotted on the back and with the ear of the male not larger than the eye, namely, the leopard frog (*Rana pipiens*), the southern leopard frog (*R. sphenoccephala*), and the pickerel frog (*R. palustris*).

In the western States three species enter into commercial catches. They are the yellow-legged frog (*Rana boylei*); the western frog (*R. pretiosa*); and the "western bullfrog" (*R. aurora*).

The above nine forms are all true frogs (*Rana*) which have teeth on the upper jaw, no adhesive, enlarged disks on the ends of the fingers and toes, and no large parotoid gland back of each eye. Most of them are smooth of skin, and all reach an adult length of at least 3 inches, not counting the hind legs.

#### EASTERN SPECIES.

**GREEN FROG.**—The green frog (Pl. II, fig. 1) is larger than a leopard frog and has two ridges down its back. The forward upper parts are bright green; the posterior region, brown or olive. The under

parts are white, with some marbling; in the male the throat is yellow. This species reaches  $3\frac{1}{2}$  to 4 inches or more in length and extends in range from the Gulf of Mexico to Hudson Bay, occurring in practically all of eastern North America.

**BULLFROG.**—The bullfrog (Pl. I) is much larger than the green frog, and the two are often confused. The bullfrog has no ridges down either side of its back. On its upper parts it may vary from yellowish green to a dark brown, while its under parts are yellowish white, with some mottlings. In size it may reach 8 inches, and its range is from eastern North America to the Rockies.

**THE SOUTHERN BULLFROG.**—The southern bullfrog is quite similar to the common bullfrog and varies from brownish olive to bone brown or blackish brown above, with some prominent, scattered black spots. The under parts often have a network of black or brown and yellow, one of the most striking ventral colorations of any North American frog. This species has a more pointed snout than the bullfrog, possesses a narrower head (measured at the eardrums), and has all the hind toes except the fourth proportionally longer than the same toes of the bullfrog. Of this form, the author has taken no specimens over 5 or 6 inches in length, while the extreme for the bullfrog may be much more. The known range of the southern bullfrog is in the extreme southeastern United States.

**LEOPARD FROG.**—The leopard frog or meadow frog (Pl. III, fig. 1), the most widespread and most common form of North America, has all the under parts white or whitish. On either side of the back is a prominent fold, which is narrower and higher than in the pickerel frog. Between these two main folds sometimes there are other smaller folds. The spots between the two folds are irregular in outline and in position, are not necessarily opposite, and occupy less space than the background color, which varies from bronze to green. The spots below the lateral fold are less regularly placed and never so large as in the pickerel frog. The leopard frog reaches a length of  $3\frac{1}{2}$  to 4 inches and is found from the Sierra Nevada Mountains eastward and from the extreme north to Mexico.

**THE SOUTHERN LEOPARD FROG.**—The southern leopard frog is very similar to the common leopard frog and varies from it in a very few characters. It usually has a distinct white spot in the middle of the eardrum, unlike the leopard frog, in which it is generally absent. Then, the head of the southern form is contained 2.5 times, or less than 3 times, in the length of the head and body combined, while the common form has it 3 to 3.5 times. Furthermore, in the southern species the snout is acuminate or pointed and is contained about 1.5 times in the head, while in the other form the snout is less pointed and is contained 2 or more times in the head. This species may reach the size of a common meadow frog and occurs in the southern States.

**PICKEREL FROG.**—The pickerel frog (Pl. III, fig. 2), in life has the under parts of the legs and belly orange yellow. On either side of the back is a broad, low fold of skin. Between these folds there are two regular, more or less opposite, rows of dark, squarish spots, which occupy far more of the back than the light-brown, ground color. Below each back fold the spots are larger and more regular than in the leopard frog. The pickerel frog reaches a length of 3 to  $3\frac{1}{2}$  inches and is found from the central plains to the Atlantic seaboard and from the Gulf of Mexico to Hudson Bay.



FIG. 1.—SPADEFoot (SCAPHIOPUS HOLBROOKII). POSSIBLE SPECIES;  
NATURAL SIZE.

(After Overton. Mus. Brooklyn Inst. Arts and Sci. Sci. Bull., Vol. 2, No. 3.)

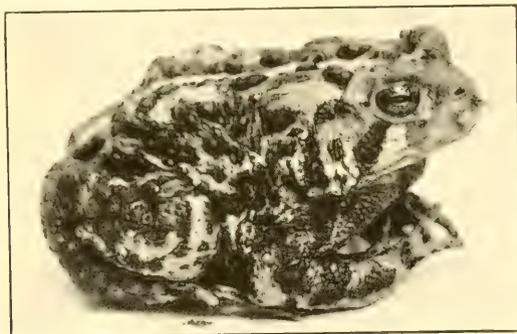


FIG. 2.—COMMON TOAD (BUFO AMERICANUS).  
POSSIBLE SPECIES; NATURAL SIZE.

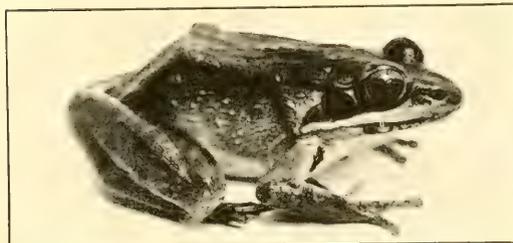


FIG. 3.—WOOD FROG (RANA SYLVATICA).  
POSSIBLE SPECIES; NATURAL SIZE.



WESTERN SPECIES.<sup>a</sup>

The western species are somewhat confusing. At present Camp (1917) recognizes three species, while Cope (1889) held there were four.<sup>b</sup> The three species are *Rana boylei*, the yellow-legged frog; *Rana pretiosa*, the western frog; and *Rana aurora* (both aurora and draytoni), the so-called "western bullfrog."

**YELLOW-LEGGED FROG.**—The yellow-legged frog has the ear or tympanic region not darker than the rest of the head, possesses no red in its coloration, and has the fold along the upper lip colored like the rest of the body. These creatures are  $2\frac{1}{2}$  to  $3\frac{1}{2}$  inches in length and occur in California. They have been less used for food because of their skin secretions.

**WESTERN FROG.**—In the western frog the hind leg, when brought forward along the body, has the inner angle of the bent heel reaching to the eye or nostril, but never beyond. The back and top of the head has prominent, inky-black spots. This species attains a length of 3 to 4 inches and extends from Nevada and northern California throughout Oregon and Washington to Alberta and east into Montana, Wyoming, and Utah.

**"WESTERN BULLFROG."**—The "western bullfrog" (Pl. II, fig. 2), unlike the western frog (*R. pretiosa*), has no inky spots on the back and top of the head, and the heel reaches to or beyond the nostril. These creatures may have their skin very smooth (*aurora*) or roughened (*draytoni*), have the lateral folds of the back indistinct (*aurora*) or prominent (*draytoni*), possess unspotted or dotted backs (*aurora*) or have regularly placed, light, centered spots (*draytoni*), be medium, 3 inches long (*aurora*), or large, 4 inches (*draytoni*). The "western bullfrog" extends from Puget Sound to Lower California.

These last two forms, the western frog and the "western bullfrog," usually have the tympanic region darker than the rest of the head, red often present in the coloration, and the fold along the upper lip usually white or lighter than the rest of the head.

## POSSIBLE MARKETABLE SPECIES (PL. IV).

There are several species of true frogs which are smaller, such as the wood frog and its relative, the northern wood frog; the mink frog (*Rana septentrionalis*) of extreme northeastern United States and Canada; the carpenter frog (*R. virgatipes*) of New Jersey and the Carolinas; or the local and rare gopher frog (*R. asopus*) of Florida. It will, doubtless, never become feasible to use these species in frog culture.

The wood frog (Pl. IV, fig. 3) is either light or reddish brown above, with a darker brown streak or mask on either side of the head. Underneath it is a glistening white. The northern wood frog is like the wood frog; but the length of the hind leg to the heel does not exceed the combined length of the head and body, while in the

<sup>a</sup> The author is indebted to Charles Lewis Camp's "Notes on the systematic status of the toads and frogs of California" (University of California Publications in Zoology, vol. 17, No. 9, pp. 115-125, Feb. 3, 1917, University of California Press, Berkeley) for most of what follows on the western forms. The author also has specimens from the Pacific coast collected by Profs. J. C. Bradley, W. A. Hilton, A. C. Chandler, and the writer.

<sup>b</sup> Cope, E. D.: The Batrachia of North America. U. S. National Museum Bulletin No. 34, 432-447 Washington, 1889.

wood frog it does. The *mink frog*, like the bullfrog, has no fold of skin on either side of the back, one joint of the fourth toe is free of web, and the male has the eardrum larger than the eye. This form is small, the body being from 2 to 3 inches in length. The mink frog is light olive with irregular spottings on the posterior back and sides, with the hind legs spotted or banded. The *carpenter frog* has no lateral folds, two joints of the fourth toe are free, and the animal is brownish, with four yellowish or golden-brown, longitudinal stripes on the back. The under parts are yellowish white, with alternating dark and light stripes on the hind legs. The *gopher frog*, unlike the pickerel and leopard frogs, has a hind leg to heel length shorter than the total length of the head and body and has its spotted dorsal skin also quite warty.

The *spadefoots* (Pl. IV, fig. 1),<sup>a</sup> with vertical pupils and sharp spades on their hind feet, are almost large enough to be of value in the market, but are uncertain in habits. The *toads* (Pl. IV, fig. 2), with parotoid glands just back of the eye and with warty skins, may some day serve as food, though a greater prejudice will have to be overcome than in the case of the frogs.

#### UNDESIRABLE SPECIES.

The tree frogs, with no parotoid gland back of the eye and with disks on the fingers and toes, comprise most of this class. The males of these creatures can always be told from true-frog males, because the area under the chin is always colored darker or differently from the rest of the under parts, while true frogs rarely have such a coloration. Rarely a male green frog or other species may have a yellow or another color under the chin, but it is not sharply indicated, as in the tree frogs, and does not appear discolored.

Common among these tree frogs are some with small disks and a length of 1 inch or less; namely the *cricket frog* (*Acris gryllus*) with a triangle between its eyes, webbed feet, and prominent, alternating, dark and light longitudinal bands on the back of the thighs; and the *swamp cricket frog* (*Pseudacris*) with webs small or absent and with a more or less smooth skin.

The tree frogs proper, with large disks, are several in number, of which the peeper, the tree toad, the Carolina tree frog, the Florida tree frog, the Pacific tree frog, and the southern tree frog are most common. None reach much beyond 2 or, at the most, 2½ inches in length. The brownish and smooth *peeper* (*Hyla crucifer*) (Pl. XXII, fig. 16), is recognized by an X-shaped mark on its back. The *tree toad* (*H. versicolor*) (Pl. XI, fig. 3) of the eastern United States is grayish brown or green; is rough of skin; and has a light spot below the eye and a network of dark and yellow on the posterior part of the thighs, while its relative of the southwest (*H. arenicolor*) has no network on the thighs. The tree toad of the piney woods (*H. femoralis*) has the posterior surface of the thighs, with round yellowish or white spots, but not a reticulation or network. The *Carolina tree frog* (*H. cinerea*) is grass-green above, with a straw-colored stripe along the side of the head and body, while *H. evittata* of Maryland and Virginia has no such stripe. The green of Anderson's tree

<sup>a</sup> See footnote, p. 22.

toad (*H. andersonii*) is bounded beneath by a white line and this by a purplish brown or purple color. The *Florida tree frog* (*H. gratiosa*) of Florida and Georgia, the largest ( $2\frac{1}{2}$  inches long) of all our tree frogs, has many roundish spots on its dorsal surfaces and very large disks. The *Pacific tree frog* (*Hyla regilla*) and the *southern tree frog* (*H. squirella*) have the thighs with no particular color pattern, are not pure green on the back, like the Carolina tree frog, and have the body not so slim as in this form. One occurs on the Pacific coast and the other in our southern States.

Our *narrow-mouthed toads*, unlike the true frogs, have no teeth in the upper jaw, are never 2 inches in length, have the eardrum hidden, and possess a peculiar fold of skin on the top of the head.

## CULTURE OF FROGS.

### BREEDING HABITS.

Those frogs which appear in the early spring usually begin croaking at once and proceed to pair and ovulate with little or no intervals between appearance and egg laying, while those which appear last wait for longer periods between emergence and croaking and between croaking and ovulation. It has been much in vogue to say of many species that they breed "in early spring," but many of our forms of which this has been said do not breed until summer. The males in many cases resort to the breeding grounds before the females, and the females may wait until their eggs are ripe before they enter the water. Or, as is the case with some toads, the two may meet on the trip to the water and become mated before the destination is reached. The croaking or mating male seizes the first female within reach and maintains his embrace until the eggs are laid. Sometimes in gregarious species six or eight males strive for one female, and often the female is killed. Fertilization comes exactly at the extrusion of the eggs or slightly after it.

At first no envelopes about the eggs are apparent and the egg mass may feel soft and sticky. After a few minutes this substance absorbs water, and each egg then is revealed to be a spherical body closely surrounded by a membrane and by one or two jellylike envelopes. (See fig. 1.) Some eggs have only the inner envelope present. This gelatinous substance comes from the oviduct and forms, when swollen, the egg capsules, tubes, bands, films, or masses to which we are so accustomed. The egg masses (Pls. XIII to XIX) are spherical in the wood frog, the pickerel frog, and in some of the other true frogs; plinthlike in the leopard frog and southern leopard frog; a spiral in the various toads; a surface film in the green frog, bullfrog, and tree toad; and a submerged film or mass in the swamp cricket frog. In the peeper and cricket frog the eggs are separate. The wood, pickerel, and leopard frogs lay their whole complement in a short time; the film form of the green frog, bullfrog, and tree frog takes longer, the first two maintaining the same position and the latter moving about during the process. With the toads and spadefoots some time is consumed in laying their spirals or bands. In the peeper several hours may transpire before the eggs are all laid.

## DEVELOPMENT AND TRANSFORMATION.

The eggs hatch in from 3 or 4 to 25 days, depending on the temperature conditions. At hatching, the larvæ have a distinct neck, with a prominent head and body. The tail is very small or absent. On the ventral side of the head is an invagination or depression which is to be the mouth. Behind this comes the ventral adhesive disk or disks, which help the little creature to attach itself to the egg mass or to hang itself upon some plants. In front of the mouth are two deep, dark pits which later become the nostrils. On either side of the head appear swellings which become the external gills. The eyes do not yet appear.

As development goes on the external gills appear as branched organs, two or three on a side; the eye shows as a ring beneath the skin; and the tail grows and presents a middle muscular portion where the muscle segments clearly show. This middle part supports a thin, waferlike tail fin the parts of which are called, respectively, the lower and upper crests. The nasal pit shifts in position and becomes the nostril, and the vent opens. The mouth appears, and dependence on the yolk of the belly ceases. Soon the external gills begin to disappear, a lateral flap or fold of skin connects the head with the body, and the neck region disappears. Beneath this fold internal gills develop. On the left side, the lateral flap does not close completely, but leaves an opening, the spiracle. The water passes into the mouth over the internal gills and out this hole on the left side. On the mouth a membranous, fringed lip, with upper and lower portion, comes into being. At the portal are horny jaws or mandibles. On the upper and lower portions are rows of horny teeth. The eye is no longer a covered pigmented ring, but is now at the surface. The intestine has become much elongated and coiled. The buds of the hind limbs begin to appear. The fore limbs start to develop beneath the skin. When the hind limbs have reached considerable size the left arm comes out through the spiracle and the right arm breaks through the skin.

The process of transformation is now on. The tail crests decrease in size, and the creature begins to live on its tail; that is, absorbs it. The gills vanish, and the lungs begin to serve as the sole respiratory organs, if the skin be not considered. The eye assumes eyelids. The tadpole mouth fringe, with its horny jaws and horny teeth, is discarded, and a true frog mouth begins to appear. The long intestine becomes wonderfully shortened, and the small frog, with a vestige of a tail, is ready to leave the water. This process is termed transformation or metamorphosis.

## SELECTION OF STOCK.

Most of the inquiries which the Bureau receives center about possible literature concerning frog culture or about the supply of breeding-frog stock, frogs either unmated or mated, eggs, or tadpoles. At the present time no supply bureau or hatchery can offer certified eggs or tadpoles of a particular species, and rarely can mated pairs be supplied. Some of the dealers in zoological supplies and some hatcheries can furnish frogs and might at certain seasons offer to furnish mated pairs. But such, which are paired in captivity, would



FIG. 1.—HABITAT OF THE LEOPARD FROG; A LARGE CAT-TAIL AND SEDGY SWAMP.



FIG. 2.—HABITAT OF THE PICKEREL FROG; THE BACKWATER OF AN UPLAND STREAM.



FIG. 1.—HABITAT OF THE GREEN FROG; A PERMANENT POND (FOREGROUND) NEAR A STREAM (BACKGROUND).



FIG. 2.—HABITAT OF THE BULLFROG; A MILL POND FILLED WITH STUMPS, FALLEN TREES, ETC.

usually be undesirable; they might lay in transit, break the embrace en route, or never lay at all, as is generally the rule. A more extended discussion of the five or six groups of stock follows: (1) Individual frogs; (2) mated pairs; (3) eggs; (4) tadpoles; and (5) transition stages.

#### INDIVIDUAL FROGS.

In many ways it might appear that the easiest and most certain method of securing stock would be to begin with the individual frogs. To be sure, they are to be found throughout the active period of the year—that is, from the early thaws of spring to the hard frosts of fall—but one must know their breeding season or he may carry them almost a year before the first eggs are secured. If the material come from a supply bureau, there is no certainty as to the period of previous captivity, the amount of freedom the frogs had in such quarters, etc. Frequently it has been found that with the leopard frog, green frog, and bullfrog the males were first captured and the females taken later, sometimes two or three weeks afterwards. To hold the males in captivity or in close quarters tends to reduce their breeding potentiality. Or, if females be captured just before breeding and be brought into the hatchery to await the subsequent capture of impulsive breeding males, the chances are that in rare cases the female may lay without the male, or that, by the time a pair or pairs are mated in the laboratory or hatchery, one or the other member may be weakened, and the pair may continue in the embrace several weeks until the death of one or both individuals. In most cases such a mated pair proves unfruitful. Over and over again has the writer taken gravid females and mated them with captive males or with males subsequently taken, and in almost every instance no eggs were laid or, if so, they were frequently infertile.

If, however, the experimenter has a good pond or water inclosure, with more or less natural conditions, he might stock it with individual frogs and not encounter the above difficulties so inherent in confining frogs in close quarters. If the prospective culturist wishes to start with the individual frogs, he must choose or determine what species he prefers or what his region offers. At present the four principal eastern species for the frog market are the leopard frog, the pickerel frog, the green frog, and the bullfrog.

If the leopard frog be chosen, the person who purposes to breed this species can usually secure enough frogs from the swampy marshlands (Pl. V, fig. 1), or backwaters and overflow ponds of streams in his own neighborhood. The leopard or spring frog appears from its hibernation in the muddy bottoms of our marshes and ponds when the streams have just freed themselves of ice and the lowlands are overflowing. When the temperature of the water reaches 41 to 50°, they may confidently be expected to appear in numbers.<sup>a</sup> From the middle of March to the middle of April is the period in which to expect them to appear for breeding. In early spring, whenever a low guttural croaking is heard in swampy stretches, it is that of the leopard frog. The croak is wholly unlike the shrill notes of the peeper and swamp cricket frog or the short

<sup>a</sup> The dates of first appearance, spawning, etc., of the commercial species were determined for the latitude of Ithaca, N. Y., but might well apply for northeastern United States if not for all of northern United States.

rattlelike note of the wood frog, all three of which are frogs too small to be considered commercially.

In the shallow water, along the edges of swamps, or on the banks of dead streams or backwaters one can find many leopard frogs. In the early spring—in fact, at all times during the breeding period—they can best be taken at night with an electric flashlight or acetylene lamp, lantern, or jack of any kind. Later in the spring the frogs are more easily captured during the day. To be sure that the captor has individuals of both sexes, he must be able to distinguish them. The male of a leopard frog has the thumb of the fore foot much enlarged on the inner edge and has a vocal sac between each ear and shoulder. These vocal sacs can be demonstrated by seizing the frog around the waist just in front of the hind limbs and alternately squeezing and relaxing the pressure. In this way a male will inflate the sacs. The ripe females are very gravid and swollen and have no vocal sacs and no enlarged thumbs. It seems advisable to have an equal, or preferably greater, number of males than females to insure all the females being mated. It seems to be the condition at the sexual congresses of this species that the males exceed the females in number. Of course there is some evidence that a male may mate the second time in a season, but this is not fully established. Frequently the author has put his captives in close quarters to obtain quick matings and then placed the pairs in the pond or inclosure meant for the breeding purposes. To keep them mated more than two or three days at the most in the laboratory or hatchery may result in a long embrace, and this defeats the purpose of the operation. If the culturist plans to begin with adult breeders, he can secure individuals of this species without great difficulty, because it is so gregarious at the time of the breeding assemblies; he will have a little more difficulty in locating the smaller gregarious breeder, the pickerel frog, and doubtless even a lesser measure of success in the case of the more solitary green frogs and bullfrogs.

It is yet a doubtful question whether the pickerel frog will become as important a commercial form as the leopard frog, green frog, or bullfrog. It is slightly smaller than the leopard frog, and the acrid secretion of its skin may militate against its availability. Whoever wishes to experiment with it will not find it in exactly the same habitat as the leopard frog. The leopard frog is essentially a frog (in its greatest abundance) of the cat-tail swamps, sedgy marshes (Pl. V, fig. 1), and grassy overflows (Pl. VII, fig. 1), while the pickerel frog is more often found in sphagnum bogs, marl ponds, cold streams, in the shallows of mill ponds, or in the quiet waters of bayous (Pl. V, fig. 2), away from the currents of our clear streams. It usually appears from hibernation about the same time as the toad and later than the leopard frog. When the air temperatures approach 48 to 58°, pickerel frogs begin to appear and become numerous at 58 to 67°. They hibernate in the water, and when it reaches 45 to 53° they come out of their winter sleep. In point of time this outcoming occurs between March 19 and April 25. The croak of the male is low and grating, and usually to the tyro this will be a poor guide for their capture. The male is usually smaller, darker in color, and with the thumbs enlarged, as in the males of the leopard frog.



FIG. 1.—HABITAT OF THE LEOPARD FROG AND TOAD; AN OVERFLOW AREA OF A STREAM. DRIES UP IN MIDSUMMER.



FIG. 2.—HABITAT OF THE TOAD AND PEEPER; A SHALLOW MEADOW POND WHICH DRIES UP IN MIDSUMMER.



FIG. 1.—HABITAT OF THE WOOD FROG; A WOODLAND POND.



FIG. 2.—HABITAT OF THE MINK FROG; A BEAVER POND FILLED WITH WATER LILIES, DORSET, ONTARIO.

The green frog is one of the solitary species. In habitat it is not as restricted as the bullfrog. Both occur in swamps, and in our deeper, larger ponds and reservoirs. In the smaller ponds and pools only the green frog is present. In fact, along watercourses there is hardly a small pond (Pl. VI, fig. 1) which can not claim a green frog. In the swamps only does the leopard frog exceed it in abundance. The latter often inhabits the less permanent situations; the green frog usually chooses more permanent, deeper bodies of water. The green frog starts to appear when the air reaches 54 to 61° and quite commonly at 61 to 69°. It also, like the leopard frog, pickerel frog, and bullfrog, hibernates in the water and awakens when the temperature of the water reaches 46 to 58°. It most assuredly is not "the first species heard in the spring." In fact, it does not begin to croak until a month after its first appearance. Then its low-pitched, short "bass-viol" note is very distinctive. The male of the green frog also has enlarged thumbs, and, in addition, has a yellow throat and a tympanum larger than the eye, while the female has a tympanum only equal in size to the eye. This species, being solitary, would be hard to secure alive in sufficient quantities for breeding purposes unless more effort were expended on its capture than it was actually worth. Wherever they are common, as in big mill ponds and small lakes, one might take enough to determine if the green frog be the species most desired. They are best taken at night.

Finally, in the East, the bullfrog appears to be the most desirable because of its size. One commonly associates the bullfrog with marshy bayous, buttonbush swamps, mill ponds (Pl. VI., fig. 2), or lakes. They are not, however, as restricted in habitat as some texts might lead the reader to infer. The author has found them along both upland and lowland streams, in clear brooks which fed cold, marly, sphagnum ponds, and along watercourses laden with such marshy vegetation as lizard's-tail, marsh cress, arrowhead, pickerel weed, and swamp loosestrife. Rarely they have appeared in small numbers in temporary or very small ponds, a more logical home for the green frog. Such distribution can ordinarily be explained by the loss or draining of a former mill pond or reservoir habitat near by, and such records are more accidental than normal. These frogs seem to prefer mill ponds, hydraulic lakes, reservoirs, and kindred bodies of water. The author's best collecting grounds were a clear, glacial lake in a New England kettle hole, with a slight suggestion of the sphagnum flora about it; a pond in a clear trout brook; a large reservoir for a hydraulic laboratory; a disused mill pond; and a wooded lake whose shifting water level had made a fringe of overhanging dead trees, floating logs, and submerged roots and limbs. In every case the shores were more or less wooded, but more important are two factors: Shallows where the species can transform; and brush, stumps whose roots are at the edge of the pond or overturned and driftwood along the banks.

When the bullfrog comes out, at least seven of the species which appear in the spring are entirely or almost finished with their spawning. The bullfrog is such a wary form that in some years its presence is not suspected until June, when croaking begins. When the air

reaches 68 to 75° (certainly 76 to 79°), the appearance of the bullfrogs may be expected, provided the temperature of the water bottoms is 57 to 64° or averages 64 to 69°. They are the last frogs to appear and come out from May 11 to June 4. They begin to croak about two or three weeks after emergence from hibernation.

When croaking begins, the males often take certain perches in which they keep a proprietary interest. About one pond the author once located seven such places, each with its possessor, only once finding two in one place. The characteristics of the stands can best be described by presenting the following list of positions occupied by certain frogs in one pond: The first was on a board in water filled with brush; another was perched on a log among brush beneath a float of a boathouse; the third was on the bank among some limbs extending into the water; the fourth was by an overturned stump whose roots were partly out of the water and partly submerged; the fifth was among some driftwood along the shore; the sixth was a stationary float; and the last was at the base of a tree fallen into the pond. At these stands one could have had good success in capturing the frogs at night. This habit of maintaining perches obtains more particularly when the species is not especially numerous in a pond or lake. When, however, the numbers of males about a lake are numerous enough to make their night croaking seem a real chorus, and when they are abundant among the fallen logs and brush of the swampy borders of lakes, it is not likely that any one individual holds a favorite site to the exclusion of the others. In such places one can easily take, in an hour or so, 30 or 40 adults with the aid of either flash light or acetylene light.

If one wishes to secure them by day he may adopt the device of the familiar red flannel on a hook or ordinary fish bait. At the breeding season one occasionally finds them in grassy situations. Here they lie on the surface of the water. One has only to wade among them to capture them by hand. At first they may become frightened, but soon they reappear. Whenever bullfrogs are hard to find or scarce in certain bad seasons let the collector search out a former mill pond whose dam is gone, and in the temporary small ponds remaining he can frequently find the frogs in their circumscribed quarters.

The males have the first finger enlarged (Pl. XII, fig. 4) and enlarged tympana. They begin croaking 15 to 30 days before actual spawning takes place. In some ponds the males are very much in evidence. In one lake, when the bullfrogs were laying freely, as many as 10 males were found within a space of 8 feet. Here among the dead branches of overhanging elderberry bushes (Pl. XIII, fig. 1) they were hidden because of the dense mat made by the shrubs. At this time in midday the author had no difficulty in capturing, by hand, in half an hour, some 25 males, while only three or four females were observed. This was in the middle of June. Later in the season the females appear more in evidence. Doubtless these easy captures of a supposedly shy form were naturally due to the fact that it was their breeding season. The author is, however, coming to believe that this species is as easy of capture as any other large frog. Even after a bullfrog has left the water's surface one may capture it while it is swimming beneath the water, for it is very slow as compared with some of the other



FIG. 1.—HABITAT OF COUCH'S AND HAMMOND'S SPADEFOOTS AND OF TWO TOADS (*BUFO WOODHOUSII* AND *BUFO COMPACTILIS*), SIERRA BLANCA, TEX.



FIG. 2.—HABITAT OF THE SOUTHERN BULLFROG; OVERFLOWED AREA AND TANGLED SWAMP OF A CLEAR SOUTHERN STREAM, THEODORE, ALA.



FIG. 1.—HABITAT OF THE CRICKET FROG; A SHALLOW GRASSY AND SEDGY MEADOW POOL, DINWIDDIE, VA.

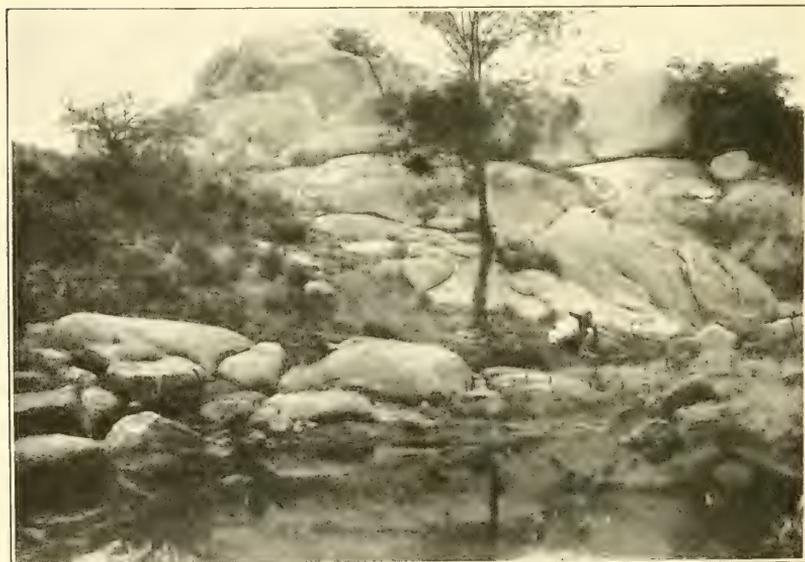


FIG. 2.—HABITAT OF THE DESERT TREE TOAD (*Hyla arenicolor*) AND OF A TOAD (*Bufo punctatus*); A ROCKY CREEK IN A DESERT MOUNTAIN PASS, DRAGON, TEXAS PASS, ARIZ.

forms. If one wish to stock his inclosure or ponds with adults, let him do it by the first of July, or preferably by June 1.

The southern bullfrog is one of the common forms of the deep-wooded swamps and of the water-lily-filled watercourses of such areas and is often called the swamp bullfrog. Equally frequent is it in the vast, open, swampy stretches or "prairies" of the Everglade, Okefinokee, and other famous southern swamps. The bright green and yellow of the under parts make it very conspicuous when in hand. Often these creatures will not dive until within an oar's length, but in the main this species is a shy form. Occasionally the author has taken them when visiting trap lanterns in aquatic situations.

The southern leopard frog is similar to the common leopard frog in habitat, mating, and general habits.

#### MATED PAIRS (PLS. XI AND XII).

Some articles on frog culture advocate stocking the suitable waters with a sufficient number of mated pairs of mature frogs. To the writer the main consideration in using individual breeders or mated pairs is that it positively proves to the beginner the identity of the species with which he is stocking his waters. Heretofore the most creditable published attempts with eggs or tadpoles taken afield leaves one with the impression that the experimenter was not absolutely sure whether he had good or worthless species. If mated pairs be the starting point, avoid pairs mated in captivity by some one other than yourself, for you do not know their period of captivity. If mated by the person concerned within one or two days after being taken in the field, return them to the out-of-door environment at once. The only sure source of fertile pairs is the field-mated pairs. The writer finds that in at least nine different species of frogs the pairs captured afield usually remain mated, no matter how long the journey to the laboratory or hatchery or pond, however roughly handled, or however hot the glass jar (not advisable) became from sun exposure. If they broke apart on the trip, they soon resumed mating and seldom released their hold when transferred from aquarium to aquarium or from pond to pond.

When mated pairs are secured in the field, one can reasonably expect them to lay the following night or the next day unless the temperature of the water drops suddenly. Rarely a pair may wait several days before ovulation. The prospective frog breeder can identify his material by the mode of embrace. All of the four principal commercial eastern frogs belong to the true-frog (*Rana*) group, in which the male holds the female behind the forearm with his hands appressed to the breast of the female (Pl. XI, figs. 1 and 2). This is the so-called pectoral embrace, and any mated pair with pectoral embrace found after April 25 is almost positively one of the four principal marketable eastern species. Before April 25 the wood frog pairs might be taken; but if the characters of this species already described are remembered, no mistake will be made.

DESIRABLE SPECIES.—Of the four principal marketable eastern species, the mating of the leopard frog is easily the most familiar. This species is not restricted to night courtship, although most of it occurs at this time, and more mated pairs can be secured at night with

a light than in the daytime. One can frequently observe the mating behavior of this species during the day, if he can discover a spot where the species has already begun ovulation. The author has taken most of his mated pairs under such conditions. Before they are mated the males may be heard croaking at the surface. Occasionally when wading through an area in which eggs are numerous, one hears croaks which at first puzzle him; they come from the mated and mating frogs beneath the water and often reveal the position of the game on the bottom. At such times, one finds several males and gravid females about and under sticks. More rarely, the pairs appear at the surface. The period of mating begins April 1 or before, but the bulk of it does not come until the middle of April; it continues for about three weeks, extending to the first or middle of May.

Like the leopard frog, the pickerel frog is gregarious at the breeding time and often gathers in small, restricted areas for egg laying. This facilitates its capture. The beginning of mating usually comes the last week in April, the earliest record being April 5, the average April 23. This species mates by day or night. The author has seen very vigorous matings at all times of day. Often, within a small area 6 feet square or less, one can find 12 to 15 pickerel frogs mating or pairs in egg-laying positions. The mating places are often, but not always, in shallows. Along one shore, within a short stretch, the author has counted 20 or more frogs actively mating, to say nothing of those in the water. In one instance, in a space 3 feet square, were 21 unmated males, 5 mated pairs, and 8 fresh egg masses (representing 16 more frogs). Usually with most of the frogs, mated pairs, captured in the field, laid the night of the same day of their capture, but the rule did not always hold true with the pickerel frog; in fact, it seemed the exception. To find pairs of pickerel frogs which had mated in the laboratory waiting two or three days before ovulation was not surprising, but frequently pairs from the field waited from two to five days before laying. In two instances in different years (one, in an early season, the other in a late season) the eggs were laid after remaining in the embrace a week. In 1912 a pair continued in the embrace two weeks before ovulation. This delayed deposition makes the pickerel frog less desirable than the leopard frog.

The green frog is a solitary species. This habit makes it difficult to capture mated pairs in the field. One might better begin with the eggs or tadpoles or adult breeders. The mating is more active at night than by day. It does not begin before the latter part of May. With captive individuals it has been noted as early as May 22. The interval between first croaking and actual mating may be considerable. In his night collecting the author not infrequently located places where a male might be found croaking several nights in succession. Egg masses have subsequently been recorded in such spots so often that it has been found a good plan to keep such localities in mind when searching for eggs by day or night. About such masses the original or other males are afterwards frequently found for varying periods. In fact, many have been captured in this way.

The bullfrog is as shy as the green frog, and only about places where they are abundant could one ever hope to capture an appreciable number of pairs.

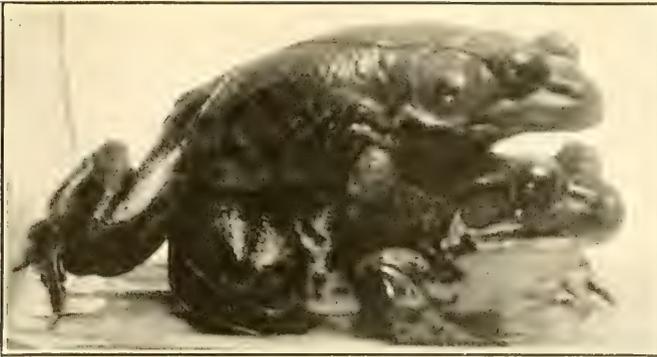


FIG. 1.—GREEN FROGS. EARDRUM NORMAL IN FEMALE, ENLARGED IN MALE.

(After Wright, Carnegie Publ. No. 197.)



FIG. 2.—LEOPARD FROGS. PECTORAL EMBRACE.

(After Wright, Carnegie Publ. No. 197.)



FIG. 3.—TREE TOADS. AXILLARY EMBRACE.

(After Wright, Carnegie Publ. No. 197.)



FIG. 4.—COUCH'S SPADEFOOTS. INGUINAL EMBRACE.



FIG. 2.—WOOD FROG, CONVEX WEB OF MALE.



FIG. 4.—BULLFROG, FOREFINGER OF MALE  
VERY MUCH SWOLLEN.



FIG. 1.—WOOD FROG, CONCAVE WEB OF FEMALE.

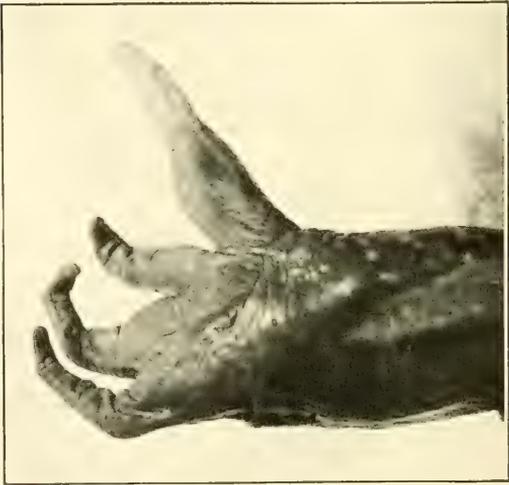


FIG. 3.—BULLFROG, FOREFINGER OF FEMALE  
NOT SWOLLEN.

The author found the southern bullfrog at the breeding season in the swampy tangles of buttonbushes and white alders, where the water was waist deep and the bushes 8 to 12 feet high. In southern Alabama he recorded croaking males as not uncommon in overflowed areas and swamps (Pl. IX, fig. 2) of clear streams, especially if overgrown with a thick mat of cat briars (smilax) and arrow arums. In the main their croakings consist of four or five notes and are wholly unlike the call of the northern bullfrog. To some people there is something of the human voice in their call; to others it sounds like an alligator. If the ventriloquial males be in tangles they are hard to discover. These croaking males may also occur along the deep-wooded, overflowed banks of southern rivers. The males have the eardrums enlarged (see green frog, Pl. XI, fig. 1) and the first finger swollen. (See bullfrog, Pl. XII, fig. 4.)

POSSIBLE SPECIES.—At all seasons, except the breeding time, the wood frog is silent and retiring. In water at the spring congress they are difficult of approach. At ordinary approach the best one can hope for is only a series of surface ripples. Such assemblies may not last more than a day or so each year. Anywhere from 50 to 200 males have thus been observed floating at the surface. The scene resembles a small toad assembly, in which there is the same scrabbling and zeal of mating. They disappear simultaneously on seeing anyone, and on going through the pond a minute later one would wonder where the 200 males could be, to say nothing of the females. At the approach of the breeding season the males have the thumb much swollen and the webbing in the hind feet with margin convex, not concave, as in the females at all seasons and in males at other seasons of the year (Pl. XII, figs. 1 and 2). The period of mating has begun in some years as early as the middle of March and may rarely extend to May 1. The species is customarily at the height of sexual ardor the last week of March or the first week in April. They mate to some extent by day, but more frequently during the night.

In the common toad the males are noticeably smaller than the females, have dark throats, and at the breeding season possess dark-brown excrescences on the inner upper side of the first two fingers (rarely on the inner edge of third finger) and on the inner carpal tubercle. Both sexes repair to the water about the same time. The migrations begin early in April, but the toads have been recorded migrating to breeding localities as late as June 14, by which date many of the early breeders are leaving or have left the ponds.

The males far outnumber the females, and the furious actions incident to the first meetings of the two sexes, or following the arrivals of other toads, are long sustained and exhausting. The male embraces the female by digging its forearms into the axilla of the female, the fore fingers of the male being folded up. (See tree toad, Pl. XI, fig. 3). In this way it is clearly seen how the dorsal horny excrescences of the first three fingers of the male come into use.

In the west and southwest six species of toads may continue to breed as late as July or August, dependent on the rains, and in each species the male has the same kind of excrescences on the fingers and the same form of embrace as already described for the common toad. Because of their greater size two of these six might be of more commercial importance than our common toad. They are *Bufo woodhousii* and *B. alvarius*.

The hermit spadefoot toad<sup>a</sup> appears suddenly after prolonged rains in April and May or sometimes June or July. At the breeding season it is fond of sprawling out on the surface of the water as a wood frog does; and it is from this position that it croaks. This species gathers in large breeding assemblies like toads, and the matings are as spirited. The male seizes the female just ahead of the hind legs (inguinal fashion), a form of embrace not known in any other American forms except in the narrow-mouthed toads and possibly *Ascaphus truei* of Washington.

The same form of embrace (Pl. XI, fig. 4) and dependence on rains seems to hold true of Couch's and Hammond's spadefoots of the southwest and west, where the writer has observed their breeding habits. In these regions, after long droughts, these creatures and other species of toads at night almost literally pour down from the mountains or in the desert to any temporary streams (Pl. IX, fig. 1), pools, or "tanks," and their strange choruses can sometimes be heard from one-half to a mile away. The croaks of the Couch's spadefoot are given from the edges of swift-flowing, temporary streams or ponds and resemble the mewling of a cat. The males of Hammond's spadefoot float more or less on the surface of the water and, like the hermit spadefoot, dip the posterior portion of the body as they croak. Sometimes when both species are breeding in the same place at the same time cross embraces between the species ensue.

UNDESIRABLE SPECIES.—In the undesirable species such as tree frogs, like the peeper and tree toad (*Hyla*), the cricket frog (*Acris*), and the swamp cricket frog (*Pseudacris*), the mating embrace is axillary (Pl. XI, fig. 3), and any mated pair with such a form of embrace is an undesirable species, unless it be the possible form, the toad. The narrow-mouthed toads (*Gastrophryne*) have the inguinal form (Pl. XI, fig. 4) of embrace, and no desirable form normally mates in this way. The possible form, the hermit spadefoot (*Scaphiopus*) does mate in this manner, and sometimes a weakened male toad (*Bufo*) with normal axillary embrace or a weakened male frog (*Rana*) with normal pectoral embrace may seize a female just ahead of the hind legs (inguinal fashion) in lieu of the normal embrace.

#### EGGS.

Several experimenters have suggested that to rear frogs for the market one could best start with eggs easily procured in nature. This apparent ease, however, has often led people to work with undesirable stock; and even some of the experimenters themselves have not been absolutely sure to which species of frogs the eggs belonged. With certain precautions as to the identity of the material, it is a convenient point at which to begin the work. It is, however, highly essential that one know the undesirable frogs and their eggs—the tree frogs, swamp cricket frog, peeper, cricket frog, and the large tree frogs; the narrow-mouthed toad; and the oak toad; and also the possible forms—the wood frog, other smaller frogs, the toad, and the spadefoot.

DESIRABLE SPECIES.—In the early spring the leopard frog is the second true frog to begin ovulation. It prefers cat-tail swamps

<sup>a</sup> Overton, Frank: Long Island fauna and flora. The frogs and toads. Museum, Brooklyn Institute of Arts and Sciences. Science Bulletin, vol. 2, No. 3, pp. 28-30. The author wishes to thank Dr. Overton and the Brooklyn Museum for the generous loan of Pl. IV, fig. 1, and Pl. XVIII, fig. 4.



FIG. 1.—A SURFACE FILM OF BULLFROG EGGS ATTACHED TO THE TIPS OF ELDERBERRY BUSHES.



FIG. 2.—AN EGG AREA OF LEOPARD-FROG EGGS, THE EGG MASSES ON THE BOTTOM OR ATTACHED TO VEGETATION.

(After Wright, Carnegie Publ. No. 197.)



FIG. 3.—A SURFACE FILM OF GREEN-FROG EGGS AMONG VEGETATION.

(After Wright, Carnegie Publ. No. 197.)



(Pl. V, fig. 1), marshy expanses of other types, grassy overflows (Pl. VII, fig. 1), and shallow, dead streams. In other situations than these it breeds sparingly. In some places it begins laying before April 1, and the period of ovulation may extend to May 15. In general, when the air temperature reaches 43 to 48°, and certainly when it averages 51 to 55°, the leopard frog begins spawning. The temperature of the water varies from 43 to 45° at the beginning of breeding to 50 to 65° at its crest. The leopard frog may lay at any time of day, even at noon, but more frequently it spawns at night. Leopard frogs have a tendency to congregate in large numbers and often 40 or more bunches of eggs are recorded within small circumscribed areas (Pl. XIII, fig. 2). At such times, when an area is approached, the mated pairs often seek cover under the bunches which have already been laid.

The egg masses of the leopard frog may be attached to submerged cat-tails, twigs, sticks, grass, etc., or as often may rest on the bottom unattached. Several times the water's surface has been observed to be so low that the tops of the bunches appeared at the surface. The bunches of eggs occur in the open, unprotected, marshy expanses, or in overflows where the edges and bottoms have plenty of grass. One will often find the egg masses interspersed with algae and dead leaves, which so fill the shallows that the bottom can not be seen. As a rule, the leopard frog tends to seek shallower water and more swampy localities than the wood frog. The egg mass at ovulation is 1 or 2 inches in diameter. After it has expanded it is plinthlike or flat, the greater diameter varying from 3 to 6 inches, the smaller from 2 to 3 inches (Pl. XIV, fig. 2). The eggs of this species might be confused with those of the wood frog, which lays during the same period. The differences between the two are elaborated under the wood frog (p. 28). Under normal field conditions the eggs hatch in from 13 to 20 days.

The southern leopard frog, as well as the northern leopard frog, breeds normally in the spring, and hence is called the "spring frog," but occasionally its breeding period may extend until July 4, or later, after the first eggs of the species are hatched and the tadpoles transformed.

The egg mass of the southern leopard frog is plinthlike (Pl. XVIII, fig. 2), and the individual eggs are hardly distinguishable from those of the northern form. These masses may occur attached to vegetation along the quiet side shallows of streams or unattached upon the bottoms of pools, or they may be laid in swampy situations.

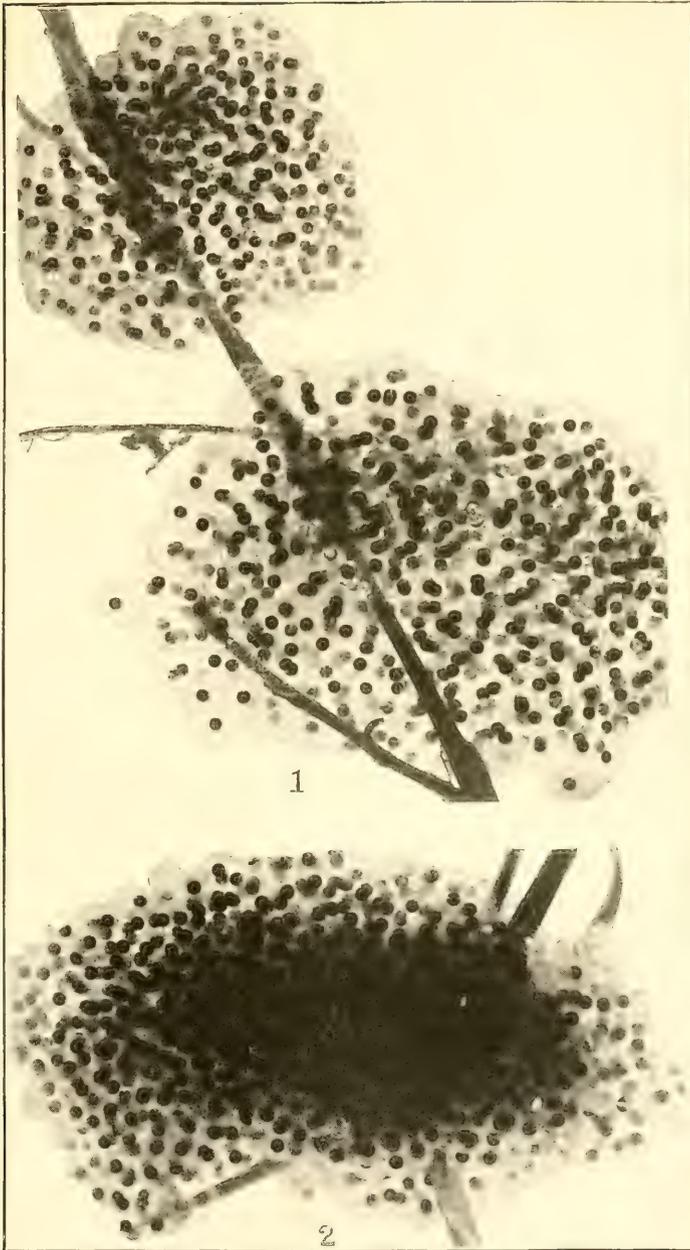
The pickerel frog, as far as the recorded situations show, seeks clear water, and, in the main, is usually found in the upper stretches of our clear streams. It frequents ponds heavily laden with dead leaves of quiet backwaters (Pl. V, fig. 2). The eggs are frequently found in the shallows of mill ponds, rocky holes of ravines, or lowland pools of wide, meandering streams. The bulk of egg laying occurs during the last week in April and the first week of May. Usually the period extends from April 23 to May 15. One may expect this species to begin laying when the temperature of the air reaches 50 to 61° and most certainly when 65 to 69° are recorded, provided the temperature of the water is 51 to 64°.

The eggs of the pickerel frog are almost invariably submerged and attached to sticks, twigs, or tufts of grass stems. The species

usually seeks the shallows for egg laying, although not exclusively. Almost every year some egg masses are found in the middle of ponds where the water is 3 feet deep or more. It tends to lay in special areas (Pl. XVII, fig. 3), as do the wood frog and the leopard frog. At one time, in an area 3 by 3 feet, 18 bunches were deposited. In another spot of the same dimensions 31 bunches were found. All of these areas gave excellent illustrations of the placing of bunches one upon another. The greatest number of bunches observed upon one support was a case in which 7 were noted. Quite frequently on one tuft of grass, or on a stick, one finds one or more bunches of eggs of the spotted salamander, a bunch of leopard frogs' eggs, and as many as two bunches of pickerel frogs' eggs immediately above them—seldom below, because laid later. At the time of deposition a bunch may be 1 to 2 inches in diameter, but it soon expands to  $3\frac{1}{2}$  or 4 inches. It is usually firm and globular (Pl. XV, fig. 3). The egg complement of the pickerel frog may be from 2,000 to 3,000. The bright yellow or orange lower and the brown upper halves of the eggs of the pickerel frog make them the most easily distinguishable of all our true frogs' eggs. In nature the eggs may hatch within 11 to 21 days.

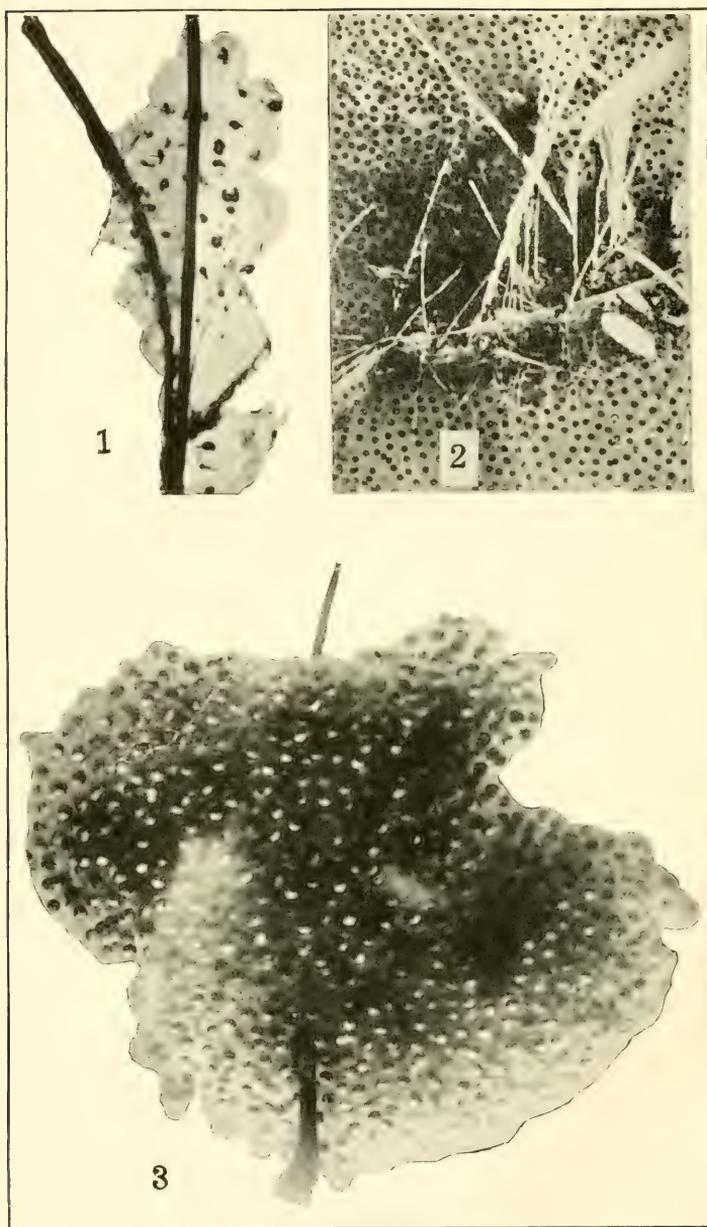
The green frog begins ovulation in the late spring or early summer, the extreme dates being May 23 and August 10. When the air temperature reaches 65 to 74°, or the temperature of the water surfaces 68 to 76°, the green frog may be expected to begin breeding. Surface temperatures are probably very influential in controlling the breeding habit, because of the position of the eggs after they are laid. When the air temperature reaches 80°, the species breeds commonly. During June and the first part of July the eggs of this form are very common; thereafter they diminish in numbers until the last of July or the first of August, when a few stragglers deposit the last eggs of the breeding season. This species lays mainly at night, but the author has twice seen it laying during the day.

The mass of the green frogs' eggs floats on the surface of the water. The typical form (Pl. XV, fig. 2) is a disklike film of a single layer of eggs, loosely attached or free. The eggs have the upper halves black and the lower halves white or creamy white. They may be found in the middle of the pond, where it is filled with a cover of algæ at the surface, or with hornwort, water milfoil, Chara, Nitella, or similar water plants, which make a mat of vegetation from the bottom to the surface, or where isolated patches of grass, water plantain, etc., grow in the middle of a pond. Usually, without such conditions, the masses occur about the edges of the pond (Pl. XIII, fig. 3), attached to grass, smartweed, etc., either growing in or extending into the water. In 100 or more cases hardly an exception to the surface deposition has been noted, but a few apparent exceptions have occurred. One egg complement was found in a somewhat scattered mass on leaves and twigs partially submerged. In another instance some of the complement was at the surface and the rest in water 4 to 6 inches deep. Inasmuch as such masses were found some time after deposition, a rise in the level of the pond could easily have brought about this anomalous condition. Another variation in the location of the egg mass is occasionally recorded. The mass may be attached to grass stems, the point of



FIGS. 1 AND 2.—FORM OF EGG MASSES.

1, Egg masses of wood frog, both masses globular; 2, egg mass of the leopard frog, mass plinthlike, not globular. (After Wright, Carnegie Publ. No. 197.)



FIGS. 1 TO 3.—FORM OF EGG MASSES.

1, Egg mass of the swamp cricket frog, several such bunches laid by one female; 2, egg mass of green frog, a surface film among vegetation; 3, egg masses of the pickerel frog, globular mass, frequently in tiers. (After Wright, Carnegie Publ. No. 197.)

attachment being some 4 or 5 inches below the surface of the water. This attachment serves as the apex of an inverted cone, and the base of the cone spreads out on the surface of the water. This also may be due to a rise in the level of the water. Rarely a mass more than a foot square is recorded. Some of these masses may be composite. In a certain pond, where numerous frogs had laid, two bunches had been placed so close together as to make a film 15 by 10 inches. In another case a mass just as large was secured, and the evidences of its double nature were even more evident than in the preceding instance.

For several years small isolated packets of eggs were found on the water's surface, distributed in the manner of tree toads' eggs, but without their individual characteristics. They could not have been those of the swamp cricket frogs' eggs, for this species lays very early in the spring. At last it was discovered that, as egg development went on, the egg masses of the green frog often lost their circular disklike form, assumed irregular shapes, and separated into small masses of 25 or more eggs, a natural process due to the jelly becoming loose as hatching approached. But the egg packets observed were composed of fresh eggs. In those instances the wind or strong currents, or both, caused them to float away from the original mass.

The bullfrog begins egg laying at air temperatures of 71 to 72°, or at water temperatures of 66 to 71°. On the average, however, breeding comes at an air temperature of 80° and at a water temperature of 70 to 71°. The bullfrog lays the last of June or in July. The author's breeding record for this frog extends from June 16 to July 10. Doubtless it begins earlier some years or extends beyond July 10 in belated seasons. The writer has taken females with ripe ova the last of July. Ovulation usually occurs at night, at which time the species is most active. The bullfrog is a solitary form, yet at the height of breeding a mill pond (Pl. VI, fig 2) may have a dozen or more pairs in it, and some lakes may be well enough supplied with them to furnish the famed bullfrog choruses of June and July.

Usually the egg masses of the bullfrog are found among brush or under similar cover (Pl. XVI, fig. 1). The disk form so prevalent in the egg masses of the green frog obtains with this species as well. In one instance the egg mass covered a space of 2 by 2½ feet, or 5 square feet; in a second case, 2 by 2 feet; and in a third, 2 by 1½ feet. The size of these masses is a sufficient criterion for identification, since it is very unusual to find an egg mass of the green frog which covers a square foot. The first of these three egg films was deposited upon a mass of driftwood and brush, which was at the surface; the second was found among some fresh white branches that extended into the water from the edge of the pond. In rare cases the masses become stringlike, due to shifting water levels. One such mass was found attached to the roots of an overturned stump in shallow water and another in brush beneath a boathouse float. Sometimes bullfrogs lay their films in midpond around stumps, or attach the surface egg film to the tips of overhanging bushes which extend into the water (Pl. XIII, fig. 1). The winds often break these films into pieces and distribute them along the shores of the lake or pond. The mass is glutinous and is not firm

and hard, as in the wood-frog, leopard-frog, and pickerel-frog eggs, which are laid earlier in the season. In the last of June and through July only one other common frog is breeding; namely, the green frog. The green frogs usually deposit their eggs upon vegetation. They lay on or among grass, water plants, and algæ, or along grassy edges of ponds, while the bullfrog almost invariably lays in brush. The egg complements of the two species are also different in size. The green frog seldom lays more than 3,500 or 4,000 eggs, while the bullfrog may lay from 10,000 to 20,000. Usually, the egg of the bullfrog has not the distinct middle envelope of jelly which is found in the green frog's egg (fig. 1, *F* and *D*). Furthermore, this middle envelope in the eggs of the green frog often is elliptical, and not round, as in the eggs of the leopard and pickerel frogs (fig. 1, *G* and *B*). In nature, the eggs hatch in four days or less.

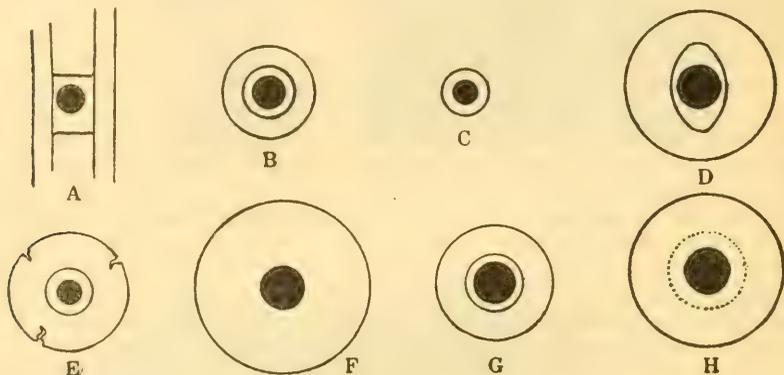


FIG. 1.—INDIVIDUAL EGGS (three times natural size).

A. Egg of common toad in two jelly envelopes or tubes, the inner of which is divided by cross partitions. B. Egg of pickerel frog. Inner envelope and egg proper of same size as egg of leopard frog (*G*) but outer envelope smaller. C. Egg of peeper. The one envelope and the egg proper together appear the duplicate of the egg of the tree toad (*E*) when it is stripped of its outer envelope. D. Egg of green frog. Unlike the egg of the bullfrog, it has an inner envelope. E. Egg of tree toad. The outer envelope often ragged in outline. F. Egg of bullfrog. Unlike the other four frogs, it has no inner envelope. G. Egg of leopard frog. Egg proper black and white, not brown and orange as in pickerel frog (*B*). H. Egg of wood frog. It has the largest egg proper of these eight species and larger envelopes than the confusing pickerel-frog (*B*) and leopard-frog (*G*) eggs. (After Wright, Carnegie publication No. 197.)

The eggs of the southern bullfrog are not known, and we are not very familiar with its breeding habits. In Georgia, Florida, and Alabama the writer has chanced upon this species in full croaking season in June and July. This species is reputed to lay small eggs in large masses on or at the surface of the water in the early summer, and if this be true the habits of this form are closely similar to those of the northern bullfrog.

POSSIBLE SPECIES.—The hermit spadefoot toad is one of the most erratic and transient of our toads or frogs. It suddenly appears after a shower, and egg laying is soon over after an ear-splitting chorus of croaking lasting a few days. Breeding usually occurs in April but occasionally persists until August. This species breeds in quiet pools and ponds (Pl. VII, fig. 2). The eggs are enveloped in a gelatinous band (Pl. XVIII, fig. 4), the cross section of which includes several eggs. In the common toads the eggs occur in one

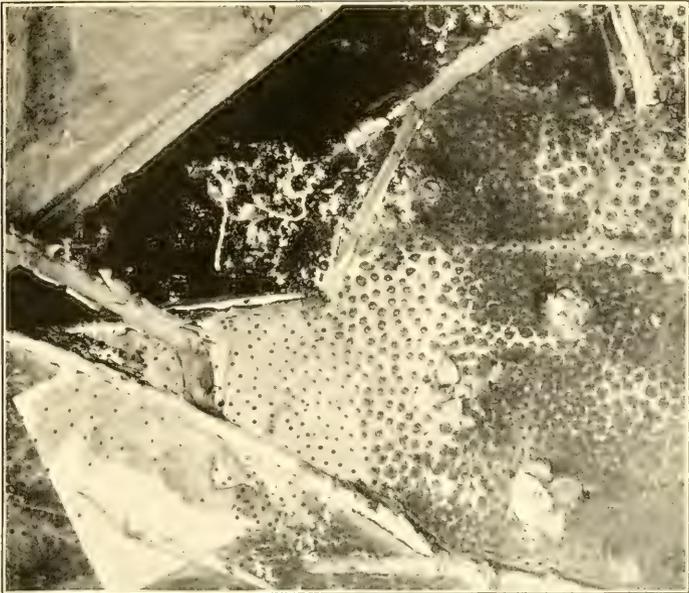


FIG. 1.—EGG MASS OF BULLFROG; A SURFACE FILM 18 INCHES IN DIAMETER LAID AMONG DEAD STICKS AND OLD BOARDS.  
(After Wright, Carnegie Publ. No. 197.)

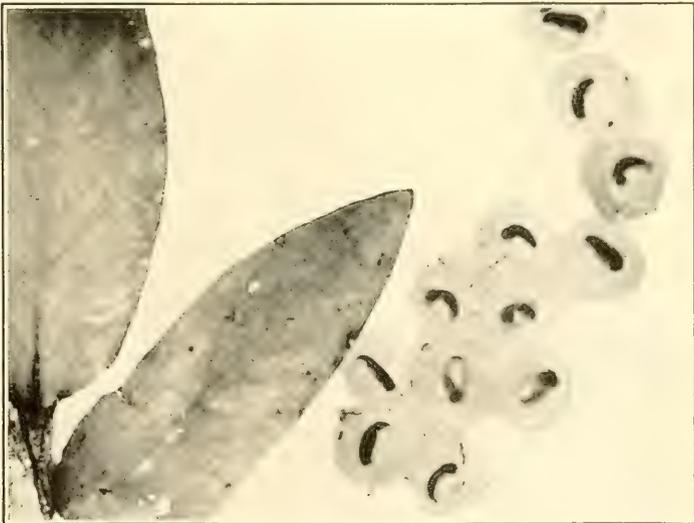


FIG. 2.—A SURFACE PACKET OF TREE-TOAD EGGS ATTACHED TO A POND-WEED LEAF.  
(After Wright, Carnegie Publ. No. 197.)

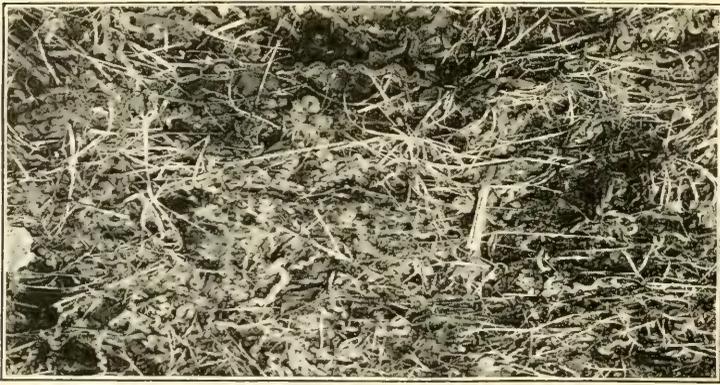


FIG. 1.—COMMON TOAD EGG STRINGS CURLED ABOUT VEGETATION.  
(After Wright, Carnegie Publ. No. 197.)



FIG. 2.—THE STALKED EGGS OF THE DESERT  
TREE TOAD (\*).



FIG. 3.—AN EGG AREA OF THE PICKEREL FROG AND TWO MATED  
PAIRS; EGG MASSES ATTACHED TO VEGETATION AND STICKS ON  
THE BOTTOM.

(After Wright, Carnegie Publ. No. 197.)

or two lines or files within one jelly tube. The eggs of the spadefoot usually hatch in a very short period.

While the hermit spadefoot lays eggs in bands like the European forms of this family, the spadefoots of the Southwest—namely, Couch's and Hammond's spadefoots—may strew them on the bottom of the ponds. These eggs may be singly placed or be in more or less agglutinated masses usually one egg deep and may be laid as late as mid-August. This peculiar arrangement of the egg complements may be due to the absence of suitable vegetation, since Strecker<sup>a</sup> has seen Couch's spadefoots lay egg bands which became attached to grass, etc.

The life histories of several smaller true frogs are unknown. These, including Cope's frog, the yellow-legged frog, and *Rana onca*, are too small to be considered.

The wood frog usually chooses still water for spawning, rarely backwaters or bayous of streams. It prefers the leaf-laden ponds (Pl. VIII, fig. 1) and transient pools of wooded districts, though not wholly restricted to such localities. Occasionally the author has seen the frogs migrating to swampy cat-tail stretches for spawning and has both observed and heard them in such situations. Two of his best collecting spots were a grassy pool and a high upland pond, both of which were out in the open and ordinarily dried up in midsummer. In wooded districts he has found them even using pools no more than  $1\frac{1}{2}$  by 4 feet in area. When the air temperatures average  $53$  to  $58^{\circ}$ , one may go out with some expectation of finding the wood frogs spawning, provided the water temperature is at least  $41$  to  $48^{\circ}$ . Spawning reaches its height usually at about  $53$  to  $60^{\circ}$ . The average date of spawning is about April 4; the author's earliest record is March 19; his latest first record, April 14. In general, wood frogs spawn most frequently in the first half of April, though occasionally earlier or later, depending on the season. In some years, when spring opens early, as the last of March, the spawning begins with a rush, and the species may be practically through laying within from four to six days after the beginning of ovulation. Most of the egg complements are laid at night, yet the author has frequent instances in which the eggs were laid during the day, both in the laboratory and in the field. In the laboratory, they have been observed to lay throughout the day; in the field, there have been numerous indications that eggs were laid during the day. This species is gregarious at the breeding season. Where the first bunch of eggs of the season is laid, one is quite certain to find other wood frogs depositing their complements later. In this way the whole egg content of a large pond may frequently be massed in a small limited area (Pl. XVIII, fig. 3).

The eggs of the wood frog may be deposited either near the edges or in the middle of the pond. They are usually attached to grass stems, weed stalks, twigs, or brush; but, in rare cases, they may rest free on the bottom. In this species the egg bunches tend to be attached more frequently than in the case of the leopard frog. In rare cases, wood-frog and leopard-frog masses are found on the same twig. The egg mass, at the time of laying, may be an inch in diameter. Within one-half hour to two hours it assumes a diameter

<sup>a</sup> Strecker, J. L.: Notes on the life history of *Scaphiopus couchii* Baird. Proceedings, Biological Society of Washington, Vol. XXI, p. 203. Washington, 1908.

of 2 or 3 inches. Freshly laid masses are always of a very bluish tinge. The eggs are usually found in shallow water, 6 inches to 2 or 3 feet deep, though occasionally eggs have been in water of a greater depth. The eggs of the wood frog are to be confused only with those of the leopard frog. In the former, the egg mass is globose (Pl. XIV, fig. 1); in the latter it is plinthlike. In the leopard-frog egg, the middle envelope is evident to the naked eye, which is not true of the wood-frog egg (fig. 1, *G* and *H*). The eggs of the wood frog are free, and the outer envelope of each egg keeps its spherical form more exactly than in the case of the leopard frog, where the eggs are closer together and both they and the outer envelopes smaller. The eggs of the wood frog are 3.6 to 5.5 mm. from each other, while in the leopard frog the eggs are 2.6 to 3.6 mm. apart. The two egg masses can be separated easily in the field by inverting the mass, thus revealing the lower side of each egg. In the eggs of the leopard frog the whiteness of the egg mass becomes very apparent, but in those of the wood frog the general effect is not decidedly that of whiteness, because of the evident encroachment of the black of the upper half upon the lower side.

The northern wood frog doubtless has breeding habits similar to those of the eastern wood frog.

The life history of the common toad will serve well enough as an example of the life histories of our more common toads. At the spawning season hundreds of pairs may be recorded laying at one time; and in one instance 10 pairs were secured within an area  $1\frac{1}{2}$  feet square. Any water hole, ditch, or transient pool may contain one or more toads at this season. They seemingly prefer the shallower waters and are apparently not particular whether it be grassy (Pl. VII, fig. 2), weedy, or swampy (Pl. VII, fig. 1), or whether the bottom be free or covered with fresh or dead vegetation. So long as water is at hand, their main desideratum is met. In choice of a breeding spot, then, the toad is easily suited and will use a greater variety of localities than any other anuran. This species may begin spawning when the temperature of the air is  $50$  to  $51^{\circ}$ , but the crest of the breeding season is reached at about  $70^{\circ}$ . Spawning may begin when the water temperature is as low as  $51^{\circ}$  but reaches a maximum when the water temperature is about  $56$  to  $66^{\circ}$ . The toad begins ovulation about April 23, the earliest examples recorded being April 5. The crest of ovulation comes about April 30. Thereafter the number of spawning pairs diminishes. By May 15 or 20 the bulk of the laying is about completed, and by May 20 or 25 nearly all the toads' eggs are hatched. In June there are a few stragglers. In rare instances the species lays through July. So, spawning in this species occasionally extends far beyond the transformation time of the first-hatched toad tadpoles of the season. Egg laying takes place both by day and by night. The female toad lays from 4,000 to 7,000 eggs. The eggs are laid ordinarily in quiet water; it may be shallow, but not always so. The eggs are found in pools and ponds, artificial or natural, in marshes, backwaters, ditches, etc. The strings may rest merely on the bottom or be twined about vegetation or sticks which happen to be near at hand (Pl. XVII, fig. 1). The eggs are laid in long, spiral tubes of jelly (Pl. XIX, fig. 2). Each egg, with its quadrangular envelope, is incased in two tubes of jelly, one tube within the other. (See fig. 1, *A*.) The hatching period is

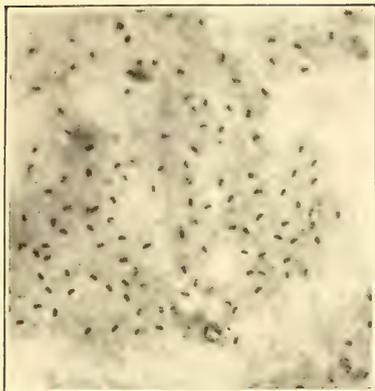


FIG. 1.—A SURFACE FILM OF TREE-TOAD EGGS.



FIG. 2.—A PLINTHLIKE EGG MASS OF THE SOUTHERN LEOPARD FROG.



FIG. 3.—AN EGG AREA OF THE WOOD FROG, THE EGG MASSES ATTACHED TO STICKS.

(After Wright, Carnegie Publ. No. 197.)

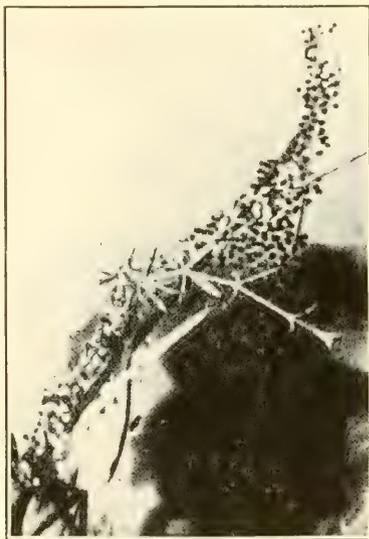


FIG. 4.—AN EGG BAND OF THE SPADEFOOT ATTACHED TO VEGETATION.

(After Overton, Mus. Brooklyn Inst. Arts & Sci. Sci. Bull., Vol. 2, No. 3.)

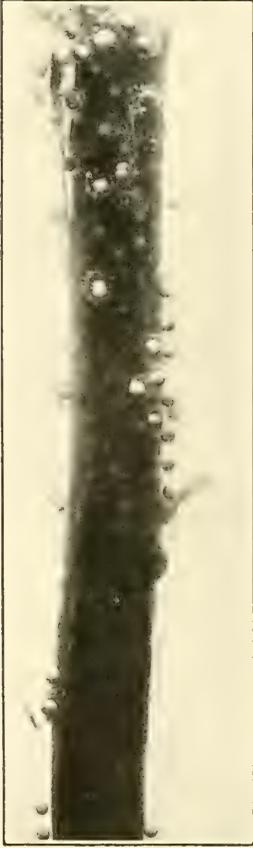


FIG. 1.—EGGS OF PEEPERS LAID  
IN THE AQUARIUM.

(After Wright, Carnegie Publ. No. 197.)

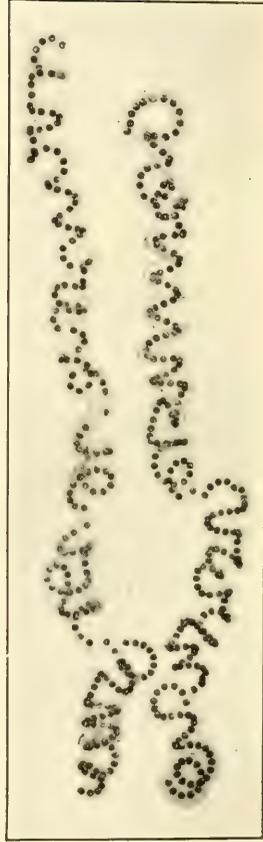


FIG. 2.—TWO EGG STRINGS OF  
THE TOAD; A STRING FROM  
EACH OVIDUCT.

(After Wright, Carnegie Publ. No. 197.)

very short. In general the eggs hatch within from three to five days. In colder seasons, the eggs may not hatch until 8 to 12 days have passed.

UNDESIRABLE SPECIES.—The swamp cricket frog, one of the first to appear in the spring, lays small bunches of eggs attached to sticks, leaf stems (Pl. XV, fig. 1), etc., in every transient pool, pond, or ditch, as well as in the swamps. In each bunch are 20 to 100 eggs. Usually the bunches are beneath the surface, but the mass is seldom over 1 to 1½ inches in diameter. The eggs, however, are black on the upper half and white on the lower half. Besides, the largest individual eggs of this species may be as large as the smallest green frog or bullfrog eggs, which, however, are not laid until summer. Furthermore, the smallness of the mass enables one to distinguish the swamp cricket-frog eggs from any of the desirable frog-egg stock.

The peeper, together with the swamp cricket frog, makes up the shrill chorus from our swampy situations in early spring. They often occur in the same situations as the leopard frog, but the eggs of the peeper (fig. 1, *C*) are laid separately (Pl. XIX, fig. 1), do not occur in masses, and are hard to find. Hence there is little danger of their confusion with those of the leopard frog, though laid at the same time.

The cricket frog is one of the first forms to appear in the spring and according to several authors breeds in March, April, and May or even later. Abbott<sup>a</sup> says the small masses of eggs are attached to blades of coarse grass along ditches in the meadows. The writer recently found them breeding actively on June 1. They had chosen a shallow (1 to 4 inches deep), grassy meadow pool (Pl. X, fig. 1). The eggs were attached singly to sedge stems or were strewn singly on the bottom. In one or two instances three or four eggs were close together. Many of the eggs were in water not more than an inch in depth.

The larger tree frogs, like the common tree toad, Carolina tree frog, and the pine wood's tree frog, lay their eggs from the very last of May to July. The color of the eggs is brown on the upper half and cream or yellowish on the lower half. On the criterion of color alone they might possibly be confused with those of the pickerel frog, which deposits eggs, the upper halves of which are brown and the lower yellow or orange. The latter species, however, lays its eggs from April 20 to May 20 before the tree frogs begin. Besides, its egg masses are spherical, 2 or more inches in diameter, and are found beneath the surface of the water. These tree frogs lay at the same period that the green frog and the bullfrog do and, as do these, lay their eggs in films on the water (Pls. XVI, fig. 2, and XVIII, fig. 1). But the bullfrog and green-frog eggs occur in large films 2 to 8 inches in diameter, while the tree-frog films are seldom over 1½ inches. Occasionally, the large egg films of the bullfrog and green frog break up into smaller films, but then they can be distinguished from the tree frogs by the fact that the egg is black above and white below.

The narrow-mouthed toad is a form whose life history is not wholly understood. Brimley<sup>b</sup> holds that it breeds from May to August, and

<sup>a</sup> Abbott, C. C.: Notes on the habits of the "Savannah Cricket Frog." *American Naturalist*, Vol. XVI, No. 9, p. 707, 1882.

<sup>b</sup> Brimley, C. S.: *Batrachia* found at Raleigh, N. C. *American Naturalist*, Vol. XXX, p. 501. Philadelphia, 1896.

the author's limited experience with the species suggests that the eggs are usually laid during the spring or early summer. Deckert<sup>a</sup> found their eggs on August 28. The eggs were "laid in oblong, jelly-like sheets or flat masses about  $1\frac{1}{2}$  inches long and 1 inch wide. The egg masses contain about 100 to 150 eggs."

The oak toad breeds in May and June, most of the egg laying doubtless occurring before June 15. The egg string is laid in warm, shallow ponds, and many of these eggs or the subsequent tadpoles are dried up by the rapid evaporation of the very transient breeding pools. The egg string or file is a small edition of the southern toad's egg string, the former being much smaller in diameter than the latter. A female oak toad may deposit 500 to 600 eggs, while a common toad produces 4,000 or more. The eggs of the oak toad are slightly smaller than those of the common toad.

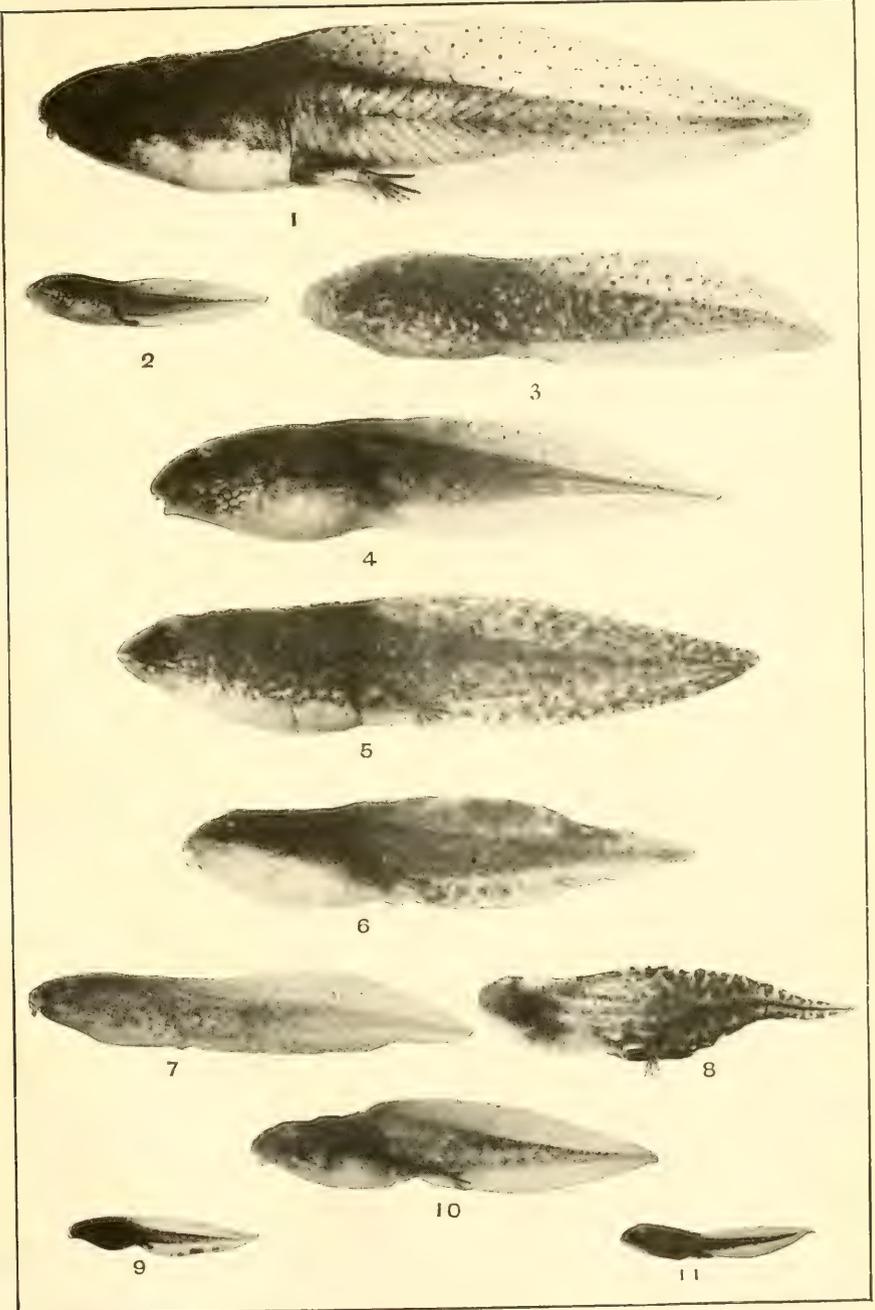
#### TADPOLES (PL. XX).

For the average layman the tadpole might prove the easiest starting point in attempting frog culture: Individual breeders must be secured just before mating; to take mated pairs is more difficult; the egg period is short and the chances of finding eggs restricted by time and the expertness of the seeker; but the tadpoles of some of the best species may be had at almost any time, the green frog remaining a year in the tadpole stage and the bullfrog two years. There are a few cardinal considerations to be borne in mind: Any large tadpole of the eastern United States found in the spring before May 1 is, so far as we now know, either a green frog or a bullfrog tadpole. Usually tadpoles taken after September 1, and almost surely after October 1, must be of the green-frog or the bullfrog species. Throughout the summer, when the other tadpoles are present, if a tadpole be at least 2 inches or more in length, it is generally either that of a leopard frog, pickerel frog, or bullfrog, all desirable species. In proportion to their size, these commercial frogs have smaller eggs than the smaller species of frogs, and, consequently, the period of tadpole development and growth to adult form may also consume more time both actually and relatively.

**DESIRABLE SPECIES.**—The tadpoles of the leopard frog transform during the same season in which the eggs are laid. The eggs are relatively larger and the size at transformation is smaller than in the green frog and the bullfrog. Usually 71 to 111 days elapse between egg laying and the change to small frogs, or 60 to 80 days elapse between the hatching of the eggs and transformation. The tadpoles of the leopard frog are very seldom found after August 15. The distinctive marks are: Crests of the tail (not muscular portion) conspicuously lighter than the body, almost transparent, and marked with widely scattered fine spots or specks; belly deep cream color with bronzy iridescence; greatest length, 3 to 3.4 inches. (See Pl. XX, fig. 4.)

The pickerel-frog tadpoles change into frogs the same season the eggs are laid. The developmental period from the egg to transformation consumes from 87 to 100 days; the period from egg hatching to transformation 76 to 85 days. The distinctive marks of the tadpole are: Tail crests not transparent or translucent, as in the leopard frog, but opaque, very dark, sometimes almost purplish

<sup>a</sup> Deckert, R. F.: Further notes on the Salientia of Jacksonville, Fla. Copeia, No. 9, p. 1, 1914.



FIGS. 1 TO 11.—MATURE TADPOLES, NATURAL SIZES.

1, 2-year-old bullfrog tadpole; 2, 3 to 5 months old bullfrog tadpole; 3, 1-year-old bullfrog tadpole; 4, leopard-frog tadpole; 5, 1-year-old green-frog tadpole; 6, pickerel-frog tadpole; 7, 3 to 6 months old green-frog tadpole; 8, tree-toad tadpole; 9, peeper tadpole; 10, wood-frog tadpole; 11, common toad tadpole. (After Wright, Carnegie Publ. No. 197.)



black, and usually marked with aggregate spots or blotches somewhat like the green-frog tadpole. In the pickerel-frog and leopard-frog tadpoles, in spite of the coppery iridescence on the belly, the elongate intestine shows through the skin, while in the green-frog tadpole the deep cream color hides the view of the intestine. The pickerel-frog tadpoles never reach 3 inches in length. (See Pl. XX, fig. 6.)

The green-frog tadpole requires one year for growth before it becomes a small fully formed frog. The same factors operate for this extension of time as in the case of the bullfrog tadpole. The tadpole of the green frog, however, has to attain a size slightly more than one-half that of the mature bullfrog tadpole, and the larval or tadpole period is, therefore, one-half as long. The distinctive marks are: Tail greenish, mottled with brown; belly deep cream color with very little or no iridescence; no round black spots; never over  $3\frac{1}{2}$  inches in length. (See Pl. XX, figs. 5 and 7.)

The bullfrog tadpole requires two years or more for growth before it transforms or becomes a frog in form. This long period of development results from several causes, among which are these: The eggs are relatively small and are laid late in the season; and the larvæ or tadpoles are hatched in an immature state and have to grow to a comparatively large size before they change into small bullfrogs; that is, the mature bullfrog tadpole may be three times as long as a wood-frog tadpole or twice that of a pickerel-frog or leopard-frog tadpole. Any tadpole over  $3\frac{1}{2}$  inches in length will prove to be that of a bullfrog. The distinctive marks are: Belly of a straw or maize yellow color; the body and the tail (except the lower crest of fin) with regular round black spots; and fine yellow dots all over the body. (See Pl. XX, figs. 1, 2, and 3.)

POSSIBLE SPECIES.—With the exception of the toad, the tadpoles of several possible forms are not well enough known to describe positively. The toad tadpoles seldom reach more than from 1 to  $1\frac{1}{4}$  inches in length. The small size required enables the tadpole to develop quickly into the toad form. The period of development from the egg to transformation is from 50 to 65 days; from the hatching to transformation, 41 to 60 days. The distinctive marks of the tadpole are: Body very dark or black (not greenish) in appearance; crests of the tail cloudy transparent or milky translucent and not high; tail tip often more or less rounded. (See Pl. XX, fig. 11.)

The tadpole of the wood frog develops in one season; usually the period of development from the eggs to transformation extends over about 90 days, though the range may be from 61 to 115 days. The tadpole period and breeding time of the wood frog coincide with those of the leopard frog. The tadpole of the wood frog never becomes more than 2 inches long. Like that of the leopard frog the belly of the wood frog has a bronzy iridescence, but it is more pinkish in the latter along the upper-jaw region, while the wood-frog tadpole has a cream-colored line; finally, the mouth of the tadpole of the wood frog has three rows of teeth on the upper jaw and four rows on the lower jaw, while all the desirable species have two rows of teeth on the upper jaw and three on the lower. (See Pl. XX, fig. 10.)

• UNDESIRABLE SPECIES.—Some of the more frequent tadpoles which should be avoided are those of the narrow-mouthed toad, the tree toad, the peeper, the swamp cricket frog, and the cricket frog.

The narrow-mouthed toad, so far as known, transforms the same season during which the eggs are laid. This period was formerly considered to be 90 to 100 days, but Deckert's<sup>a</sup> captives required only 16 days from hatching to transformation, an amazingly short period. The largest of the tadpoles of this species reach a length of  $1\frac{3}{4}$  inches and are very easily distinguished from those of other species. The body is very flat, and the depth of it is contained  $1\frac{1}{2}$  times in the width, while other tadpoles have round bodies; there is no spiracle; there are no horny-edged mandibles, and the lower lip of ordinary tadpoles is not present, while the upper has either a faint row of teeth or none at all. The color of the tadpole is quite conspicuous. On the back and sides it is a uniform brown or olive black. Along the middle of the muscular part of the tail there is a bright, clear, white band one-fourth to one-half inch long. Along either side of the belly there is a similar white line, and most of the belly is of this clear white. All in all, it is our most remarkable tadpole.

The known tree-frog tadpoles of this country, with the exception of the peeper, have the two rows of teeth on the upper lip and two on the lower, thus differing from the desirable frogs which have two rows on the upper and three on the lower. Furthermore, the upper tail crest (this is also true of the peeper tree frog) extends onto the back almost to between the eyes, which are lateral, visible both from the back and belly. In the tree-frog tadpoles the eyes are not visible from the lower side of the animal, and the tail crest seldom reaches onto the back beyond the vertical of the spiracle.

The common tree-toad tadpole takes about 50 or 60 days for development from the egg to the transformed tree toad. Sometimes the period may be no longer than 45 days or, in other cases, as great as 65 days. These tadpoles can be distinguished at once by their long tails, which are 2.2 to 3.5 times the length of the body and scarlet or orange vermilion in color, with black blotches more prominent near the margins of the crests. The belly is conspicuously of a white or light cream color, slightly iridescent, and the intestine does not show through. These tadpoles reach a length of 2 inches. (See Pl. XX, fig. 8.)

The peeper tadpole may have the rows of teeth two and two, as in American tree frogs in general, or some of the tadpoles may have a small third goateelike row on the edge of the lower lip. The peeper tadpole transforms about 90 or 100 days after egg laying and never exceeds 1.3 inches in length. The tail is only 1.4 to 2.1 times the length of the body. The tail crests are clear and usually heavily pigmented with purplish black blotches near the outer edges. (See Pl. XX, fig. 9.)

The swamp cricket frog spends about 75 to 100 days in passing from the egg to transformation. The tadpole is the darkest in color of any tree-frog tadpole; the body is brownish black all over, and the back and the upper two-thirds of the muscular part of the tail have the same color. The lower third of the muscular portion of the tail is whitish. The tail crests are transparent and practically unspotted, a character which is distinctive in an adult tadpole. The rows of teeth are 2-2, or 2-2 with a slight suggestion of a third lower row.

<sup>a</sup>Deckert, R. F.: Loc. cit., pp. 1, 2.

The tadpole of the cricket frog develops in about the same length of time as that of the peeper. The tadpoles of the former transform the same season the eggs are laid and seldom exceed  $1\frac{1}{2}$  inches in length. They are larger than peeper tadpoles, have the crests blotched like tree-toad tadpoles, but have not the scarlet color of these creatures. The conspicuous character is the arrangement of coloration on the muscular part of the tail. There are four long bands—the first a brown band from body to tip of the tail; above this a cream white band, followed by another brown band to tail tip; and this surmounted by another short cream white band. There are two rows of teeth on the upper lip and three complete rows on the lower, as in the case of some of the frogs.

TRANSITION STAGES (PLS. XXI AND XXII).

Many of the attempts at frog culture have consisted in carrying eggs through hatching or even in carrying tadpoles through to transformation; but the efforts have ended at the latter stage. In nature, there is always considerable loss of tadpoles particularly just before transformation, and hitherto, in captivity, the same trouble has often been encountered. Some culturists might, therefore, prefer to begin their first efforts with the transformed frogs which have passed the critical stage, and thus avoid this large percentage of loss of stock. In many ways it is easier than gathering mated pairs or eggs and ought to be almost as successful as the capture with a seine of tadpoles or of individual adults at breeding time. At the approach of the transformation the tadpoles continually remain in the shallows. To be forehanded, a person might pull a minnow seine along such an area, particularly if it be somewhat or quite weedy, and obtain four-legged stages with the stumps of the tail remaining. These complete the tail absorption in a few days and are often easier of capture than the spry small frogs along the bank. If one try to make the captures immediately after transformation is wholly completed, he will have considerable success with leopard frogs and pickerel frogs and often secure 50 to 100 frogs at one time. The aquatic forms, the small green frogs and bullfrogs, however, immediately leap into the water at one's approach and never start landward through the vegetation, as the young leopard frogs and pickerel frogs so commonly do.

DESIRABLE SPECIES.—All of the four principal desirable species for the frog market (the leopard frog, the pickerel frog, the green frog, and the bullfrog) transform at an average size of 1 to 2 inches, while all the possible or undesirable species usually transform at sizes below that of 1 inch. Of course, the danger comes in the layman mistaking a growing undesirable form for a transformed frog of a desirable species; but if he thoroughly learns the cardinal characters of the four adult commercial frogs no error should occur, for the young frogs are sufficient replicas or duplicates of the adults to make their identification easy.

Most of the leopard-frog tadpoles change to small frogs in July, although a few may wait until August before complete transformation. The average range of dates extends from June 30 to July 25, with the bulk of the transformations occurring in mid-July, the latest ones recorded being on August 6. At the approach of transformation

the young come out into the open shallows or rest at the edges of the ponds in the thick mats of vegetation. If the season has been very rainy and the mortality consequently low, a region may have almost a plague of small frogs. Then temporary ditches, holes, and transient diggings are filled with these creatures migrating from the water over the land, and these constitute the so-called rain of frogs. This shows the apparent ease with which young transformed leopard frogs can be captured at such rare occasions with pitfalls, but ordinarily the operation is less easy. If the pond about which the frogs are transforming have a heavy growth of vegetation the frogs prove

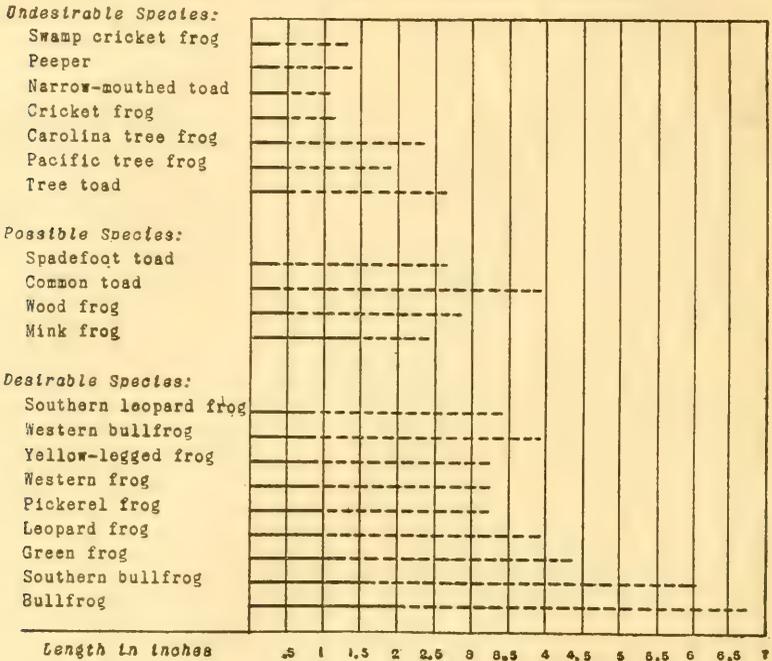
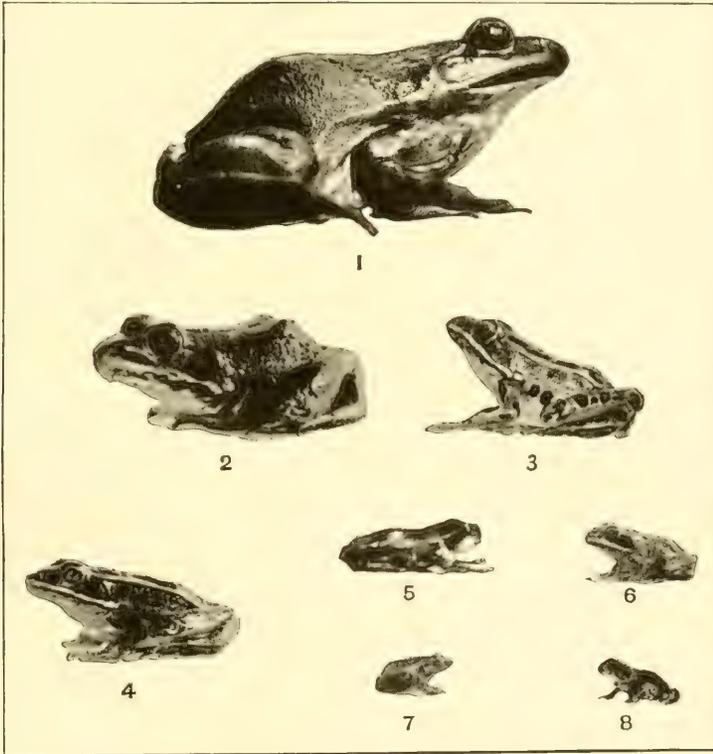


FIG. 2.—Transformation and adult sizes of frogs. Length of continuous line equals the transformation size. Length of continuous and broken lines gives adult size. Adult size determined by largest adult in author's collection.

difficult of capture and are quickly lost in the weeds; therefore, the sure method is to seine the swampy area or pond just before the final stage is reached. At transformation a young leopard frog is, on the average, 1 inch long, the range of size being 0.75 to 1.25 inches. (See fig. 2 and Pls. XXI, fig. 4, and XXII, fig. 6.)

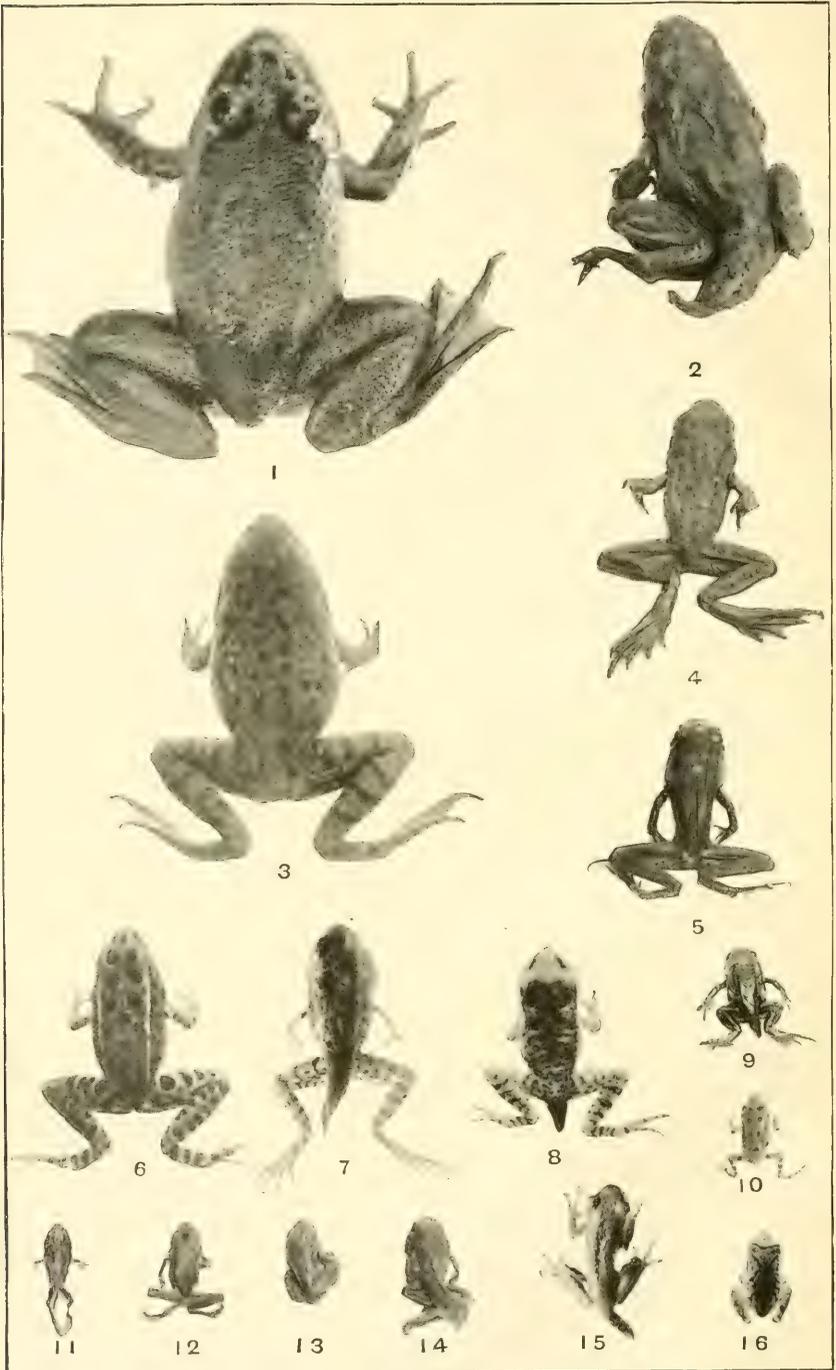
The southern leopard frog transforms during the last of June and in July. The transformed frogs range from 0.75 to 1 inch in length, the average being seven-eighths of an inch. (See fig. 2 and Pl. XXII, fig. 5.)

The pickerel-frog tadpoles may begin to transform the last week in July, but by far the greater number of larvæ transform in August. Occasionally some tadpoles do not transform until September 1 or rarely until October 1. The length at transformation averages 1 inch, and the range of size is 0.75 to 1.1 inches. What has been said



FIGS. 1 TO 8.—TRANSFORMATION SIZES, NATURAL SIZES.

1, Bullfrog; 2, green frog; 3, pickerel frog; 4, leopard frog; 5, tree toad; 6, wood frog; 7, peeper; 8, common toad. (After Wright, Carnegie Publ. No. 197.)



FIGS. 1 TO 16.—TRANSFORMATION SIZES, NATURAL SIZES.

1, Bullfrog; 2, mink frog; 3, green frog; 4, western frog; 5, southern leopard frog; 6, leopard frog; 7, pickerel frog; 8, wood frog; 9, narrow-mouthed toad; 10, common toad; 11, spadefoot toad; 12, Pacific tree frog; 13, swamp-cricket frog; 14, cricket frog; 15, tree toad; 16, peeper. (Photos of 2, 4, 5, 9, 11, 12, 13, 14 from spirit specimens.)

of the leopard frog is more or less true of the pickerel frog. A capital place to secure transformed and half-grown pickerel frogs is along the banks of the headwaters of our clear streams. (See fig. 2 and Pls. XXI, fig. 3, and XXII, fig. 7.)

The newly transformed green frogs vary in length from 1.1 to 1.5 inches, the average being 1.3 inches. Most of the transformations occur in the latter part of June and throughout July. Usually, by the first of August transformation for this species is largely, but not wholly, completed. In a species which lays from the last of May to the middle of August, or later, it is evident that some transformations may occur at any time within the same limits. This form spends one winter in the tadpole stage and is a year old before it changes to the frog form. Of all the commercial forms, this has proved the hardest to collect in numbers at the transformation stage. The long period of transformation, the smallness of some of the ponds and of their green-frog tadpole content, and the shyness of the species make it more difficult to secure a quantity of young green frogs than a similar number of young bullfrogs. It does not seem at present a convenient starting point in the culture of the green frog. (See fig. 2 and Pls. XXI, fig. 2, and XXII, fig. 3.)

The bullfrog tadpole spends two winters as a tadpole. Inasmuch as the eggs are small and deposited late in the season (usually the last of June or in July), the tadpoles are small when winter arrives. The whole of the next season is consumed in growth, and it is not until another winter is passed that the larvæ begin to approach transformation, which usually comes in July—that is, two years after egg deposition. More rarely does the tadpole spend a third winter before transformation. According to all of our data, transformation occurs in July or later. An average of the first dates recorded places the beginning of transformation at July 15. The species evidently does not begin transformation before July 1, and the period of transformation often extends to August 15. In one year, when first recorded on July 30, tadpoles were found which would require two weeks more before transformation. In another year several were found transforming on August 20, and a few other tadpoles which appeared as if they might transform in October or November or during the next season were found. The mature tadpoles begin to come out in the shallow water in early summer. Here they hide in the Chara, Nitella, hornwort, water milfoil, etc., or they rest beneath the lily pads, pond weeds, and other surface plants. Another favorite place of transformation is among the pickerel weed, arrowhead, and water plantain, which afford an overhead cover. Occasionally, around ponds where shallows are absent, stumps of trees, fallen logs, and trees fringe the edge, and their roots extend out into the water. These are favorite transformation sites for the species. At this period they are present in hundreds, or even thousands. The transformed individuals present a spirited sight as one approaches. They are shy, and long before one gets within range start skipping over the vegetation, giving the alarm note so characteristic of the species when surprised. Equally interesting is it when they occupy perches along the stumpy edges of deep ponds. It seems as if a wave of little bullfrogs keeps going before one as he skirts the pond. Inasmuch as this species requires two years to mature, it might naturally be expected that with varying conditions the tadpoles would be of diverse sizes at transforma-

tion, due to inequalities of growth. This supposition is borne out by observation. In none of the species under consideration is there such a range of size at transformation as in the bullfrog, which at this period varies from 1.7 to 2.35 inches in length, with an average of 2.1 inches. (See fig. 2 and Pls. XXI, fig. 1, and XXII, fig. 1.)

Some of the southern bullfrog tadpoles may transform in the very last of May, and the minimum transformation size recorded is  $1\frac{3}{4}$  inches. (See fig. 2.)

**POSSIBLE SPECIES.**—The toad tadpole is among the first of the season to transform. When transformation is taking place, the shores of some ponds are black with myriads of little toads, their numbers being particularly noticeable when they leave the shores and cross near-by roads and streets. Transformation begins the last of June and may continue into August and rarely into September. The author's earliest record of transformation is June 8. The average date is June 21. The size at transformation is small, ranging from 0.3 to 0.5 inch in length, the average being 0.4 inch. (See fig. 2 and Pls. XXI, fig. 8, and XXII, fig. 10.)

The wood frog usually begins transformation about July 1. The transformation may begin as early as June 8 or extend to August 1, and the transformation size varies from 0.5 to 0.85 of an inch, the average being 0.6 of an inch. (See fig. 2 and Pls. XXI, fig. 6, and XXII, fig. 8.)

The hermit spadefoot toad transforms from June to August and ranges in size from 0.3 to 0.5 of an inch at the time of transformation. (See fig. 2 and Pl. XXII, fig. 11.)

**UNDESIRABLE SPECIES.**—The undesirable forms, when full grown, are small and the young transformed frogs are also small of size, none of them ranging over 0.8 of an inch and most of them having an average size of 0.3 to 0.7 of an inch.

The narrow-mouthed toad tadpole may transform from the middle of June to September or October. The average size at transformation is 0.5 of an inch. (See fig. 2 and Pl. XXII, fig. 9.) The tree toad transforms largely during the last of July and the first of August. The size at transformation varies from 0.5 to 0.8 of an inch, the average being 0.6 of an inch. (See fig. 2 and Pls. XXI, fig. 5, and XXII, fig. 15.) The peeper tadpole usually begins to transform as early as July 1, although the average date is July 6. The range of transformation is from June 12 to August 1, and the range of size is 0.35 to 0.55 of an inch, the average being 0.4 of an inch. (See fig. 2 and Pls. XXI, fig. 7, and XXII, fig. 16.) The swamp cricket frog usually has finished transformation by July 1 and may transform as early as June 1. At transformation the frog is 0.3 to 0.5 of an inch in length. (See fig. 2 and Pl. XXII, fig. 13.) The cricket frog transforms from June 1 to July if the eggs be laid early, or in August if the eggs be laid in June. At transformation it averages a greater length than the swamp cricket frog, being 0.5 of an inch in length. (See fig. 2 and Pl. XXII, fig. 14.)

#### RATE OF GROWTH.

The rate of growth from transformation to the full-grown adult condition (fig. 2) is very important. If a frog requires a long period to reach adult estate, then such a factor is one item which militates

against the species as a desirable frog for cultural purposes; and other favorable factors must counterbalance if the species is to be kept in the preferred list. If, in nature, two years are required for the bullfrog to pass through the tadpole stage and five or six years more to reach a length of 6 inches, in order to make its cultivation worth while, the dangers and enemies to which it is subjected during those seven or eight years must be overcome or reduced, or else the numbers of bullfrogs must be increased by careful handling to allow for the great losses in the course of their growth. Through many years the growth of our food fishes has been observed at our numerous fish hatcheries, but there is next to nothing in the literature of this country concerning the growth of frogs. Some authors have assumed that if, just previous to hibernation in the fall or at the outcoming in the spring, the collector found three or four groups of different sizes, these groups had been hatched in as many succeeding years. There are, however, great variations. A species which laid from May to August might, in the following August, include some frogs  $1\frac{1}{2}$  of a year old and some 1 year old. For growth studies it is imperative that not only the average and range of transformation size, but also the time of transformation, be known; for example, a small frog little beyond the transformation size if found in May must be almost a year old, because rarely, if ever, does any frog transform earlier than June. The results which the writer presents in the following table are merely tentative conclusions based only on measurements of frogs of all sizes collected at random over a period of 10 years.

ESTIMATED SIZES, RANGE, AND AVERAGE OF CERTAIN FROGS AT YEARLY INTERVALS OF GROWTH, SHOWN IN INCHES.

	Transformation.		1 year old.		2 years old.		3 years old.		4 years old.	
	Range.	Average.	Range.	Average.	Range.	Average.	Range.	Average.	Range.	Average.
Pickereel frog.....	0.75-1.1	1.0	1.1-1.75	1.5	1.75-2.1	1.875	2.1-2.45	2.3	2.45-2.75	2.6
Leopard frog.....	.72-1.25	1.0	1.25-1.75	1.5	1.75-2.2	2.0	2.2-2.5	2.35	2.5-3.0	2.7
Green frog.....	1.1-1.5	1.3	1.5-2.05	1.8	2.05-2.6	2.25	2.6-3.15	2.85	3.15-3.85	3.5
Bullfrog.....	1.7-2.35	2.1	2.35-2.85	2.6	2.85-3.6	3.25	3.6-4.4	4.0	4.4-5.2	4.75
Wood frog.....	.5-0.84	.62	.84-1.15	1.0	1.15-1.59	1.375	1.59-2.05	1.8	2.05-2.55	2.25
Tree toad.....	.56-0.81	.62	.81-1.15	1.0	1.15-1.6	1.375	1.6-2.0	1.8	.....	.....

In most of these forms the frog reaches the breeding condition in four years, and in the case of the pickereel frog, leopard frog, and green frog some individuals may possibly breed when 3 years old. The bullfrogs which reach 7 or 8 inches in length must require seven or eight years for such a growth. In all the forms, a growth of an inch a year is unusual, the normal rate being from 0.35 to 0.75 of an inch a year. The wood frog reaches maturity in four years, and the tree toad in three years. In both, the rate of growth is apparently about 0.35 inch a year.

#### FOOD.

The food problem is one of the crucial questions in the feasibility of frog culture. No very systematic seasonal study of the food of

our frogs has ever been undertaken and successfully completed. The toad has been quite thoroughly studied throughout its feeding season.<sup>a</sup> The best food investigation of any of our frogs (*Rana pipiens*) covers a very short feeding period from August 8 to 22,<sup>b</sup> while the food of the bullfrog has aroused interest and some attention because of some of its bizarre tendencies. As a consequence, the food of the tadpoles, transformed frogs, and adults of our commoner species can not be spoken of as positively as would become scientific parlance. A summary of what has appeared will have to suffice until comparative studies which are in progress are forthcoming.

#### FOOD OF TADPOLES.

In the earlier days armchair scientists held that the food of a tadpole had to be almost or quite wholly vegetable in nature, because of the elongate intestine the creature possessed; but even casual observers have noted with what avidity tadpoles assemble around a dead fish. The taxidermist knows very well to what a bone-clean condition tadpoles reduce carcasses of mammals, birds, or cold-blooded vertebrates. Several experimenters in frog culture have maintained that they could raise tadpoles on dressed submerged fish or on liver, a well-known fish food. These animal tendencies in the diet of an apparent vegetarian extend even to the devouring of their own kind under stress of unusual circumstances. It must, however, be remembered that most of this animal food, if not all of it, is dead and immobile. Seldom do they prey on larger aquatic animals or even on the smaller forms, unless these incidentally occur in the food stream which is mainly vegetable in character. Their animal-feeding proclivities are mainly those of scavengers, and it is therefore hardly correct to call them carnivorous or omnivorous, as has been done by some. Up to the present time there has been no serious extended examination of the food of tadpoles, because of the enormity of the task and on account of the previous uncertainty of the identification of the frog species to which they belonged.

#### FOOD OF TRANSITION STAGES.

This period when the tadpole changes to a small frog is a critical time in the life history of any individual frog and is in many ways the most important point of attention for the frog culturist. The creature makes a complete change of form, becomes truly carnivorous, spends some of its life on the banks or in the fields, and therefore can not be expected to adjust itself in an instant to a new existence. Dr. Philip A. Munz, who is studying the food of transforming and transformed frogs, presents the following preliminary and provisional summary from his examinations:

Thus far a fairly representative series of each of the following species of *Rana* has been studied: *R. catesbeiana*, the bullfrog; *R. clamitans*, the green frog; *R. sylvatica*, the wood frog; and *R. palustris*, the pickerel frog. In each species the same general tendencies are evident:

<sup>a</sup> Kirkland, A. H.: The habits, food and economic value of the American toad. Hatch Experiment Station of the Massachusetts Agricultural College, Bulletin 46, April, 1897, Amherst, Mass.; also, Usefulness of the American toad, U. S. Department of Agriculture, Farmers' Bulletin No. 196. Washington, 1904.  
 Garman, H.: Kentucky Experiment Station Bulletin No. 91. 1901.  
 Hodge, C. F.: Nature study leaflet. Worcester, Mass., 1898.  
<sup>b</sup> Drake, Carl J.: The food of *Rana pipiens* Schreber. Ohio Naturalist, March, 1914, Vol. XIV, No. 5, pp. 257-269. Columbus.

(1) The larval alimentary canal is very long, but slightly differentiated in its various portions and filled with ooze and silt scraped up from the objects in the pond and containing many species of diatoms, blue-green and green algæ of filamentous and nonfilamentous forms, small pieces of green plant tissue, and bits of fibers and other nondecaying material found in ooze. As yet I have found no tadpoles containing animal tissue, but as is generally known, they nibble off small pieces of flesh when it is available. Insects, mites, spiders, etc., are quite universally absent from the larval food; even the small water crustacea are rarely met with.

(2) After the fore and hind legs are both in evidence and the horny plates of the tadpole mouth are shed, the tail is gradually shortened and the alimentary canal shortens to become dilated anteriorly and posteriorly, forming the stomach and the rectum, the latter communicating with the cloaca. During this time there is practically no food taken in, although the fat in the body cavity is scarcely reduced in amount; evidently the material available as the result of the absorption of the tail is sufficient. The epidermis is evidently shed often during the absorption of the tail; for in many cases, especially in the bullfrog which is large enough for it to be more apparent, epidermis is present in the alimentary canal: this tendency to swallow the cast epidermis seems quite universal. Occasionally a few algal filaments seem to become entangled in it and are then present in the stomach contents.

(3) After the tail is reduced to a mere remnant with a length of 1 to 2 millimeters (0.4 to 0.8 of an inch) and the mouth has increased to several times its former size, the alimentary canal has become from one-sixth to one-tenth of its larval length, and the young frog again begins feeding, now taking mostly animal food. The range of forms consumed is very great, each species of frog apparently eating anything alive and moving and yet small enough to swallow. Crustacea, Isopoda, Acarina, Arachnida, and almost every group of Insecta have been found. The forms fed upon are not aquatic to any extent, but feeding is done largely above and near the water. Naturally such life as is to be found on or near the ground is most available and the stomach content is largely ground beetles, plant lice, springtails (Collembola), leaf hoppers, snout beetles, spiders, mites, sow bugs, ants, and small flies. Of the molluscs, snails are occasionally met with, and of the vertebrates only a few have been observed, such as young frogs and toads in young bullfrogs.

The differences in selection of food may come under two categories: (a) Those due to the size of the species of frog—the bullfrog, for example—can and does eat much larger forms than can the smaller species, and yet it also takes the smallest mites; and (b) those due to the location and nature of the ponds from which the specimens were taken; for in different locations are to be found different food materials. But as yet I have been able to observe no difference in the range of insects or other forms eaten by each species.

By way of summary, then, the tadpole is largely herbivorous; the transforming individual does but little or no feeding, and the young frog is carnivorous, eating plant and inorganic materials perhaps as a matter of accident while seizing insects or other prey.

#### FOOD OF ADULTS.

Growing and adult frogs are carnivorous. To be sure, they may accidentally take in vegetation or mineral matter, but this is an incident to their pursuit of moving prey or synchronous with the swallowing of their own cast skins. If their prey remains quiet it may escape. If our frogs pursued their prey in the water as do fishes there would be no particular need for a tongue, and some of the most aquatic frogs of the world have little or no tongue as a consequence. Practically all of the frogs of the United States are possessed of a good, thick, adhesive protrusible tongue, which is fastened at its forward end. The posterior end of the tongue can be shot forward and then quickly retracted with the prey affixed or held.

It must be remembered that our frogs do not pursue their prey beneath the water; therefore it becomes evident that practically all food prehension for our species takes place at or above the water's surface, on the shores of bodies of water, on the banks of streams, in the meadows, or in some cases in the trees. Some remain in favorable position and capture the passing prey; others hop toward

their prey until within range; still others occasionally stalk their prey; and a fourth group, like the tree frogs, may at times leap into mid-air for their game.

The tongue is the main organ of prehension, but the forefeet are often used in a ludicrous manner to help in forcing into the mouth a difficult or cumbersome object. If one tries to force food or other objects into the mouth of a captive frog, however, the same feet may often be employed to prevent the operation.

A general summary of the various food elements as thus far determined by previous authors follows.

**VEGETABLE MATTER.**—What Kirkland<sup>a</sup> found true for the toad obtains more or less for our species of true frogs. He held that—

Vegetable material formed less than 1 per cent and from its character appears to have been taken by accident and can not be properly considered as food. Since the toad takes the greater part of its food from the ground by means of its large, fleshy tongue, nothing can be more natural than that a small quantity of vegetable detritus should be swept into the mouth along with the insects on which the animal feeds. The most common vegetable substance found in the stomachs is grass, both dry and fresh. Bits of rotten wood, broken acorn shells, seeds of the linden (*Tilia americana*) and maple (*Acer saccharinum*) and bits of apple parings have also been detected. All these vegetable substances were usually associated with a large quantity of ants and other terrestrial insects.

Possibly the more aquatic frogs, like the bullfrog and green frog, might take more vegetable matter than the more terrestrial leopard frog or wood frog. The former have a feeding ground where the algal carpet of the water's surface may be the alighting ground for the prey, or where the wet, broken vegetation of the shore may be the hiding ground of numerous insects.

**MINERAL MATTER.**—Of this habit Kirkland writes the following:<sup>a</sup>

The mineral matter found in the stomach forms slightly more than 1 per cent of the total contents and consists of gravel, sand, and, in a few cases, coal ashes. When a large piece of gravel is swallowed it is regurgitated; this I have proven by experiments on toads in confinement. Otherwise the gravel passes through the alimentary canal and may be found in the castings. Since the toad does not masticate its food, but depends on the stomach for the whole process of trituration, it is probable that the gravel when present assists in grinding the strongly chitinized bodies of beetles, etc., yet in the majority of the toads examined there was no gravel present in the alimentary canal, although many of the stomachs contained finely ground beetles. A proper inference from the above is that gravel is not essential to digestion in the toad, and the writer inclines to the opinion that, as in the case of the vegetable matter, the presence of gravel in the stomachs is the result of accident rather than of design.

**ANIMAL MATTER.**—No doubt, in the case of our four principal commercial species this element constitutes from 97 to 98 per cent of the food, as in the toad.

**Mollusks.**—Mollusca are seldom eaten by the wood frog and pickerel frog and constitute about 1 per cent of the food of the toad and about 3 per cent of that of the leopard frog. Mollusca no doubt enter to an appreciable extent into the diet of the more aquatic forms of anurans. Surface<sup>b</sup> found the green frog alone had eaten mollusks to any extent, while Dyche<sup>c</sup> found 12 of his 30 bullfrogs had eaten snails, one having 9 in its stomach.

**Worms.**—These enter into the nocturnal toad's diet more than into that of any other species and constitute 1 per cent of its diet. Worms

<sup>a</sup> Kirkland, A. H.: Loc. cit., pp. 13-14.

<sup>b</sup> Surface, H. A.: Bi-Monthly Zoological Bulletin. Division of Zoology, Pennsylvania Department of Agriculture. Vol. III, Nos. 3 and 4. 1913.

<sup>c</sup> Dyche, L. L.: Ponds, pond fish, and pond-fish culture, pp. 150-153. State Department of Fish and Game, Kansas. Topeka, 1914.

have been recorded in the food of the leopard frog but are rare in the food of the other four common species of frog.

*Spiders.*—Spiders and their relatives are eaten by the smaller forms like the cricket frog, swamp cricket frog, peeper, and tree toad, as well as by all of the larger forms. "Spiders occur in the stomachs of the toad in all months, but form only 2 per cent of the total food."<sup>a</sup> In the case of the leopard frog, according to Drake,<sup>b</sup> they constitute 27 per cent of the food of the species and are, next to beetles, the largest single item, while in the wood frog, pickerel frog, green frog, and bullfrog, spiders form 8 to 12 per cent of the food of these forms.

*Crustaceans.*—The smaller forms, like the cricket frog, swamp cricket frog, peeper, and tree toad, very rarely, if ever, eat small crayfish, and only in very shallow water or in pools which are drying up do the leopard frogs attempt an extensive diet of crayfish. There are no records of these creatures being used as food by the pickerel frog, wood frog, or toad, the two latter being quite terrestrial. The more aquatic creatures—that is, the green frog and the bullfrog—eat them, the first to the amount of 4 or 5 per cent, while the last, being larger, makes them 20 or 25 per cent of its whole diet. The opposite condition obtains in the case of the sow bugs, since the bullfrog does not eat them and the green frog very seldom, while the more terrestrial leopard frog may make sow bugs 4 or 5 per cent of its food. These creatures form 2 per cent of the toad's food, and the pickerel frog also occasionally eats them.

*Myriapods.*—"Myriapods [according to Kirkland <sup>a</sup>] form a constant article of diet for the toads. \* \* \* These creatures form 10 per cent of the food for the season." They constitute 1 or 2 per cent of the food of the leopard frog, 4 or 5 per cent of the food of the pickerel frog, and 5 or 6 per cent of the food of the green frog.

*Insects.*—Insects are the main food reliance for frogs, tree frogs, and toads. Five orders, possibly a sixth (Diptera), enter largely into their dietary list. The five principal orders are Coleoptera, Lepidoptera, Hymenoptera, Hemiptera, and Orthoptera. The evidence serves again to prove that these amphibians get most, if not all, of their food above the water or outside of it.

Coleoptera, mainly ground, lamellicorn, and click beetles, and weevils constitute 27 per cent of the food of the toad, while in the animal food of the leopard frog beetles form 33 per cent of the whole, the principal groups being ground, tiger, and snout beetles. In the food of the wood frog, pickerel frog, and green frog the proportion is equally large, while in the diet of the bullfrog the beetle element is surprisingly large; no doubt, water beetles of the surface enter into the food of the bullfrog more than into that of the other species of frog.

Lepidopterous (moths and butterflies) larvæ prove very tempting morsels to toads and make up 28 per cent of their food, while this order constitutes 13 per cent of the leopard frog's diet, about 15 to 17 per cent of that of the wood frog, pickerel frog, and green frog, and only about 5 or 6 per cent of that of the bullfrog.

Hymenoptera form an appreciable part (19 per cent) of the food of the terrestrial forms like the toad. In the diet of the smaller tree frogs and of the young of the larger forms, hymenoptera (ants, etc.),

<sup>a</sup> Kirkland, A. H.: Loc. cit., p. 15.

<sup>b</sup> Drake, Carl J.: Loc. cit., p. 265.

together with flies, replace the beetles of the adults. In the food of the wood frog and of the pickerel frog this order of insects constitutes 4 per cent, or less, and is a negligible factor in the green frog's and bullfrog's diet.

Orthoptera: Roaches, crickets, and grasshoppers make up a prominent part of the food of the adult leopard, wood, and green frogs, while mole crickets not infrequently enter into the diet of the bullfrog. Orthoptera furnish 3 per cent of the animal food of the toad.

Hemiptera: Bugs enter but slightly into the food of the wood frog and bullfrog, form less than one-half per cent of the food of the toad, 4 per cent or less of the leopard frog's diet, 8 per cent of that of the green frog, and 12 per cent or more of that of the pickerel frog.

Diptera: Flies and their relatives form  $1\frac{1}{2}$  per cent of the food of the leopard frog and one-half per cent of that of the toad. They are rather a negligible factor in the food of the large forms, while in such creatures as the cricket frog they may play a prominent rôle.

*Vertebrates.*—Vertebrates enter but seldom into the diet of any but the largest forms, such as the bullfrog. Dyche<sup>a</sup> records the finding of bullheads, crappies, sunfish, goldfish, bullfrog, and other frog tadpoles in the stomachs of bullfrogs. There are extant records of unusual food, like young ducklings, sparrows, mice, snakes, and young newly hatched alligators, in the food of this same species. The other frogs are too small of maw to essay the devouring of any vertebrates.

#### ENEMIES.

No article is more sought for or more relished as a food by a diversity of animals from fish to man than frogs. The latter's defense consists in concealment and in the possession of poison glands in the skin, neither of which means is aggressive in its nature. Insects and plants may prove a more constant fare, but to any fair-sized animal a frog diet is one of the preferable menus, if obtainable.

INVERTEBRATES: One would naturally think the insect and small animal life of the inland waters was a negligible factor in the reduction of the number of frogs, tree toads, and toads. But for the tender early larval stages and even for the more mature tadpoles these are very serious foes. Anyone who has collected a miscellaneous mass of aquatic life and put it all in one jar knows from dear and sad experience that these small creatures of the water often prey upon and kill the confined tadpoles and small frogs. In the open, especially at night, has the writer seen adult peepers and swamp cricket frogs or their tadpoles in the fatal grip of giant water bugs. Other aquatic bugs, like the well-known Zaitha, walking sticks, and, not least, the back swimmers, make life precarious for tadpoles or miserable for adult frogs in the water. The water beetles, especially their larvæ (water tigers) and dragonfly nymphs also take their heavy toll of tadpole lives. Many of the smaller, almost microscopic, crustaceans, like daphnia and others, are reputed to be incessant enemies covering the whole bodies of the tadpoles. Some of the larger crustacea, like the crayfish, may possibly take the live tadpoles, but it can not be definitely stated that they do. Mosquitoes, gnats, etc., pester frogs and tree frogs when out of the water, but in general little is known of this matter, because it usually happens at night when man is seldom observant.

<sup>a</sup> Dyche, L. L.: Loc. cit., pp. 150-153.

**FISHES.**—Fish which are almost wholly restricted to the same habitat as frogs might be considered the most serious foe of the early aquatic stages of the frogs and toads. It is very doubtful, however, if their depredations compare with those of the aquatic snakes. In the quiet waters where tadpoles frequently resort the worst depredators are the members of the pike family. From the lunge down to the little grass pike is a series of forms which revel in frogs and their tadpoles. Equally appreciative of small frogs and tadpoles are basses, but some of the larger, like the smallmouthed bass, are not abundant in the habitat of frogs. Forms of the quiet water, like the largemouthed bass and sometimes the rock bass and others of similar habits and of equally large maws, feed on them. The omnivorous catfishes sometimes eat the young tadpoles, the growing frogs and the trouts especially do. The horned dace and some of the larger voracious minnows occasionally eat the newly hatched larvæ of frogs.

**AMPHIBIANS.**—The aquatic salamanders, like the newt, frequently pull off eggs from a frog's egg mass for food. The larger forms, like the mudpuppy (*Necturus*) and hellbender (*Cryptobranchus*), may eat frog's eggs or larvæ if favorably situated. Among frogs there are several species whose adults do not stop at fratricide or cannibalism. In fact, it is one of the factors which has led some frog culturists to abandon bullfrogs, which will feed on anything from insects to small alligators, not even sparing their own progeny.

**REPTILES.**—In this group we find some of the most inveterate and merciless foes of frogs. In the southern States an arch-enemy is the alligator. Among the turtles the snapping turtles lie in wait for frogs and their tadpoles, while the more alert and active soft-shelled turtles may at times pursue them. The equally vicious musk turtle also is a foe of the frog. The spotted and painted turtles and some of the other "sliders" or so-called terrapins are said to feed on tadpoles, but of this the writer has no first-hand evidence.

The snakes, both aquatic and semiaquatic, are the worst pests the frog has to meet. Among the cold-blooded vertebrates there is no more relentless preying of one thing upon another than the persistent hunting by day or, better, by night of a ribbon snake or water snake for frogs. In fact, frogs are, par excellence, the food of the aquatic snakes. Several of the semiaquatic garters eat or prefer true frogs, cricket and swamp cricket frogs. The very aquatic water snakes (*Tropidonotus*) of several species, are the worst offenders and at times feed exclusively on frogs. The rainbow and red-bellied (*Farancia*) snakes also feed on frogs or their tadpoles. On the land the spreading adder is the main enemy. The black snake and garter snakes are quite partial to them, and the pilot snake, copperhead, or ground rattlesnake do not scorn them.

**BIRDS.**—Whoever plans to raise frogs must beware of several of our largest and most distinctive forms of birds. The herons and bitterns are the most serious frog eaters. Their long legs and toes equip them for wading, and their long necks and bills are adapted either for a silent waiting game or a slow, stalking search. They frequent the shallows where the tadpoles and transforming frogs are abundant. The great blue heron, the little green heron, the little blue heron, and some of the less familiar forms of the South wait

long periods or slowly patrol in the open stretches of lakes, ponds, and streams for their game. The bitterns inhabit the cover of the marshes and stalk their prey. Among the hawks, the various species of kites feed upon frogs, but because of their rarity are a negligible factor. The marsh hawks eat some frogs. The despised Cooper's hawk rarely takes to a frog diet, while the red-shouldered hawk and sometimes the broad-winged hawk eagerly seek frogs. Into the diet of owls frogs seldom enter, the barred owl most frequently being the depredator. W. B. Barrows<sup>a</sup> found that no food occurs more regularly in the crow's stomach than frogs and toads. In April to July it is the largest live animal item, except insects, in the crow's diet. Of the kingfisher frogs need to beware, though they are seldom seen with frogs or tadpoles, fish being the usual fare. Bronzed grackles eat frogs but rarely. The totipalmate birds, like the snakebird, cormorant, and pelican, are largely fish eaters, but they, no doubt, pursue and capture some frogs. Several ducks are reputed to eat frogs, and one, the hooded merganser, is often called the "frog duck." It would also be well to bear in mind the charge that domestic ducks eat the tadpoles and occasionally the transformed and transforming stages.

**MAMMALS.**—In this country the four-footed mammals which eat frogs are very few. Most of these belong to the weasel tribe. The skunk enjoys a good frog when he can catch it, and the mink quite frequently varies his diet with them. The weasels are occasional depredators, but are not comparable to the house or brown rat, which tries anything and everything it can catch. The muskrat is a nuisance in any pond and should be held with suspicion, as should the raccoon. Some individual domestic cats have been known to develop a fondness for frogs, and particularly for tadpoles.

Man is not content with cleaning up and draining the "frog holes" or swampy stretches, but he kills the frogs at all seasons. Few, if any, of our State legislatures see fit to protect them and establish open and closed seasons. As a result, they are taken mainly when they congregate for breeding purposes, and such a toll hardly accords with the ideas of conservation held at the present day.

Nine-tenths of the wild supply is secured at the breeding season or just before breeding. Such a profligate expenditure can not long escape our attention. As thoughtless youths many of us often counted our strings of 100, and some of us hunted them regardless of the season.

In the eastern United States the four important commercial forms should not be killed in the wild state before the following dates:

Leopard frog.....	May 1, or, better, May 15.
Pickrel frog.....	May 10, or, better, May 20.
Bullfrog.....	July 1, or, better, July 15.
Green frog.....	July 15, or, better, August 1.

<sup>a</sup> Barrows, W. B., and Schwarz, E. A.: The common crow of the United States. U. S. Department of Agriculture, Division of Ornithology and Mammalogy, Bulletin No. 6, pp. 50, 51. Washington, 1895.

# FRESH-WATER TURTLES: A SOURCE OF MEAT SUPPLY

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Appendix VII to the Report of the U. S. Commissioner of Fisheries for 1919

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# FRESH-WATER TURTLES: A SOURCE OF MEAT SUPPLY.

By H. WALTON CLARK, *Scientific Assistant*, and JOHN B. SOUTHALL, *Shell Expert, Fisheries Biological Station, Fairport, Iowa.*

## INTRODUCTION.

Among the aquatic food resources of the United States to which but little attention has as yet been given are the several species of edible turtles and terrapins of the rivers and lakes. One species of turtle, the famous and much-sought-after diamond-back terrapin, has indeed long been utilized to the fullest extent consistent with the preservation of the species; and in recent years its propagation on privately controlled farms has been inaugurated. The green turtle of the sea has also for a long time been so generally esteemed and extensively fished as to have been brought into actual danger of extinction. It is worthy of note that, while these two species have been regarded as delicacies of a high order, their relatives of the interior waters have been comparatively little utilized, at least under their proper names. It seems quite probable, however, that certain species of fresh-water terrapin have been rather widely used as an illegitimate substitute for the diamond-back terrapin. Within the last year or two a more general interest in the subject of the use of fresh-water turtles as food appears to have developed, and the Bureau has received many inquiries for information in regard to methods of capture of turtles and the preparation of their meat for the table. It is the aim of the present paper to supply answers to these inquiries, so far as the information is at present available. The data herein presented have been secured by the authors through correspondence with dealers in turtles and by personal visits to many markets in the larger and smaller cities of the Middle West and to various points of commercial fishery, principally on the Mississippi and Illinois Rivers.

## THE SNAPPING TURTLE.

### DISTRIBUTION AND HABITS.

Commercially speaking, by far the most important species of the Mississippi Basin is the snapping turtle, *Chelydra serpentina* (Linnaeus) (Pls. I and II), known also in different localities and under different conditions as the snapper, mud turtle, and mossback. Its position in the market and in the consciousness of the people, the methods of its capture, and the like, are so closely bound up with its natural history that, in order to properly estimate its economic status, it is necessary to give in some detail the main facts regarding its habitat and habits.

In the first place, it has a broad geographic distribution, its range extending from Nova Scotia to the Equator and westward to the Rocky Mountains. It is, therefore, one of the most widely known of turtles; and the New Englander who has migrated to the banks of the Wabash, the Ohio, or the Mississippi, or to the prairies of Illinois, recognizes it at once as an old acquaintance. This wideness of distribution indicates a hardiness and an ability to live under greatly varying conditions.

Not less important than its wide geographic distribution is its varied habitat. It is found in a great many different situations—in lakes, ponds, rivers, creeks, marshes, and bogs, and often travels overland a considerable distance from water. Only those familiar with the faunas of woodland ponds know the pretty, speckled tortoise; only the travelers along shaded creeks know Blanding's turtle; and to those who dwell afar from the larger lakes and rivers the soft-shell is known, if at all, only through the medium of books or museums. There are few, however, to whom the snapping turtle is a complete stranger.

In addition to its great variety of habitat, the leisurely habits of the snapper make it familiar. When approached it does not beat a hasty retreat, as do most other animals, but holds its ground against all comers. Many who are fairly familiar with the pond turtles and terrapin know them principally as a sudden splash from a log, and many who visit the sand bars where the soft-shells love to bask know them principally as a streak over the sand, as a splash at the water surface, and as a wake like that made by a big fish. The snapper, however, is the living embodiment of the status quo. He is willing to wait for the closest and most scrutinizing inspection; and, closely gazed upon, his appearance may have much to do with his being used as an article of food. One could not exactly call him handsome; a better statement would be that he looks good enough to eat. His corpulent, bulging body, projecting in rolls from his inadequate shell gives above all else the impression of meatiness. The rough skin, not greatly unlike that of a freshly plucked chicken, and the narrow cartilaginous bridge and small plastron all suggest easy preparation, much edible material, and little waste.

All the other details about this species—manner of capture, the peculiarities of the market, and, finally, the methods of cooking—are, as will be observed, closely connected with its life history and habits.

#### SEASONS AND METHODS OF CAPTURE.

During the summer the snappers are rather unsocial. They are solitary in habits, the individuals being widely scattered, so that it is difficult to take an accurate census of them. Because of these solitary summer habits, there is, generally speaking, very little fishing for this species in that season. There may, of course, be local exceptions; thus it was reported that throughout at least part of the summer of 1913, along the Grand River, Mich., there was an active turtle fishery, both snappers and soft-shells being caught in seines and shipped to the large near-by cities, such as Detroit and Chicago. In general, however, the summer is a dull season for turtles. One market man remarked that "the turtle is like the oyster, only in season when the

name of the months contains an 'r.'" Nearly all the other market men explained the situation by saying that "practically all the turtles are used for soups, and few people eat soups during hot weather." The situation is perhaps a little more complicated; it may have to do also with capture and storage. In summer occasional snappers are picked up while on their migrating trips; a few are now and then caught on set lines; and fishermen sometimes catch them in their seines or in baited hoop nets set for fish. It is doubtful whether any of these occasional summer-caught snappers get into the general market. The greater number are released, and a few are locally consumed.

During the autumn and early winter the snappers collect in considerable numbers and hibernate in suitable locations. In the vicinity of Muscatine, Iowa, it was stated that a favorite place for turtles to hibernate is in muskrat holes. According to report, as much as 5 tons of turtles have been taken from the various muskrat holes in one season. Our informant also stated that as many as 26 individuals have been found in one muskrat burrow, while at another time 1,420 pounds were obtained in one run. From 500 to 1,000 pounds of turtle were estimated as a recent catch for one day.

Along the sloughs of the Mississippi they congregate about and under old logs. A specific instance was cited of a fisherman who obtained 20 snappers, weighing from 10 to 20 pounds each, under a log in one of the sloughs of the Mississippi River.

Along the Illinois River, the Cedar River of Iowa, and, indeed, wherever there are springy places near large bodies of water, the snappers "mud up" for the winter.

It is from their hibernating places that the greater number of snappers found on the market are taken, and the captors are usually fishermen or trappers. The methods of capture employed for the various forms of winter quarters—whether muskrat holes, old logs, or springy places—are all, so far as could be learned, very much the same. The implement used is a stout hook, made by bending an iron rod at one end, sharpening the short or hook end, and leaving the other as it is or driving it into a wooden handle to make it better to manipulate during very cold weather. If there is much ice, it is cut and the hook probed or prodded about until a turtle, which feels much like a chunk of wood, is encountered. It is then pulled out by the hook. It is somewhat difficult to land large turtles, although they are benumbed and offer little resistance. The turtle catchers rely upon their hunting instinct to discover the turtles, and when a good place is found many can be taken from it, as indicated in the account given above.

Activity in snapper catching may be stimulated or depressed by widely different circumstances. The general wage scale probably has little influence, since fishermen and trappers are as much attracted by the fascination of their calling as by its emoluments and are not likely to desert their profession for a better-paying job. A high price for pelts and furs may divert greater attention to trapping. One fisherman said that the existence of saloons greatly helped the turtle market, as they dealt extensively in turtle soup. Under favorable conditions the turtle catcher can make very fair wages and still sell the meat at a reasonable price. During the winter of 1918-19 a market man reported: "Turtle meat is the cheapest meat I can buy."

## SHIPMENT AND STORAGE.

Generally speaking, the men who catch the turtles make no attempt to hold or store them but ship them to market as soon as they can collect a sufficient quantity.

The turtles are usually shipped in barrels with holes bored through the bottom and through the sides for ventilation and with burlap nailed over the top. In this condition, of course, the contents are not open for observation, and a thriving turtle fishery may be in active operation in a particular region unknown to the general public. Since barrels have become expensive, the catches are sometimes shipped in crates similar to those used for chickens.

Upon arrival at the larger markets the containers may simply be stored in a cool place, where the turtles will remain in hibernation, ready for disposal by wholesale or retail as the market demands. It is with the return of warm weather that the storage question becomes important.

A good many dealers do not attempt to hold turtles at all but pass them to the consumer as rapidly as possible. In the basement of a large wholesale market at Chicago, a cool moist situation, there is a large turtle pen, or, rather, a series of pens, which will hold about 2½ tons of the living animals. They do very well here until summer arrives, when the loss is considerable. Here the snappers are washed off occasionally, but the problem of feeding them has not been satisfactorily solved.

It might do much toward stabilizing the market if the intermediate buyers along the rivers, in order to be ready for early fall delivery, would establish large pounds to retain the spring catch, as well as the occasional turtles taken during the summer. It was stated that there was formerly a storage pen at Clear Lake, Ill., where 25,000 or 30,000 turtles could be satisfactorily kept; but that in recent years, owing to changed stream conditions, together with the consequent diminution in abundance of the animals, the pen has been abandoned. At Grafton, Ill., a pound was observed which has been in existence about four years and which was originally designed to retain carp, as well as turtles and terrapin. It is located near the river and comprises a pond supplied by seepage from the river and by rainfall. The size of the pond varies, therefore, according to weather and stream conditions, but at the time observed its dimensions were about 207 by 135 feet. This pond, having banks of considerable steepness, occupies nearly the entire area of the pen. The walls are riprapped with stone and surmounted by a wire fence of 1-inch-square mesh. The pound was said to contain 4,000 or 5,000 terrapin and 2 tons of snappers. It was observed at Grafton, as elsewhere, that quantities of terrapin are always estimated by number, and snappers by weight. Two kinds of terrapin were distinguished; the river terrapin described as "rough," which proved upon examination to be *Graptemys lesueurii*, and the "pond terrapin," described as "striped," which proved to be *Pseudemys elegans*. The former was regarded as much superior to the latter. During the summer, according to information furnished the authors, the turtles had been fed on fishery waste and on hog lights, of which they appeared to be very fond. They were being shipped to the markets of Boston and Philadelphia.

## SOURCES OF SUPPLY.

Dealers at Chicago mentioned their source of supply as the Central States—Wisconsin, Minnesota, Iowa, Indiana, South Dakota, and Michigan—although they also received snappers and terrapin from Kentucky. Specific localities mentioned were Winona, Minn., and Guttenburg and Muscatine, Iowa. At one time the Illinois River was an important source of supply during the winter, and parts of it, especially toward the mouth, continue to be so. Kofoid states:<sup>a</sup> “The Illinois River and its backwaters, under present conditions, contribute annually \* \* \* 15,000 dozen turtles” (probably including both snappers and terrapin). During the progress of the investigation of the Upper Illinois in June, 1918, there was no fishing at all on account of the closed season on fishes and, naturally, no capture of turtles.

## MARKET CONDITIONS AND PRICES.

The amount of turtles handled by the markets of the large cities does not, of course, indicate the quantity which is consumed locally. As stated above, the winter is by far the most active market season. However, along the rivers the turtles are eaten the year around, whenever they can be obtained, fried soft-shells being especially consumed during the summer. The wholesale market in Chicago previously referred to handles about 10,000 snappers a year, valued at \$5,000. Its buyer thinks he could handle a ton a week. Another market handled 1 to 1½ tons a month. The snappers on the Chicago market range in weight from 5 to 25 pounds each. At Peoria they were said to reach a weight of 30 pounds, the average being 7 or 8 pounds. According to the census of 1908, the Mississippi River Basin produced 713,000 pounds of turtles and terrapin, with a value to the fishermen of \$25,000.

In these days of uniform prices for standard commodities a striking feature of the turtle market is the variety of prices. A turtle catcher at Muscatine, Iowa, stated that he could get 5 cents a pound live weight or 10 cents a pound dressed at Davenport. He said there was more money selling them alive, as they dressed off more than half, and also the trouble of dressing them had to be considered. One dealer in Chicago sold in wholesale lots at 8 cents a pound and retailed at 10 cents. A buyer quoted them at 6 to 7 cents a pound live weight. At St. Louis it was said that “turtle meat is selling higher than ever before, it being now (June, 1918) about 18 cents; whereas it used to be from 12 to 15 cents a pound.”

A published commercial price list (Chicago, 1918) quoted live snapping turtles, usually 10 cents per pound, falling to 9 cents for the week of June 8, to 14, and rising to 11 cents July 20 to 26, 1918, and turtle meat, strictly fresh, 16 to 17 cents, rising during the progress of the summer. In the early part of the season frozen turtle meat was listed at 15 cents.

Many of the points covered above regarding source of supply, prices, and amount handled can best be illustrated by quoting from

<sup>a</sup> Kofoid, C. A.: Plankton studies. IV. The plankton of the Illinois River, 1894-1899, p. 562. Bulletin, Illinois State Laboratory of Natural History, Vol. VI, 1901-1903, Art. II. Champaign.

a letter received June 4, 1918, from a fish company in La Crosse, Wis., which goes into the subject with unusual fullness of detail:

We receive turtles from all of the commercial fishermen of the Mississippi, no one in particular fishing for them especially, as usually they are caught in such small lots that the average fisherman does not make much of an effort to gather them up. Usually the price this last year has been from 3 to 4 cents, and, getting them in such small quantities, the fishermen figured not money enough in them to bother with them.

We also get quite a few from the Indians who are moving about up and down the river. The general selling price has been (Philadelphia) from 7 to 12 cents, the high price being in the extreme cold weather, and usually the wholesale price runs from 4½ cents f. o. b. shipping stations, and the average quotation from the wholesale houses in Chicago and other places is from 7 to 9 cents.

The following is the amount that we have handled since November, 1917, and conditions were such that we have had to carry quite a lot of this stock on hand, as we were unable to sell it at all times or very readily:

	Pounds.
November-----	13, 166
December-----	2, 551
January-----	1, 689
February-----	90
March-----	1, 496
April-----	5, 206
May-----	5, 411
Total-----	29, 609

The demand has been diminishing from year to year. Ten years ago we used to handle them by the carloads and could always find a ready market in New York, whereas at present there is very little demand in New York; in fact, practically none.

The kind of turtle we are handling is what is known locally as the mud or snapping turtle. There is some demand for the soft-shell turtles, but not enough to warrant our handling them.

At Grafton, Ill., it was stated that Boston afforded the best market for terrapin and Philadelphia for snappers.

#### PROPORTION OF WASTE.

In the consideration of any article to be used for food the item of waste is an important feature, since this must be accounted for somewhere between the producer, or in this case the captor, and the consumer. The opinion of dealers differed somewhat as to the amount of waste in the snapping turtle. It varies considerably according to the manner of cleaning. One dealer thought the turtles would dress off more than half, large ones dressing off less than small ones. Another thought a 12-pound turtle would dress off to 6 pounds, and a 5-pound one to 3 pounds. A dealer at Fort Madison, Iowa, said that by discarding the shell they would dress off two-thirds, but that the shell could be used in making soup, serving as a soup bone. One dealer added that "in making soup the liver and eggs are used, so there is not so much waste." In the Washington market some snappers were seen dressed for sale. The epidermis having been scalded off, and the scutes or epidermal plates of the shell removed, the remaining portion presented a very attractive appearance. Along the backbone of the turtle is a considerable mass of flesh known as "tenderloin," which in rapid or "shop" cleaning is discarded with the shell, but in careful cleaning is saved, thus reducing the waste. At Pekin, Ill., where turtles were cleaned rapidly, discarding tenderloin, liver, and eggs, as well as shell, a 14-pound

snapper furnished 6 pounds of meat. At Fairport, Iowa, one which weighed 11 pounds produced 5½ pounds of meat when carefully dressed, with tenderloin saved, but shell, liver, etc., discarded. The relatively small difference in market prices between live turtles and turtle meat among practiced dressers and dealers (10 cents alive, 17 cents dressed) does not account for so much waste, since one must also consider the labor of dressing the meat.

In considering the subject of waste it may be of interest to compare turtles with other familiar objects, such as fish and poultry, which may be bought either whole or dressed to suit the wishes of the buyer. The proprietors of some of the fish markets on the Mississippi (Muscatine, Iowa, and New Boston Ill.) and on the Illinois (Peoria), who have much experience weighing fish, since they buy them living from the fishermen and sell most of them dressed, were consulted in this regard, and their reports agreed very closely. Carp were reported to dress off about 30 per cent, or from 30 to 40 or 45 per cent, the higher percentages applying to the females full of roe, which is usually discarded. Buffalofish were reported to dress off somewhat less than carp. Catfish differ greatly, according to kind and condition, but dress off on the average 60 pounds to the 100. At the Fairport biological station two ripe male carp weighting 5 pounds 8 ounces were dressed. The head, scales, and entrails weighed 1 pound 3 ounces and the milt 8 ounces, leaving the weight of the dressed fish 3 pounds 12 ounces, a waste of 31.8 per cent. In looking through publications at hand devoted to poultry, under the subject of waste, cocks were reported to dress off 23.4 per cent, cockerels 26 per cent, hens 24.2 per cent, and pullets 25.8 per cent of the live weight. These wastes, of course, leave bones out of consideration. For fuller estimates and comparisons of the absolute amount of wastes of various fishes the reader is referred to a publication by Dr. W. O. Atwater, published as an appendix to the report of the United States Commissioner of Fisheries for 1880.\* Unfortunately our data on the flesh of turtles are not in such a condition that they can be compared with the fish discussed in that article.

To one who has not watched the process it might appear that turtles would be difficult to dress. There is not nearly the labor involved in cleaning a snapper, however, that there is in plucking and dressing a chicken, and a novice would acquire the knack even more quickly with the reptile than with the fowl. The bones and joints are not so thoroughly ossified in the turtle and offer less resistance to the carver. Along with economical considerations it may be mentioned that one dealer remarked that "8 pounds of turtle will make soup for 50 people." Another phase of the subject which has to do with economy, but which is more closely related to the subject of cooking, will be discussed in that connection.

#### QUALITY OF FLESH.

The value of turtle flesh as a food and the extent to which it can be used as a substitute for other meats is a question to be solved

\* Atwater, W. O.: Report of progress of an investigation of the chemical composition and economic values of the fish and invertebrates used for food. Appendix D, Report of the Commissioner, U. S. Commission of Fish and Fisheries, for 1880, pp. 231-286. Washington.

by nutrition experts, by chemists who can compute its value in terms of calories, carbohydrates, proteins, digestibility, etc., and by experiments with "diet squads." This is fundamentally the most important question. Certain it is that the white and the deep-red, dressed meat as displayed in the fish markets is very attractive in appearance.

Scarcely less important, however, is the question of its gustatory qualities; for whatever gives zest to our necessary foods is by no means to be despised. References in literature to the relative merits of different species of turtle are rather few. Nash<sup>a</sup> says of the common soft-shelled turtle (*Amyda spinifera*): "The flesh of this turtle is considered a delicacy;" and of the snappers: "Their flesh is considered good and in some localities they are much sought after for making into soup."

The flavor of the snapper, like that of other sorts of game or meat, varies somewhat according to the habits of the individual animal and according to the method of preparation. Perhaps the best method of approach to this phase of the subject is a consideration of the habits of the turtle.

The snapper is very voracious, feeding on frogs, fishes, crayfish, young water birds, etc. It has been accused of catching and eating young ducks. Those examined at Lake Maxinkuckee, Ind., had been eating snails (*Vivipara contectoides*), and seven individuals examined at the Pekin (Ill.) market, caught at Fort Madison, Iowa, in June, 1918, contained solid masses of mud. Two had fragments of crayfish in the mud, one a piece of wood, and another the bones of a frog. A large one caught at Fairport, Iowa, a good deal earlier in the season had its stomach practically empty.

In the summer the snappers may be caught far from water, in grassy places, or in mudholes and puddles, and those caught in one place would doubtless differ in flavor from those caught in another. The turtle from the mud puddle would taste differently from the one caught on the grassy sward, just as beef from cattle and milk from cows grazing in a garlicky meadow differ from the products of a blue-grass pasture; just as the canvasback duck well fed on wild celery is the delight of epicures, while the same species feeding on the fetid *Chara* is as distasteful as any coot and the celery-fed coot excellent eating, and as a carp from a warm, muddy puddle is soft and rank, while one from a cool clear stream or pond is firm and excellent. Doubtless, the hibernating turtles taken from their winter quarters have approached a uniformity of flavor.

Still, taking the snapper by and large, it is sufficient to say that it has been exceedingly difficult to find, either spoken or printed, any words of disparagement. At Lake Maxinkuckee, it is true, the opinion was expressed that old snappers have a rank flavor and are tough; but the animals were there taken in summer from the beds of fetid *Chara*, which, when fed upon, will give even the choicest waterfowl a rank flavor. In addition to this, they naturally haunted the muddier parts of the lake, and, as has been said, subsisted on snails. Also, the delicious soft-shells were very abundant in that region, and the snapper would naturally suffer by comparison. In

<sup>a</sup> Nash, C. W.: Manual of the vertebrates of Ontario. Published by Dept. of Education, Toronto. 1908.

most other places the snapper met with praise on every hand. Many had eaten no other kind of turtle but snapper, and it was liked in a great variety of ways.

In many respects, indeed, the eating of turtles may be well compared to the consumption of mushrooms. They are looked upon as a viand rather than as a food. Unknown or untried kinds are regarded with suspicion. The flesh of the box turtle is reported on pretty good authority to be unwholesome, and one man along the Mississippi asserted, but probably without reliable evidence, that "the striped turtles are poisonous." The general use of the snapper is much like that of the morel, or sponge mushroom. Persons who eat turtle at all eat this particular kind because they know it and are not so certain about the others. Those who had had experience with various sorts of turtles would always compare the snapper with other species. Some, but rather few, and these usually people fond of a pronounced gamy flavor, liked the snapper best. One man interviewed said: "The meat of the snapper is more like beef, while that of the soft-shell is more like chicken." An almost universal opinion was that the snapper contains several kinds of meat. One man said it contains 6 or 7 kinds; another, 7 to 9 kinds; and still another, 14 kinds.

The living snapper has a somewhat musky odor, but this may disappear or be diluted to a pleasant aroma by cooking, since no one complained of it. The meat of old snappers is said to be rather tough. One man said it was rendered stringy by cooking too long, and in making soup should be cooked only until the flesh left the bones. It may, indeed, be these two qualities—gaminess and toughness—that have made the snapper preeminently a soup turtle. Persons who discussed the matter of turtle soups asserted that "all turtle soups are really vegetable soups in which turtle takes the place of other kinds of meat." Some of these soups are highly spiced and flavored. One dealer reported that "restaurants are the only extensive users of turtles, and the snapper is used only for soup, which is not in much demand during hot weather." In the markets of the large cities there is little or no family buying of turtles, and the citizen who is accustomed to buying live chickens and either having them delivered or carrying them home would not think of doing the same with a snapper. Even the dressed meat is rarely bought for individual or family use. In the small river towns, however, there is more individual buying and a greater number of methods of cooking are in vogue. In one instance, at Pekin, Ill., when a half barrel of snappers, 10 in number, was received, 7 were immediately dressed for local sale. Usually, however, the people prefer soft-shells when they can get them.

#### THE ALLIGATOR SNAPPER.

The alligator snapper, *Macrochelys temmincki* (Harlan), which is found principally in the southern part of the United States, is similar in general habits to its smaller and more northern relative, the common snapper. It is especially abundant in the swamps of Louisiana, where an active fishery is carried on at certain seasons. It reaches an immense size, examples weighing as much as 219

pounds having been reported. Its sale is confined chiefly to southern markets. As it is too large to ship in barrels, it is prepared for shipment by drilling holes with a breast drill through the edge of the upper and lower shells on each side of the neck and feet, running wires through and fastening it so that the head and legs can not be protruded. The shell of one reported to have been taken at Hannibal, Mo., was seen by the senior author in St. Louis. The turtle was reported to have weighed 27 pounds.

### THE FRESH-WATER TERRAPINS.

#### COMMERCIAL SIGNIFICANCE.

Within the Mississippi Basin the word "terrapin" is either a book name or a commercial term applied by market men to such of the hard-shelled turtles as find their way into the trade. Along the upper Mississippi and Illinois Rivers the only terrapin likely to be used is the Le Sueur terrapin, *Graptemys lesueurii* (Pls. III and IV). Along the upper Illinois a turtle, which from the description was supposed to be this, was referred to as the "Genetta." In the fish markets at Chicago lots of Le Sueur's terrapin and the elegant terrapin, *Pseudemys elegans* (Wied) (Pls. V and VI), were mixed together in barrels, no market distinction being made between them. Some of the *elegans* were said to be from Memphis, and they were called "Texas terrapin." In the turtle pen on the lower Illinois (Grafton) *elegans* was about as common as *lesueurii*, and was known as the "pond terrapin," the other species being the "river terrapin." At St. Louis the only terrapin seen at the opening of the turtle season in autumn was *elegans*. At Grafton *lesueurii* was the most highly esteemed of the two. Throughout the area under discussion there is another terrapin, the map turtle, *Graptemys geographica* (Le Sueur), so very similar to the Le Sueur terrapin that anyone but a specialist (and this includes both zoologist and fisherman) is likely to confuse them. The map turtle is probably as good as the others, but we saw none on the market. It apparently does not reach so large a size, however, and this may help explain its absence.

Exceedingly few terrapin are used even by the dwellers along the rivers, who are familiar with all sorts of aquatic food. This is probably due, not to their lack of excellence, but to the abundance and well-known qualities of the snappers and soft-shells, which have the additional advantage of larger size. The stimulus to the capture and sale of the terrapin, which is as yet rather feeble, comes from a demand in eastern cities, such as Philadelphia and Baltimore, where the diamond-back has been long known and esteemed and where the transition to other terrapin is easy. Along the Mississippi one man, an old fisherman who had at one time been a restaurant proprietor and famous for his cookery, said that they were most excellent eating. One of the fish dealers on the Illinois River said that terrapin is as good as the soft-shell, and each when fried is superior to chicken similarly prepared. In the Chicago market, unlike the snapper, which is sold by the pound, the terrapin are quoted by the individual or by the dozen. At one market they were quoted at from 25 to 30 cents apiece, and a fair sample weighed 2 pounds

and 11 ounces. Another dealer quoted them at 75 cents to \$3 per dozen.

Along the Illinois River a little more was learned about the terrapin market. No actual fishing was in progress, but a turtle buyer from Philadelphia had visited the various fish markets and had distributed some information about its peculiarities and market requirements. He stated that the terrapin were used as a substitute, or partial substitute, for diamond-back, and that for this purpose the males were not desired. What was wanted was the egg-bearing or "queen" terrapin. (At the Washington market in the autumn of 1917, when the first western—Le Sueur's—terrapin were coming on the market, it was learned that one of the "egg terrapin" was mixed with several diamond-back to make "diamond-back soup.") The river fishermen were unable to distinguish the sexes; but the Philadelphia buyer could do so, and readily picked out the "queens" from a lot of terrapin at hand, discarding the rest. During the summer of 1918 "queen" terrapin were being quoted at that place at \$1 each. At St. Louis, in October, it was learned that the market men there distinguished the female of at least *Pseudemys elegans* by its much longer claws. There was no opportunity to verify this by dissection; but some of the turtles—a numerically small proportion of those at hand—had much longer and sharper claws than the others, and there was no marked intergradation in this respect. This may be a correlation with their habit of digging for the purpose of laying their eggs. The long-clawed terrapin, assumed to be females, also generally exhibited a different marking on the under side of the plastron. Late in the autumn (1918) a barrel of elegant terrapin, a few individuals of which possessed exceedingly long, sharp claws, was noted at Chicago.

Both at Chicago and St. Louis the market men reported that the only local buyers of terrapin were the Chinese, who are also buyers of the diamond-back shipped from the east. One of the proprietors of a fish market stated that the Chinese used the terrapin chiefly medicinally, "to clear the blood," and that by calling at a Chinese restaurant designated by him further information and a recipe could be secured. Upon visiting the place a very accommodating Chinese chef furnished the following information: "Turtles are good for internal troubles, for the blood, and especially for tuberculosis. They are cooked together with herbs imported from China and for which there is no English name. According to one recipe, the bones of the turtle are removed and the under part of the shell is boiled two or three hours with the skeleton of a duck. According to another, the meat is boiled in a double boiler with strong alcoholic wines, whisky, gin, etc." He added that he partakes of turtle in this manner only a few times in a year, when he feels in need of a tonic, stating that it makes him feel like a new man. Diamond-back terrapin was said to be the best turtle to use for this tonic, but, as it is very expensive, the hard-shell turtle, "Texas terrapin," is used as a substitute. Both from the remarkable similarity of the last given recipe to that of ordinary diamond-back-terrapin soup, and, from the statement of a native of China that the people of that country do not eat turtle, we are inclined to suspect that the use of terrapin is an American extension of the native bill of fare.

The most probable reason for the exceedingly limited use, one might almost say the nonuse, of the terrapin within the Mississippi Basin is the unfamiliarity with them. They rarely stray any distance from considerable bodies of water and are not often seen by the general population. To the frequenters of river and lake shores they are, however, the most commonly seen of turtles.

Other features that have prevented their coming into use are their relatively small size, 2 pounds being about the average, and the amount and hardness of shell, making the percentage of meat relatively small and difficult to get at. So long as there is a great abundance of other forms of game and fresh food the only reason for resorting to them would be the superior flavor of the flesh, and they would be sought after as luxuries rather than necessities. Their appeal would be to the taste rather than to the satisfaction of hunger. There is, of course, the deep-seated feeling that nothing common can be a luxury, as is indicated by the old contracts that servants should not be fed shad too frequently and by the fable about the farmer and crayfishes.

That the terrapin is of excellent flavor would appear from the testimony of those who have tried it and from the fact that it can be successfully substituted for the diamond-back. As a rule, it inhabits clean waters. The different species of terrapin differ in their food and feeding habits, and doubtless in their flavor, to a corresponding degree.

#### METHODS OF CAPTURE.

Because of their habits, the manner of the capture of the terrapin is entirely different from that of the snapper. They do not crowd together in hibernating places during the winter and can not, therefore, be taken in numbers during that season, as the snappers are. In the summer they are gregarious, crowding together in great numbers on projecting logs and banks. They can be easily taken in traps, a number and variety of which are known along the Illinois River. By simply sinking a box in a place full of snags and brush, a goodly number of terrapin will manage to drop in. A fish dealer reported that one man had a waterproof box sunk in water by weighting it with stones. He visited it daily, removing 30 to 40 turtles. Another form consisted simply of a box with an inclined board for a slide leading up to it. The turtles climbing up the slide to bask crowded the end ones into the box. A still more complicated form had the slide so placed on a pivot that if one or more turtles got beyond the pivot and overbalanced the lower end they were dumped into the box. The success with which an old sunken boat on a bar in Lake Maxinkuckee was observed to catch terrapin indicates the effectiveness of any of these devices. The gunwale of the boat would be crowded with the basking terrapin; and upon anyone's approach they would plump at once into the water, about half of them landing in the boat. The boys in the region, out of sport, caught 50 or 60 of the animals in one afternoon in this manner.

A method used in trapping the "slider," a species of terrapin in the southeastern part of the United States, doubtless would also prove efficacious. A projecting log is chosen and a heavily leaded

net placed entirely around it, except at the lower or entering end. The turtles climbing up on the log to bask keep pushing the foremost one off, and, if anyone approaches, all but one or a few at the lower or entering end of the log drop into the net. By this means great numbers can readily be taken.

#### SHIPMENT, STORAGE, AND MARKETING.

The shipment, storage, and marketing of the terrapin are the same as that of the snapper, except that, as has been said, practically all are sent to eastern markets. In the local markets they are sold by the individual or by the dozen instead of by weight.

#### THE SOFT-SHELL TURTLES.

Among the possible aquatic resources of the country an important place is occupied by the soft-shell turtles, of which there are two common species—the spiny, or common, soft-shell, *Amyda spinifera* (Le Sueur) (Pls. VII and VIII), and the smooth soft-shell, or leatherback, *Amyda mutica* (Le Sueur). These turtles are generally northern in their distribution. They are confined chiefly to the larger streams and lakes and are therefore rather unfamiliar objects to the general population. They never stray far from the water's edge and are very timid in disposition, taking to the water with exceeding swiftness when alarmed, so that even those who spend a great deal of time along rivers and lakes rarely get a very good view of uncaptured specimens. They are gregarious, assembling in considerable numbers on banks and sand bars.

#### COMMERCIAL SIGNIFICANCE.

The soft-shell turtles are seldom found in the markets. None was seen in the Washington market nor in Chicago, where it was reported that "they could not be given away, much less sold." And yet, where well known, the soft-shell is regarded as the most delicious of turtles. It is, indeed, a species of soft-shell turtle which is reared in Japan, much as the diamond-back terrapin is beginning to be raised in this country.

One reason for the absence or rarity of soft-shell turtles on the market is that they are too little known at the great market centers and too well known at the place of capture. No general demand has been created, and no special efforts are made to capture them. Numbers are incidentally caught by various forms of fishermen's gear, such as set lines, seines, and hoop nets, especially baited "fiddler nets" (the nets used to catch channel catfish). These incidentally caught turtles are not usually allowed to get beyond the fisherman who catches them; they are consumed mostly in the immediate locality where caught. In the small towns along the Mississippi and Illinois Rivers they are the favorite food turtles. The snappers are shipped to market and the soft-shells consumed locally. The dealers attribute their absence from the markets to several reasons. They do not stand shipment as well as other turtles, being of a more delicate nature. They are flatter and not so meaty as the

snapper; so there is more waste. The soft-shells, therefore, rank with those "home-consumption" delicacies, the famous honey banana, the emerald-gem muskmelon, and the fall pippin apple, which are too good for the market place and can not retain their original flavor after passing through the hands of the middlemen. The fish dealer at one of the towns visited shipped out a barrel of snappers, but when visited later it was found that he had a goodly number of soft-shells on hand. "They do not get beyond me," he explained.

The soft-shells are prized, not only for soup, but for frying; and for this purpose the younger individuals, weighing from 1 to 1½ pounds, are preferred. In making soup the shell may either be used or discarded.

The soft-shell loves the clear water over sandy bottoms and prefers a good current. Its principal food, to judge from a few specimens examined, consists of crayfishes. Both its habits and habitat are therefore conducive to an excellent flavor of flesh.

#### METHODS OF CAPTURE.

On account of their habits, the soft-shells can not be taken in quantities by the methods used for either the snapper or terrapin. They are gregarious, like the terrapin, but, as a general thing, they do not seek elevated positions in basking, any good sand bar proving satisfactory. They would not drop in numbers into boxes, and they do not "mud up" in large numbers, as do the snappers during the winter. They are rather hard to get in an ordinary seine. During the summer of 1907 several hundred were seen basking on one of the sand bars of the upper Mississippi not far below St. Paul. The sand bar was surrounded by a long net, with the expectation of bagging several barrels of turtles. These all took to the water and the net was drawn in. Only two turtles were obtained, the net having passed over the others, which had, no doubt, simply flattened down close to the bottom.

As previously stated, most of the soft-shells are captured incidentally on set lines or in hoop nets operated for fish. They can readily be caught in baited hoop nets, and one fisherman said that it was easier to get them, when desired, than it was to capture snappers. The nets must be visited at least every 12 hours, especially in warm weather, as the imprisoned turtles soon drown. Prof. Jacob Reighard in Ward and Whipple's "Fresh-water Biology," page 66, gives the following description of a turtle net:<sup>a</sup>

Turtles are best taken in a turtle net, which is a form of fyke net. It should be of heavy twine and coarse mesh and, if it is desired to keep the turtles alive, should be modified as follows: The terminal section of the pot is made cylindrical or the whole pot may be made with square hoops. A circular opening is cut in the upper side of the terminal section of the pot and to this is attached the lower end of a cylinder of netting which extends to the water's surface. The upper end of this cylinder is attached to an opening cut in one side of a wooden box, provided on the opposite side with a hinged lid fastened with a hasp. The box is supported at the surface of the water on poles set in the bottom. When turtles reach the terminal section of the pot, they are able to

<sup>a</sup> Reighard, Jacob: Methods of collecting and photographing. Chap. III of Fresh-water Biology, by Henry B. Ward and George C. Whipple. John Wiley & Sons, New York, 1918.

enter the box through the cylinder of netting and are thereby saved from drowning, which would ensue if they could not reach the air. They may be removed through the lid at the convenience of the collector.

#### SHIPMENT.

In the upper Mississippi and in some of the glacial lakes in the northern part of our country the soft-shell is exceedingly abundant and if made use of would offer a considerable amount of meat to the inhabitants of those regions. The market men say that it can be beheaded and rough cleaned—that is, with just the viscera removed—and shipped on ice. In this condition it keeps as well as fish similarly treated. Frozen, they say, it remains in perfect condition and is as good when thawed as when fresh. Handled in this manner, it could, if there were a sufficient demand, furnish a considerable meat supply to a large area.

Taking the country at large, the turtles are much more scarce than formerly. From along the upper Illinois River comes the complaint that the turtles, especially appreciated there, are “becoming very scarce” or “practically exterminated” and that the local market demand is greater than the supply. This exhaustion is attributed to the draining of the feeding areas of the turtles and the building of levees. The State law of Illinois protects both turtles and terrapin of any size under a 7-inch shell. All that has saved the turtle to this day is probably the fact that it has remained more or less unappreciated.

#### ENEMIES OF TURTLES.

In spite of the various means with which nature has endowed the turtles for their welfare—the protecting shell of all of them; the timid disposition of the terrapin, which prevents them from wandering afar from safety and causes them to drop into the water at the first sign of alarm; the inconspicuous colors of most of them; the timidity and swiftness of the soft-shells; and the longevity of such as have passed the vicissitudes of early life—they are subject to many dangers and, on the whole, seem to be scarcely holding their own. A good many young appear to perish during the first winter. Muskrats kill a few of the smaller species, but do not appear to molest those of larger size. Leeches often accumulate on turtles in considerable numbers, and, though they may never directly kill them, they doubtless greatly lessen their vitality. In the Japanese breeding establishments old turtles devour their young, and this may occasionally happen in nature. Doubtless carnivorous animals often dig up the nests and devour the eggs, as one often finds eggs scattered about and evidence of digging where the turtles make their nests.

By far one of the most important enemies is man. Fishermen finding turtles in their nets or on hooks often kill and discard them, instead of either releasing or using them. Many persons make it a practice to rob turtle nests by the wholesale, either for so-called sport or to use their eggs for fish bait. By digging into the sand bars used for nesting places hundreds of eggs can be taken and destroyed in a short time. Many turtles, especially soft-shells, are drowned in hoop nets used by fishermen.

## PREPARATION OF TURTLES FOR THE TABLE.

## KILLING THE TURTLE.

Notwithstanding the formidable appearance offered by the shell, the killing and dressing of turtles is a comparatively easy matter, and the men at the fish markets soon become expert at it and can kill and clean them with surprising rapidity. The first step is to get the animal to protrude its head. In the case of the snapper, this is easily accomplished by presenting to its head a stick of suitable size for the reptile to snap. It takes tenacious hold, and the head can readily be pulled out. The heads of the other species may be made to protrude by applying pressure, as with the foot, to the back or upper part of the shell. After the neck is well stretched out the turtle can readily be decapitated. At fish markets, where many turtles are dressed, the cleaners usually have a killing plank with a sharpened spike driven through at an angle, and the spike is thrust through the chin during the process of stretching.

Once beheaded, a sharp knife is run around the edges of the skin where it joins the shell and the skin pulled back over the legs to the feet, which are then disjointed. The lower part of the shell or plastron is then removed by cutting through the bridges which join the upper and lower shells, cutting close to the lower part of the shell. With snappers and soft-shells, in which the bridges are rather soft and cartilaginous, this can be done with a sharp knife. With the terrapin the bridge may be cut with a hatchet or saw. Having cut the bridges, the plastron or under shell may be readily removed by inserting a sharp knife just under it and lifting it off. This done, the entrails may be extracted with very little trouble, and the four quarters easily taken out from the carapace or upper shell. If one wishes to save the tenderloin in the upper part or "ceiling" of the carapace, the ribs may be cut with a hatchet. To the reader this may appear to be a lengthy and complicated process; but, as stated above, it is a simpler process than killing, plucking, and dressing a chicken.

A visit to a place where turtles are being dressed by professionals would prove very instructive. It need hardly be said that each has his own method as regards the smaller details. Some cut off the feet before skinning; others skin down to the feet and then disjoint. Some even cut off the feet before decapitation, but this is unnecessarily cruel. The smaller turtles and terrapin are often killed by dropping the living animal into boiling water just as lobsters and crayfishes are killed. This is a convenient method and not especially cruel, as death is practically instantaneous. With a large kettle the same method might be used for the soft-shell and snapper.

## RECIPES.

Doubtless one reason for the general nonuse of turtles for food is the lack of knowledge as to just how to prepare them for the table and the lack of experience with turtles properly cooked. To meet this deficiency, the following recipes, which have been obtained from various available sources, are offered. A few have been gleaned from cookbooks, but most of them have been procured from per-

sons noted locally for their preparation of turtles. Special thanks are due to Henry Lemm, of Pekin, Ill., and to Mrs. Saunders, of the Saunders Fish Market, St. Louis, Mo., for choice recipes.

## SOUPS.

These recipes apply especially to the snapper, which is the great soup turtle of the Mississippi Basin. They could, doubtless, be applied to terrapin and soft-shell also, as they are as good for soups as the snapper.

In making soups, cook the turtle only until the bones leave the flesh. Many cook too long, which makes the flesh stringy.

1. *Turtle soup*.—A favorite way to cook snapper is to make the soup like old-fashioned beef soup, with any assortment of vegetables desired, with the turtle meat cut up into small pieces.

2. *Turtle soup*.—Make up a soup stock, without vegetables, but add egg.

3. *Turtle chowder*.—One-half pound turtle meat, 2 medium-sized potatoes, 3 onions, 3 carrots, any other vegetables wanted, as parsley, all diced into the pot; add  $\frac{1}{4}$  pound of salt pork diced, 1 teaspoonful pepper, 1 level teaspoonful of butter, and cook about 2 hours over a slow fire. This is fine, a regular turtle chowder. With soft-shell turtle cut up the shell also, and cook for 4 hours.

4. *Soft-shell turtle soup*.—Use turtle meat same as for beef soup, adding a slice of bacon and onion to modify the flavor. (Soft-shell turtle meat is also good with noodles.)

5. *Turtle soup à la creole*.—This is the ancient recipe for turtle soup, and it is safe to say that when once eaten after this delightful way no other will seem quite so savory. Cut the turtle meat into small pieces. Let it brown in a pot with a little lard, cut up several onions, a slice of ham, and a little garlic, and stir and mix with the turtle meat. Then let the mixture brown well. Put in some flour and mix, pour a quantity of the soup stock into the pot, let it cool, and add a knee joint of veal. Let it simmer for an hour, then put in some thyme, laurel leaf, parsley, shallots, and when everything is cooked add more parsley and a couple of slices of lemon chopped fine. Just before serving add a wineglassful of Madeira wine, or, in lieu of this,  $\frac{2}{3}$  that amount of lemon juice.

6. *Terrapin soup*.—Use the meat and eggs from 1 terrapin, put into a stew-pan with 2 tablespoonfuls of butter, and let it simmer until quite hot throughout, keeping the pan closely covered. Serve with the following sauce: 1 beaten egg yolk flavored with nutmeg and mace,  $\frac{1}{2}$  cup currant jelly, 1 pinch of cayenne, salt to taste, 1 tablespoonful of butter.

## FRIED TURTLE.

Although the turtles generally preferred for frying are medium-sized soft-shells weighing from  $1\frac{1}{2}$  to 3 pounds, many like fried snapper. For frying, the younger and more tender snappers are to be preferred, although the older ones can be used by cooking correspondingly longer.

7. *Fried turtle*.—Cut the turtle meat into small pieces, add salt and pepper, roll in flour, and fry in one-half lard and one-half butter until brown, then add a little water, cover up, and steam until done (about  $\frac{1}{2}$  hour).

8. *Fried turtle*.—Fry as above; when browned add some catsup, a few mixed spices, a glass of wine, or, in lieu of this, 2 tablespoonfuls of vinegar and a little water; cover, and steam until done (about  $\frac{1}{2}$  hour).

9. *Fried turtle*.—Some cooks prefer to fry dry, without steam; in this case one must cook slowly, and of course old turtles must be cooked longer than young ones.

10. *Fried turtle*.—Simply parboil the turtle meat and fry in butter.

11. *Fried turtle*.—Put the turtle meat into salt water for a short time, remove and wipe dry, sprinkle with corn meal, and fry in hot grease, or use butter, salt, and pepper, and thicken with barley. (The person who furnished this recipe generally preferred snapper to other turtles, and had this species in mind.)

12. *Fried snapper*.—Put the turtle meat into salt water overnight, take out, wipe dry, sprinkle with flour, and fry in plenty of grease. Fry slowly until brown. This is said to be better than fried chicken. For this old turtles are said to be as good as young.

## MISCELLANEOUS.

The following recipes were obtained at St. Louis and apply to the native turtles used there. They were meant to apply especially to the snapper; it is believed, however, that they could be applied to the more delicate soft-shell, where procurable, with even better results.

13. *Steamed turtle*.—Take fresh turtle meat, fill with black pepper and a bit of butter, steam until the flesh separates from the bones, then add black sauce (the soy-bean sauce to be found in Chinese restaurants) or Worcestershire sauce.

14. *Turtle cutlet*.—Take lean turtle meat, pound until like hamburger steak, dip into egg, roll in meal, and fry in hot fat. This tastes like veal cutlet.

15. *Simmered turtle*.—Take 1 pound turtle meat, wash, cut into cubes, brown in fat (lard or butter) with 1 large or 2 medium-sized onions, simmer until tender, add Chili pepper while simmering. To serve, pour over boiled rice.

16. *Curry of turtle*.—Take 1 pound of turtle meat, brown as above, with 1 large or 2 medium-sized onions. Put into the pot 1 medium-sized potato, 1 carrot, the onions which have been cooked with the turtle, a small piece of parsley,  $\frac{1}{2}$  teaspoonful of pepper, 1 teaspoonful of salt, and  $\frac{1}{2}$  teaspoonful of curry powder. Add the browned turtle meat to the mixture in the pot and let simmer until tender. Make molds by hollowing out cups of boiled rice and serve in the molds. This tastes like curry of chicken or curry of veal.

17. *Turtle rivola*.—(a) One-half pound turtle meat, best chopped through a food chopper, add 2 onions, cook until tender, add  $\frac{1}{4}$  pound of cheese and salt and pepper.

(b) Take 1 cup flour, 1 egg,  $\frac{1}{4}$  teaspoonful salt, make a thick batter, roll out thin into a sheet of noodle dough, and cut into 2-inch dice.

(c) Take 1 spoonful of minced turtle meat, lay on the diced noodle dough, fold over 3 corners and inclose the meat, cook like noodles in the water that the turtle meat was cooked in, to which a spoonful of butter has been added.

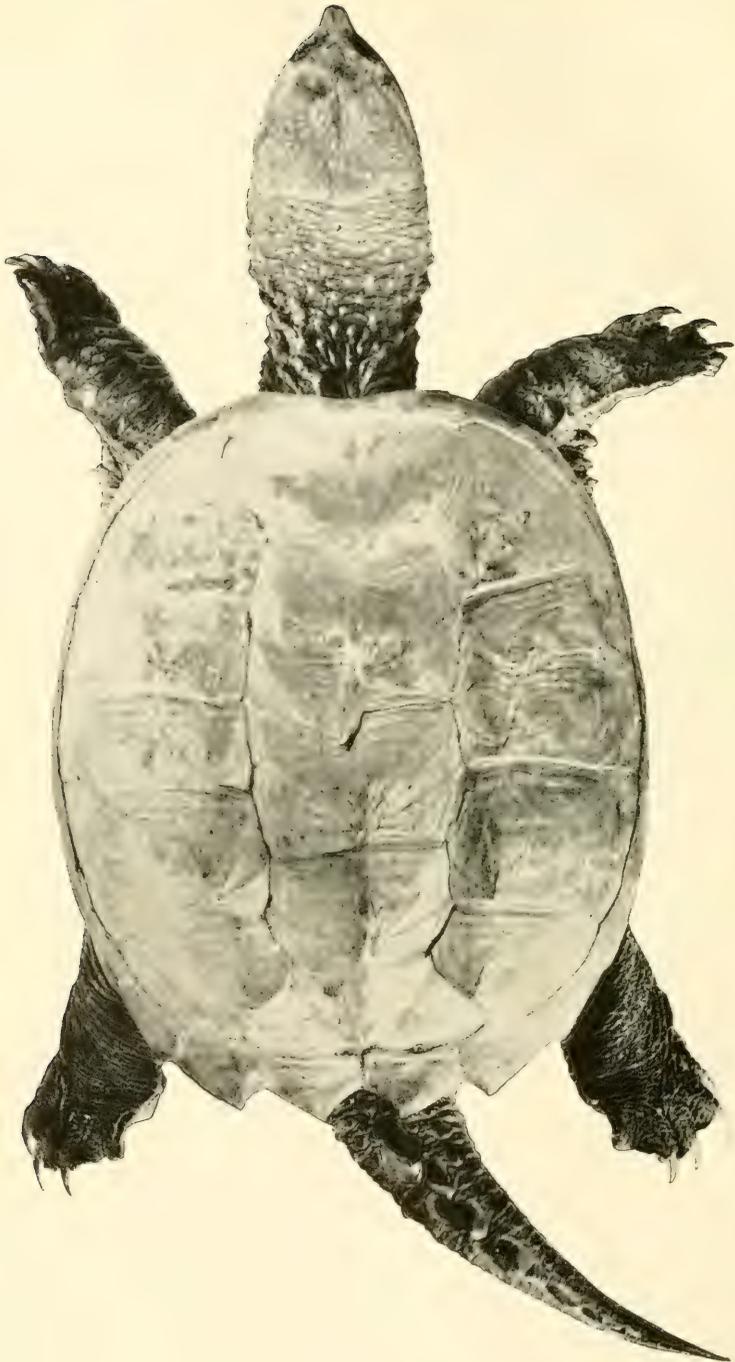
18. *Turtle sausage*.—Cook 2 pounds of turtle meat until tender, run through a food chopper, add 2 eggs, drop into hot fat or fry right off the spoon until brown.

While the following recipe was originally intended to apply to the diamond-back terrapin, it would doubtless serve very well for the fresh-water species, and possibly for snapper or soft-shell turtle also:

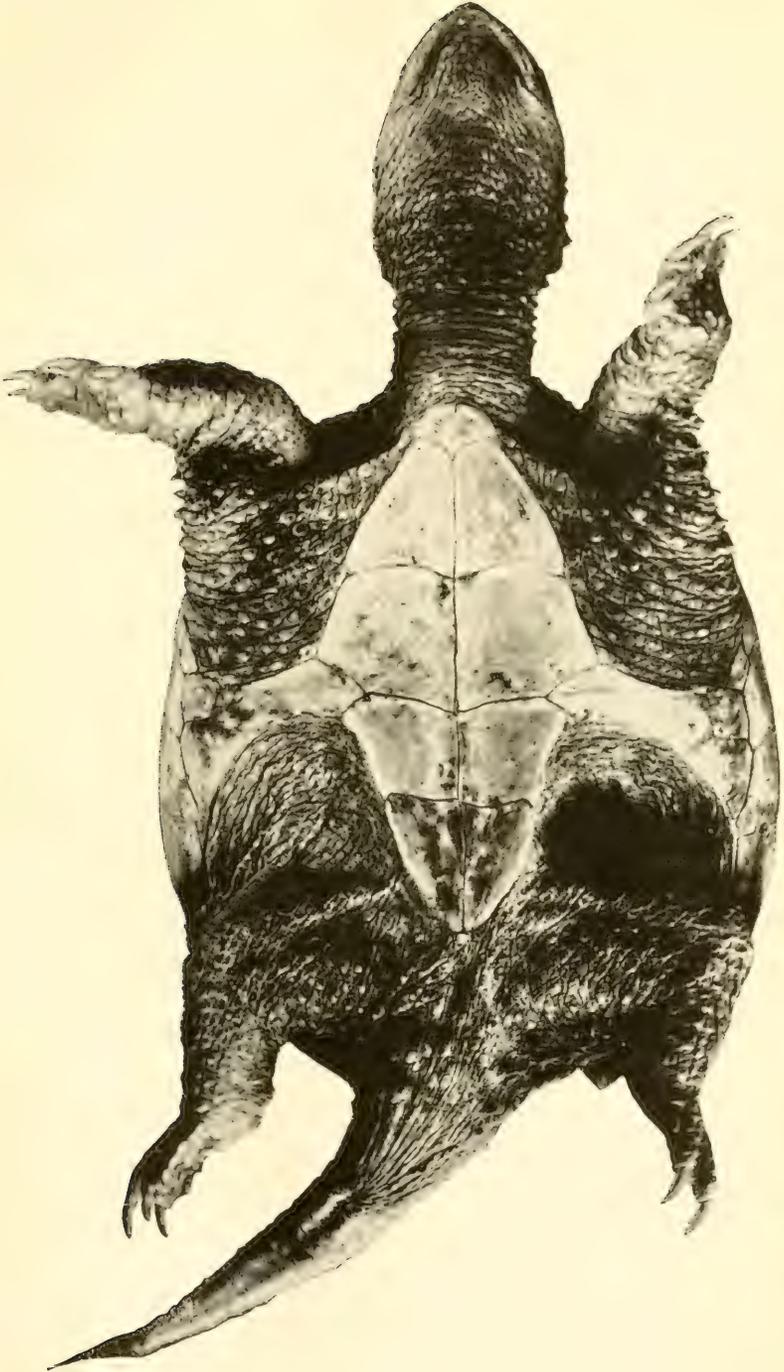
19. *Stewed terrapin with cream*.<sup>a</sup>—Place in a saucepan 2 tablespoonfuls of butter and 1 of rice flour, stir over a fire until it bubbles, then stir in a pint of thin cream, 1 tablespoonful salt,  $\frac{1}{2}$  tablespoonful white pepper,  $\frac{1}{4}$  tablespoonful grated nutmeg, and a very small pinch of cayenne, next put in 1 pint of terrapin meat, and stir it all until scalding hot. Move saucepan to back part of stove, where contents will keep hot, but not boil, then stir in 4 well-beaten yolks of eggs. Do not boil, but pour immediately into tureen containing 1 tablespoonful lemon juice. Serve hot.

<sup>a</sup> From the "White House Cook Book."

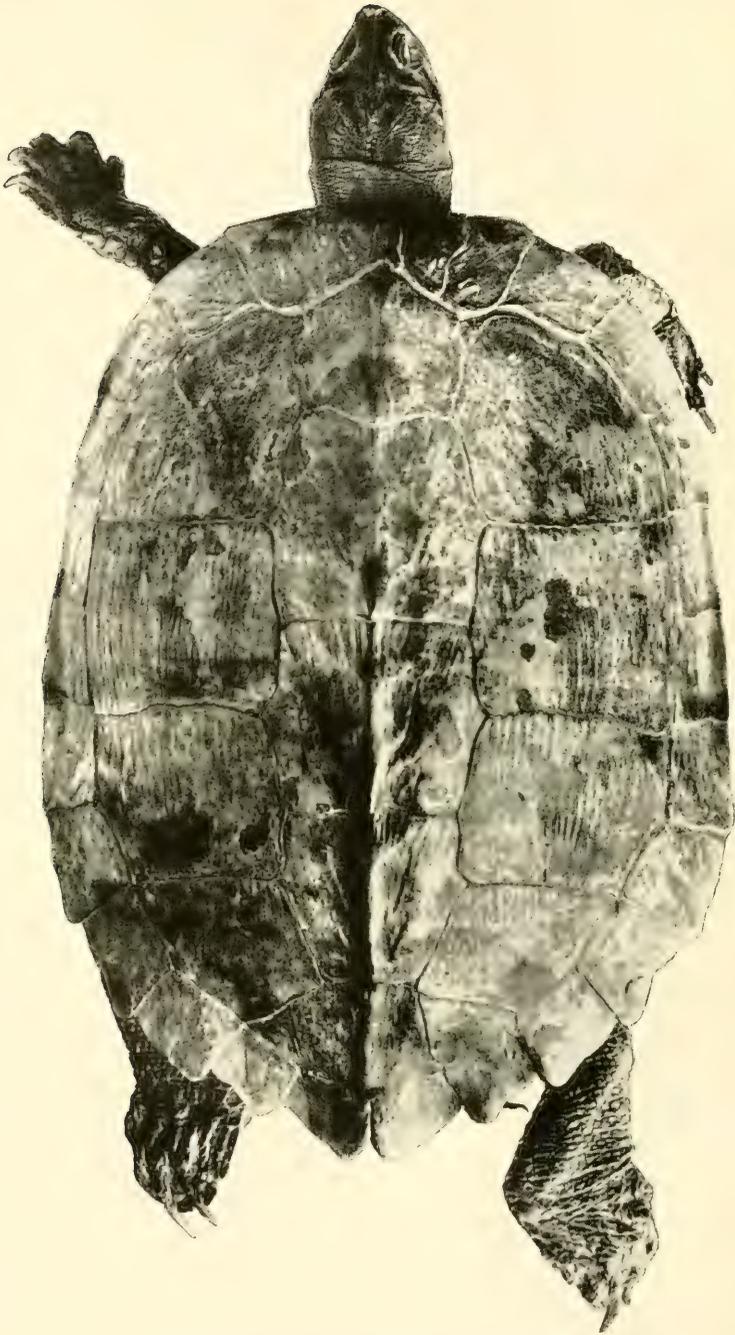




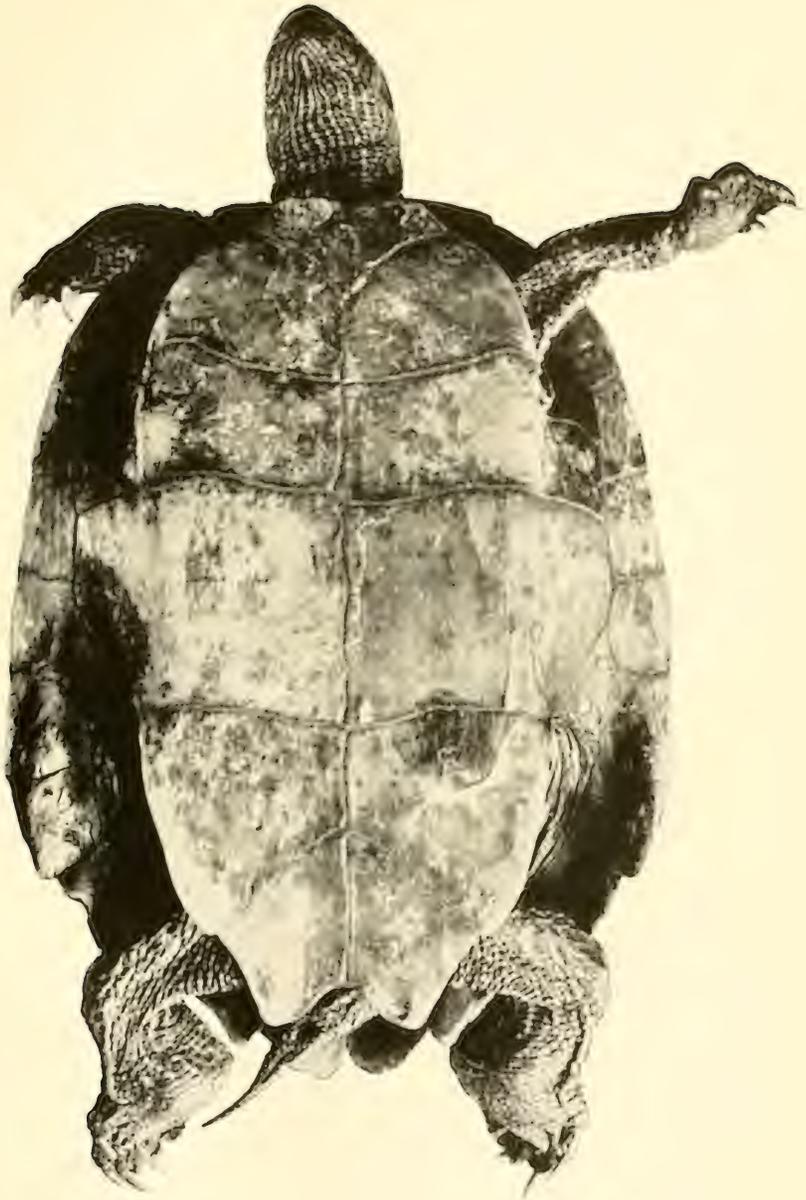
SNAPPING TURTLE, *CHELYDRA SERPENTINA* (LINNAEUS).



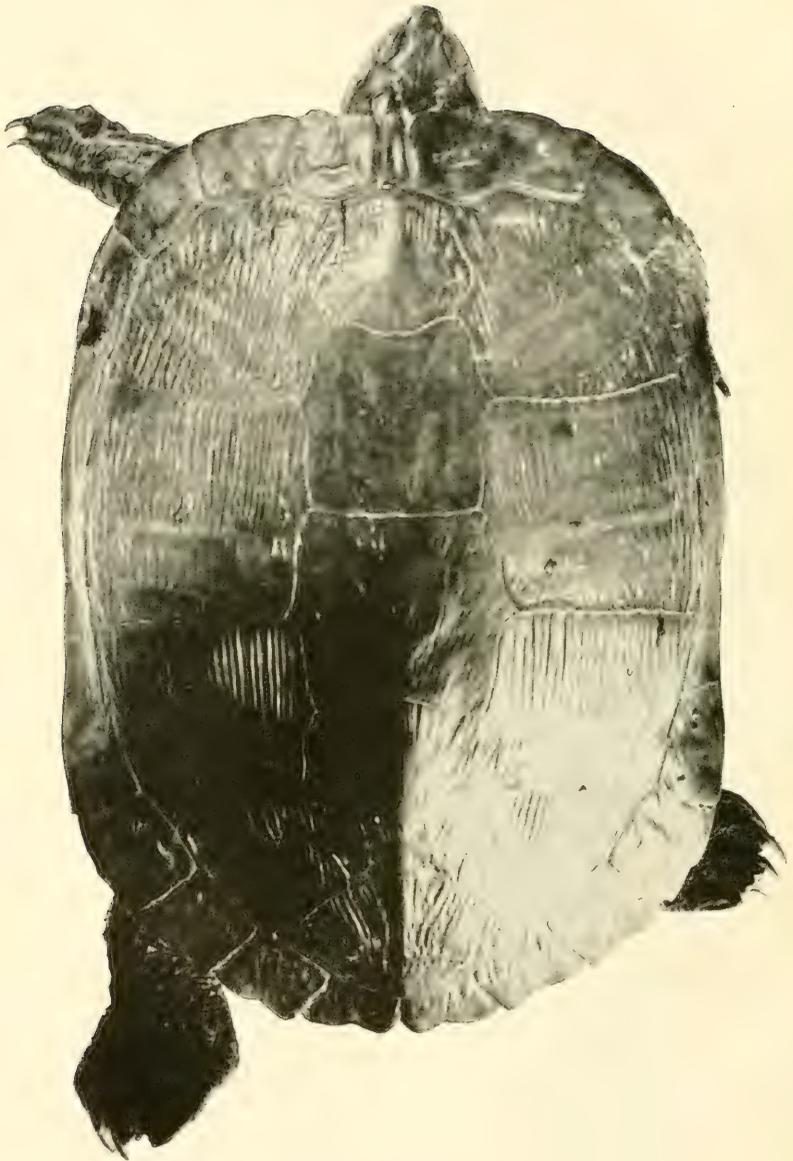
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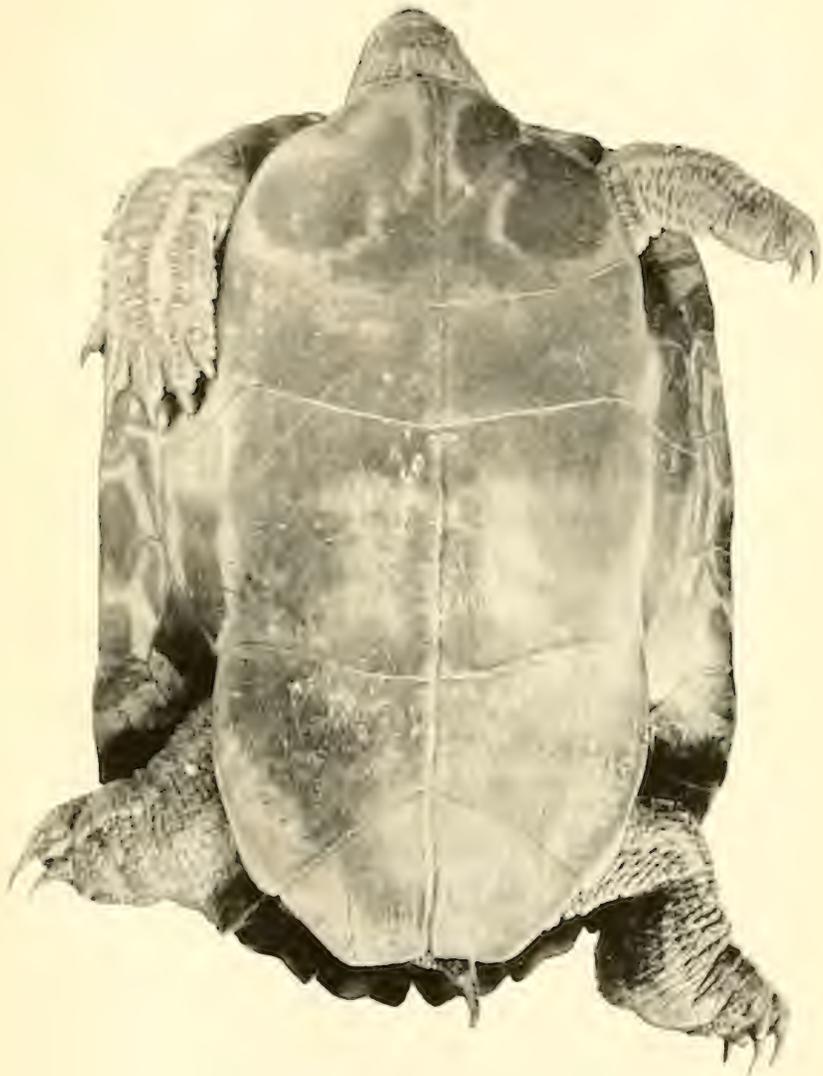
LE SUEUR TERRAPIN, *GRAPTEMYS LESUEURII*.



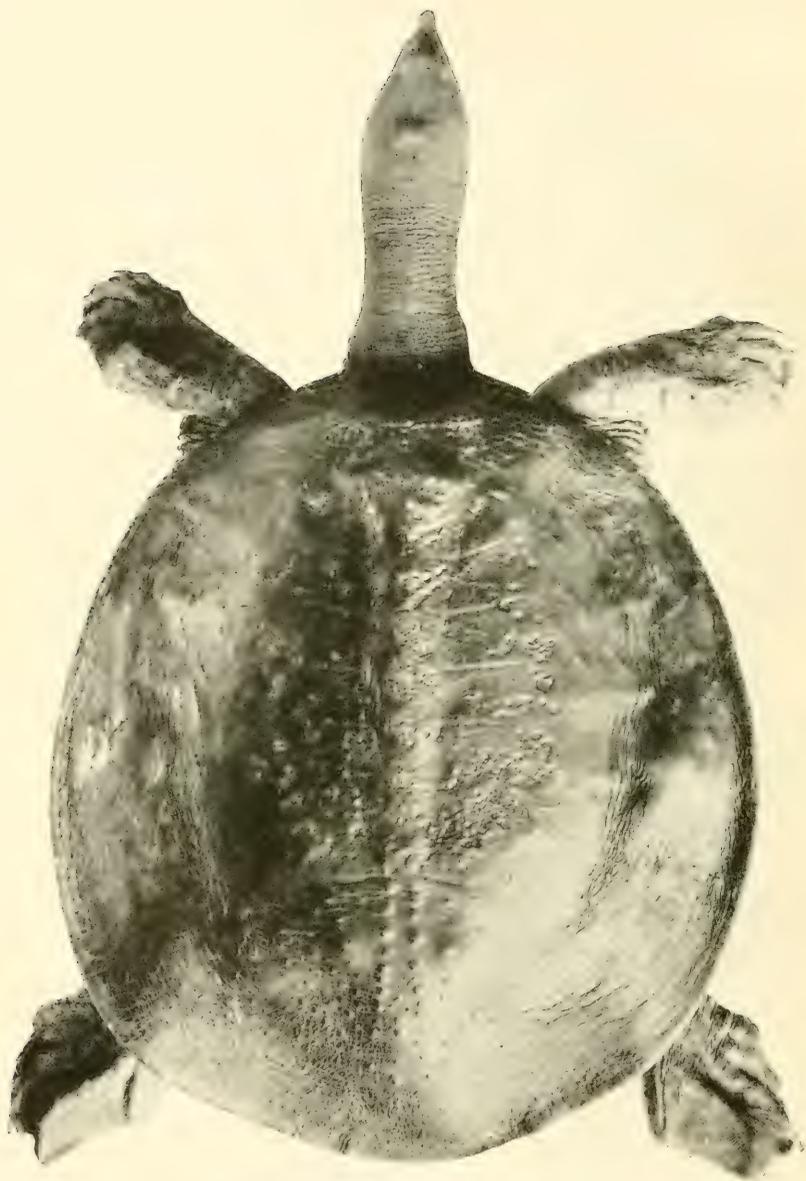
LE SUEUR TERRAPIN, GRAPTEMYS LESUEURII.



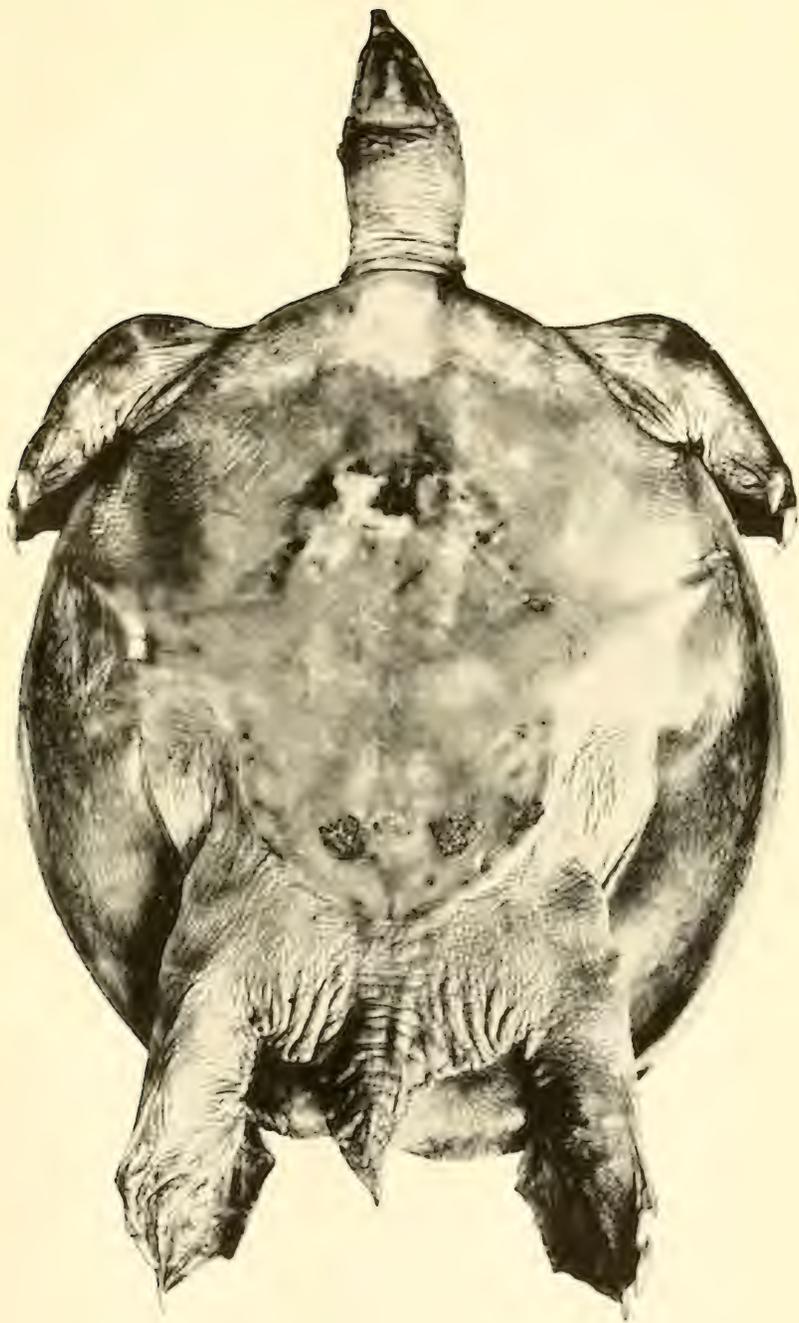
ELEGANT TERRAPIN, *PSEUDEMYX ELEGANS*.



ELEGANT TERRAPIN, *PSEUDEMYSL ELEGANS*.



SOFT-SHELL TURTLE, *AMYDA SPINIFERA*.



SOFT-SHELL TURTLE, *AMYDA SPINIFERA*.



# THE OYSTER AND THE OYSTER INDUSTRY OF THE ATLANTIC AND GULF COASTS

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By E. P. CHURCHILL, Jr.

*Assistant, U. S. Bureau of Fisheries*

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Appendix VIII to the Report of the U. S. Commissioner of Fisheries for 1919



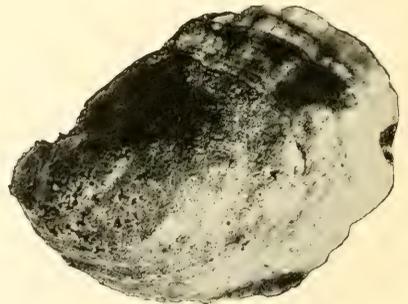
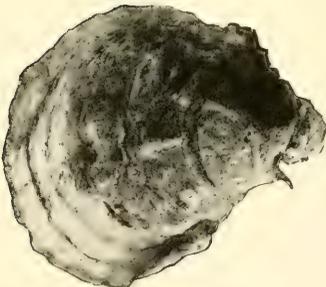
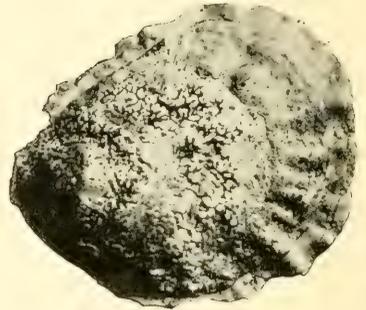
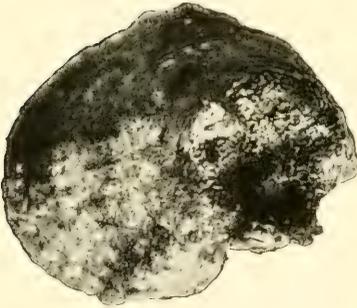
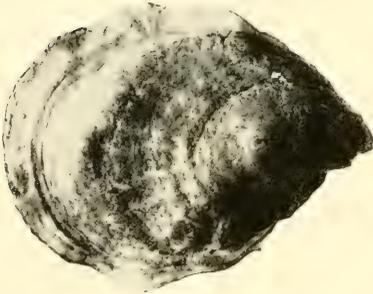
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BLUE POINTS, FROM NEAR BLUE POINT, LONG ISLAND.  
About one-half natural size.

# THE OYSTER AND THE OYSTER INDUSTRY OF THE ATLANTIC AND GULF COASTS.

By E. P. CHURCHILL, Jr., *Assistant, U. S. Bureau of Fisheries.*

## INTRODUCTION.

The taking of oysters constitutes the most valuable fishery of the United States and one of the most valuable in the world. The annual yield in this country is about 30,000,000 bushels, with a return to the fishermen of nearly \$15,000,000. At least 99 per cent of the oysters of the United States are produced on the Atlantic and Gulf coasts, as shown by the following table:

### OYSTER PRODUCT OF THE UNITED STATES.

[From statistics collected by the U. S. Bureau of Fisheries.]

Region.	Private grounds.		Public grounds.		Total.	
	<i>Bushels.</i>	<i>Value.</i>	<i>Bushels.</i>	<i>Value.</i>	<i>Bushels.</i>	<i>Value.</i>
New England States (1910)....	5,549,318	\$3,439,450	92,703	\$157,584	5,942,021	\$3,597,034
Middle Atlantic States (1911-12).....	7,090,883	5,204,124	11,815,193	4,059,432	18,906,076	9,263,556
South Atlantic States (1910)...	456,194	171,298	1,244,804	192,886	1,700,998	364,184
Gulf States (1918).....	1,227,969	528,123	2,165,526	578,597	3,393,495	1,006,720
Pacific Coast States (1915).....	152,560	548,005	3,544	8,619	156,104	556,624
Total.....	14,476,924	9,891,000	15,301,770	4,997,118	30,098,694	14,788,118

The report of the Commissioner of Fisheries for 1913 stated that the total number of persons engaged in the oyster industry of the United States was 67,257, the yearly wages paid amounting to \$10,876,801, and that the investment in vessels, apparatus, property, etc., was over \$17,000,000.<sup>a</sup>

### GEOGRAPHICAL DISTRIBUTION.

On the eastern and southern coasts of the United States oysters are found from Wellfleet, Mass., on the inner shore of Cape Cod, to the southern extremity of Texas. The industry on these coasts is bounded by the same limits. Although in past times oysters were found in Maine and New Hampshire, practically none occurs there now, and these two coastal States alone have no oyster industry.

The location of the main oyster beds in each State concerned and the principal towns in which the industry is centered are cited below. The Atlantic and Gulf coast is not lined with a solid bed of oysters along its entire length. Oysters are not found in the open sea, but in coves, bays, estuaries, and mouths of rivers—in a word, in partially

<sup>a</sup> Report U. S. Commissioner of Fisheries, 1913, p. 40. Washington.

inclosed waters rendered brackish by drainage from the land. This fact will become more apparent during the reading of the ensuing paragraphs.

#### MASSACHUSETTS.

The main oyster beds are in Wellfleet Harbor, in the waters in the vicinity of Chatham, in Cotuit Harbor, and in Poponesset Bay. Some oysters are also taken from Centerville Harbor and from the mouths of Wareham and Taunton Rivers. The principal towns concerned are Wellfleet, Chatham, Cotuit, and Falmouth. The oysters are shipped in the shell or shucked, on ice.

#### RHODE ISLAND.

The main oyster beds are in Narragansett Bay, the industry being centered at Providence, where there are about a half dozen oyster-houses. The oysters are shipped in the shell or shucked, on ice.

#### CONNECTICUT.

Although oysters are found along practically the entire coast, the principal beds are inside Thimble Islands, in New Haven Harbor, Milford Bay, Bridgeport Harbor, South Norwalk Harbor, around Great Captains Island, and in the deeper water offshore from these places. All the oysters are shipped in the shell or shucked, on ice. There are 6 oyster houses at South Norwalk, 16 at New Haven, and 1 each at Milford, Stony Creek, Guilford, and New London.

#### NEW YORK.

The oyster beds of New York are in the waters around Long Island. The oysters are shipped in the shell or shucked, on ice. There are 4 oyster houses at Greenport, 1 at Suffolk, and 2 at Northport, on the north side of the island. On the south, West Sayville and Patchogue are the centers of the oyster trade, there being extensive beds in Great South Bay. New York City is the great center of the oyster trade of the State.

#### NEW JERSEY.

The main oyster beds are in Raritan, Barnegat, and Great Bay, on the eastern coast, the oysters being handled chiefly at Tuckerton and Keysport; and in Delaware Bay, on the west, especially in Maurice Cove and vicinity. The oysters from this region are shipped from Bivalve, where there are several houses handling oysters in the shell or shucked, on ice.

#### DELAWARE.

The oyster beds are in Delaware Bay, mainly from Bombay Hook to below the mouth of St. James Creek. Most of the oysters are marketed through Bivalve, N. J.

## MARYLAND.

The principal oyster beds are in the Chesapeake Bay, there being some, however, in Chincoteague Bay and Potomac River. The number of oyster houses at the main centers of trade are as follows: Crisfield, 40; Baltimore, 28 (15 being oyster canneries); Cambridge, 25; Oxford, 15; Annapolis, 13; Tilghman, 8; and St. Michaels, 6. There are about 160 oyster houses in all in the State. Baltimore is the only city in the State where oysters are steamed and canned, and is the most northerly point on the coast where this process is employed.

## VIRGINIA.

The waters covering the main oyster beds of the State are those of Chesapeake Bay, Chincoteague Bay, and the eastern coast of Accomac and Northampton Counties, and the Potomac, Rappahannock, York, and James Rivers. There are about 35 oyster houses, 19 at Norfolk and Portsmouth, 2 at Hampton, 1 at Phoebus, 3 at West Point, 2 at Urbanna, and others scattered about in Northampton, Middlesex, Lancaster, and Accomac Counties. The oysters are shipped in the shell or shucked, on ice, none being canned. One firm prepares an oyster powder from the dried meats.

## NORTH CAROLINA.

Four-fifths of the oyster beds of this State are in Pamlico Sound. There is one cannery at each of the following points: Beaufort, Morehead City, Washington, Vandimere, Davis, Bay River, and Sea Level. There is one shucking house, or "raw house," as such a place is termed in the South to distinguish it from a cannery, at Newbern and several at Wilmington.

## SOUTH CAROLINA.

Most of the oyster beds are in St. Helena and Port Royal Sounds near the southern extremity of the coast. There are five canneries at Charleston and six at Beaufort, besides two or three at smaller cities.

## GEORGIA.

The oyster beds are found along the entire coast line, especially in St. Catherines, Sapelo, Do Boy, Altamaha, St. Simons, St. Andrews, and Cumberland Sounds. There are 18 canneries in the State—four at Savannah, and the rest scattered along the coast. There are five wholesale dealers in raw oysters, besides several retailers at Savannah, Brunswick, and other points.

## FLORIDA.

The principal oyster industry of the State is located at Apalachicola, where there are four canneries and nearly a dozen raw houses, the oysters coming from Apalachicola Bay and contiguous waters. There is a small oyster business at Carabelle and some beds at Cedar Keys. A few oysters are canned at Fernandina, on the east coast. There is a small local oyster business at other points in the State.

## ALABAMA.

The oysters are found in the lower part of Mobile Bay and the east end of Mississippi Sound. There are 13 dealers in oysters in Mobile, but most of the oysters are opened or reshipped in the shell at Bayou Labatre and small adjacent points on the Mississippi Sound. The only oyster cannery in the State is located at Bayou Labatre.

## MISSISSIPPI.

The principal oyster beds in this State are in Mississippi Sound, but 90 per cent of the oysters opened in the State are brought from Louisiana waters, especially from St. Bernard Parish. At Biloxi there are 12 canneries and 6 raw houses, the only city having a larger number of canneries being Baltimore, Md., which has 15. The following Mississippi cities have one cannery and one or two raw houses each: Gulfport, Pass Christian, Bay St. Louis, and Ocean Springs.

## LOUISIANA.

The principal oyster beds are in the waters on the east of St. Bernard Parish, although important beds are found on the coast of Terrebonne and Plaquemines Parishes, and others are being developed to the westward. As a result of experiments conducted by the U. S. Bureau of Fisheries between 1906 and 1909, valuable oyster beds were established in Baratavia Bay. These were subsequently broken up by a hurricane and the oysters washed about to different parts of the bay. From the natural propagation of the oysters so scattered several beds developed which have grown to be of considerable value. There are about 24 wholesale oyster dealers in New Orleans. One cannery is located near New Orleans, two farther down the river, two or three at Houma in Terrebonne Parish, and a new one is just starting at Franklin.

## TEXAS.

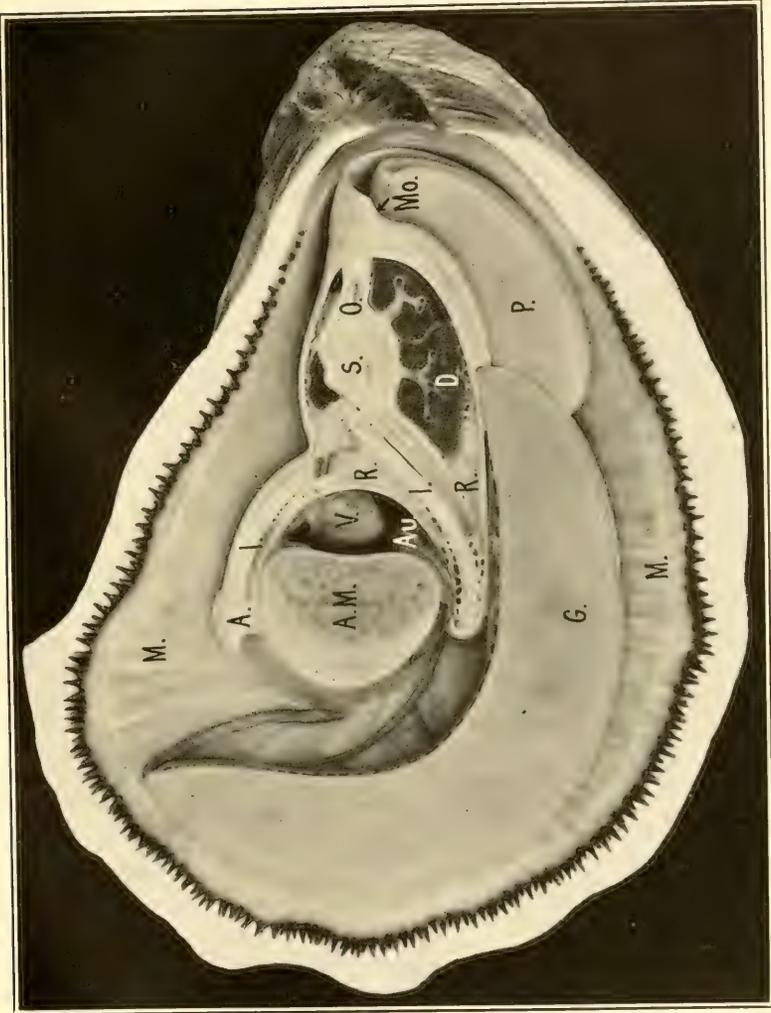
The principal oyster beds of this State are in Galveston, West, Matagorda, Lavaca, Espiritu Santo, Aransas, Mesquite, and Corpus Christi Bays. There are from two to six oyster-shucking houses at Corpus Christi, Port Aransas, Rockport, Port O'Connor, Port Lavaca, Seadrift, Palacios, Matagorda, and Galveston. There are no oyster canneries in this State.

## OUTPUT OF VARIOUS REGIONS.

Chesapeake Bay produces more oysters than any other body of water in the world.<sup>a</sup> Some notion of the size of the industry there may be gained from Plate XVIII, figure 1, showing the oyster fleet operating out of Cambridge, Md., which is only one of the several large oyster centers on this bay. Virginia and Maryland, within whose borders Chesapeake Bay is embraced, lead the United States in oyster production with over 5,000,000 bushels each annually.<sup>b</sup>

<sup>a</sup> Smith, H. M. Oysters: The World's Most Valuable Water Crop. National Geographic Magazine, March, 1913, p. 261. Washington.

<sup>b</sup> Report, U. S. Commissioner of Fisheries, 1913, p. 41. Washington.

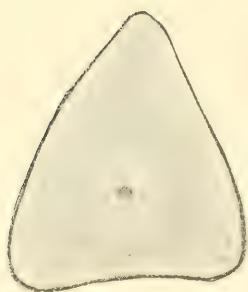


OYSTER WITH RIGHT SHELL AND MANTLE REMOVED.

A., anus; A. M., adductor muscle; Au., auricle of heart; D., digestive gland or liver; G., gills; I., intestine; L., liver; M., mantle; Mo., mouth; O., oesophagus; P., palps; R., reproductive organ; S., stomach; V., ventricle of heart. (Photo from American Museum of Natural History.)

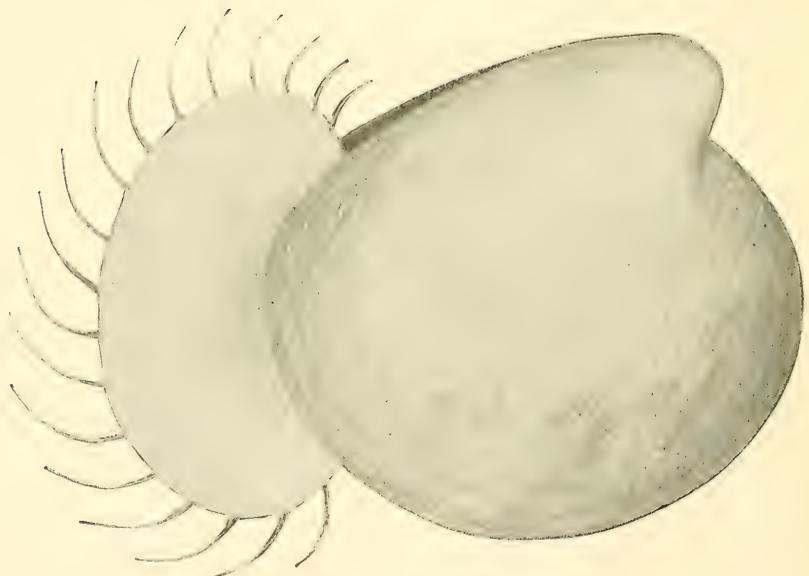


1.



2.

3.



4.

FIG. 1.—SPERMATOZOON OF MALE OYSTER. Magnified 1,700 diameters. (After Stafford.)  
FIG. 2.—OYSTER EGG. Magnified 600 diameters.  
FIG. 3.—FREE-SWIMMING LARVA OF OYSTER, ABOUT 10 DAYS OLD. Magnified 300 diameters.  
FIG. 4.—FREE-SWIMMING OYSTER LARVA WITH VELUM, OR SWIMMING ORGAN EXTENDED. Magnified 300 diameters.  
(Figs. 2, 3, and 4 drawn by J. S. Gutsell.)

Connecticut is third with over 4,000,000 bushels. Rhode Island, New York, New Jersey, and Louisiana produce over 1,000,000 bushels annually.

### DESCRIPTION AND ANATOMY.<sup>a</sup>

#### CLASSIFICATION.

The oyster of commerce in the United States, with the exception of certain parts of the Pacific coast, is the so-called "eastern oyster," belonging to the species *Ostrea virginica*, Gmelin. It is a member of the group of molluscs popularly known as bivalves, since it has two valves, or shells, which are joined at the narrower ends by a hinge.

#### EXTERNAL APPEARANCE.

The figures in Plates I, XX, and XXI, though reduced in size, give an idea of the usual shape and appearance of the oyster. The average length of the shells of the marketable size is about 5 inches. Oysters, however, may grow to much greater dimensions, and under certain conditions of growth, such as crowding or development on a mud bottom, are forced into various distorted or elongated shapes.

The shell of the adult oyster varies greatly in thickness, ranging in extreme cases from somewhat less than one-fourth inch to an inch and one-fourth. The usual thickness is from one-fourth to three-eighths inch, decreasing to paperlike thinness on the margins of a rapidly growing shell.

The exterior is marked by laminations and more or less concentric lines of growth; it is often covered by a yellowish cuticle, but is sometimes white and flinty in appearance. The inside of the shell is generally white, somewhat tinged with purple near the margins, and with a more or less pearly luster. The muscular impression is generally nearer to the posterior margin than to the hinge; it is a well-defined scar, kidney-shaped in specimens of ordinary size, but becoming more elongate in very large individuals; in young specimens it is pale, but it afterwards becomes purple or almost black. The left, or lower, valve is deeply concave within, the upper valve being flat or, usually, slightly concave. The animal portions are large, nearly filling the shell, and the mantle border is comparatively narrow.<sup>b</sup>

#### ANATOMICAL FEATURES.

The two valves of the shell of the oyster are held together at the hinge by a dark-colored elastic ligament so placed that it tends to throw the free ends of the valves slightly apart when the large muscle of the oyster is cut or relaxed. The main structures of interest making up the body of the oyster are shown in Plate II and in text figure 1. Plate II represents an oyster lying in the left valve, which is deeper than the right, and more cup-shaped. This is also nearly always the valve by which the oyster is attached to rocks, etc. The flatter right valve is represented as having been removed. The narrow part of the oyster is the anterior or front end, the mouth being located in that region. The broad part is the posterior or rear end. The back or dorsal side is at the top of the picture and the ventral or under side below. The oyster, however, being attached by its left side, may rest in the water in any conceivable position, depending on the surface to which it has fastened itself.

<sup>a</sup> The brief account of the anatomy and life history of the oyster is based chiefly on the researches of Brooks (1895), Julius Nelson (1888-1893 and 1900-1915), and Stafford (1913).

<sup>b</sup> Moore, H. F. (1897, p. 266.)

Each valve or shell is lined with a thin membrane called the mantle, fringed on the edge and attached to the shell over nearly all its expanse, but free along the margin. The right mantle has been removed with the shell in Plate II. In about the center of the body is the large adductor muscle, by the contraction of which the oyster closes its shell. As stated above, when this muscle is relaxed or cut, the ligament in the hinge forces the valves apart. The main body of the oyster lies between the right and left sides of the mantle and is attached to it and the adductor muscle. It will thus be seen that the oyster is held to the shell by the mantle and the muscle.

In Plate II part of the body wall is represented as having been removed with the right side of the mantle, thus exposing to view the liver or digestive gland and the œsophagus or gullet leading from the mouth to the stomach, which opens into the intestine. This extends downward and backward beneath the muscle, then curves sharply and runs forward on the left of the stomach to the œsophagus, where it again turns to the rear and extends backward to the vent or anus above the muscle.

In a thin-walled sac, the pericardium, immediately in front of the muscle, lies the real heart of the oyster. (The adductor muscle is often erroneously referred to as the "heart," since when it is cut the oyster eventually dies from inability to close its valves.) The circulatory system of the oyster is of the "open" type; that is, the arteries do not terminate in capillaries which lead to the veins, as in man, but deliver the blood, which is colorless, into large spaces, or lacunæ, between the tissues. The blood, as it spreads through these lacunæ, bathes the various cells of the body and is then gathered up by the veins and collected in the auricle or lower chamber of the heart. It then passes into the ventricle, or upper chamber, which contracts and forces the blood through arteries to the different parts of the body. A hinged valve between the two chambers of the heart prevents the blood being driven back into the auricle.

The nervous system of the oyster (not shown in the figures) is very simple, consisting of two ganglia or knots of nervous matter, lying just over the gullet and two nerves passing back from them, one on each side, to another pair of ganglia beneath the adductor muscle. Smaller nerves extend from these two pairs of ganglia to the various parts of the body.

At the anterior end of the body four thin lips or palps hang free in the mantle cavity and extend backward from beneath the mouth for about one-third the length of the body, the posterior ends lapping under the ends of the gills. The latter, four in number, are somewhat similar to the palps in appearance, and extend backward and upward in crescent fashion, as shown in Plate II. Microscopic examination shows that the gills are covered on both sides with very fine hairs or cilia, arranged in rows. These beat back and forth and, when the oyster is lying with the valves open, cause a current of sea water to pass on to the gills. The water is forced through fine openings on the surfaces of the gills into water tubes inside the gills and thence into the cavity above them. As the water passes through the gills the blood is aerated as in the case of a fish. In Plate II the openings of the tubes can be seen on the inner edge of the gills. The right mantle having been removed, the cavity into which the water passes is exposed. It lies in the space just above the inner edge of the gills.

From this cavity the water passes behind the adductor muscle and out between the edges of the valves of the shell around the rear end of the gills, at a point in the upper left of the figure.

The food of the oyster consists entirely of minute animal and vegetable organisms and small particles of organized matter. Ordinary sea water contains an abundance of this sort of food, which is drawn into the gills with the water, but as the water strains through the pores into the water tubules the food particles are caught on the surface of the gills by a layer of adhesive slime which covers all the soft parts of the body. As soon as they are entangled the cilia strike against them in such a way as to roll or slide them along the gills toward the mouth. When they reach the anterior ends of the gills they are pushed off and fall between the lips, and these again are covered with cilia, which carry the particles forward until they slide into the mouth, which is always wide open and ciliated, so as to draw the food through the oesophagus into the stomach. Whenever the shell is open these cilia are in action, and as long as the oyster is breathing a current of food is sliding into its mouth.<sup>a</sup>

The food then passes to the stomach, is acted on by the fluids from the liver, and moves along the intestine. The nutritive portion is

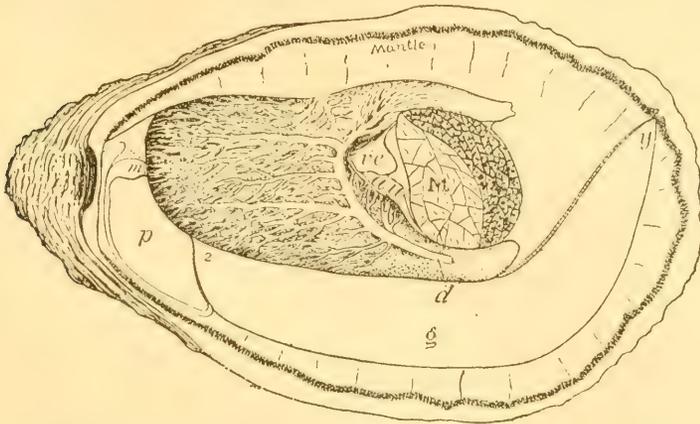


FIG. 1.—Diagram of dissection of oyster to show reproductive organ, consisting of the branching tubules spread over the dotted portion. *au*, auricle of heart; *d*, external opening of reproductive organ; *g*, gills; *M*, adductor muscle; *m*, mouth; *p*, palps; *ve*, ventricle of heart; *y*, posterior end of gills. About natural size. (After Moore.)

absorbed and the feces are thrown out the vent in long, ribbonlike form and carried outside the shell with the stream of water passing out from the chamber over the gills.

The position, form, and general appearance of the reproductive organs of the oyster are the same for both sexes. Really there is but one reproductive organ, which consists of a mass made up of microscopic tubules and connective tissue lying between the folds of the intestine and investing it and the stomach and liver in such a manner as to cover the visceral organs when the opened oyster is viewed from either side. In Plate II most of the reproductive organ has been removed, a small portion being shown about the folds of the intestine. Text figure 1 represents an oyster with the left valve and mantle removed, showing the reproductive organ as it appears from the left side, covering the visceral mass and partially surrounding the heart and adductor muscle. Numerous ducts arise from the organ, unite into one and open at point *d* below the adductor muscle. A view

<sup>a</sup> Brooks, W. K. (1880. p. 9.)

of the right side of the organ would present practically the same appearance, there being a similar system of ducts opening on that side beneath the muscle. Through these two openings the genital products are discharged into the water at spawning time.

### LIFE HISTORY.

#### TIM OF SPAWNING.

The oyster may spawn when the water reaches a temperature of 68° F., but spawning proceeds at normal speed only when the water is 70° or above. For this reason the spawning period varies in different regions, depending on the temperature of the water, which is regulated by the depth of the water and the general meteorological conditions. Shallow bodies of water, even though in more northern latitudes, often become warm as early or earlier than deeper waters farther south. In the north, where the season is shorter, the spawning period is relatively short, often lasting only two or three weeks, while in the south oysters may be found in a spawning condition from early spring until fall.

In Long Island Sound, the bulk of the oysters spawn about the last of July; in Great South Bay, spawning occurs from about June 5 until after the Fourth of July. In New Jersey waters spawning begins about June 1. Spawning extends in Chesapeake Bay from May until September. On the Gulf coast, spawning begins in March and spawning oysters may be found as late as November.

#### REPRODUCTION.

In spite of the fact that the sex of the oyster can not be distinguished by the external appearance of the shell, of the body, or of the reproductive organs, the sexes are separate. Some oysters are male, the reproductive organs developing spermatozoa or milt; other oysters are female and produce ova or eggs. While it has at times been stated that the sex might change from year to year, an oyster being perhaps male one year and female the next, or the reverse, there is no evidence on which to base this belief, except some inconclusive researches made nearly 50 years ago and not borne out by subsequent investigations. It can be almost conclusively stated that the sex of the eastern oyster is permanent and does not change during the life of the individual.

The sexes can be distinguished only by an examination of the products discharged by the reproductive organs. The spermatozoa and eggs are so extremely small that a lens must be employed to distinguish one from the other. The eggs (Pl. III, fig. 2) vary from roughly pear-shaped to oval or nearly spherical and measure about  $\frac{1}{500}$  of an inch in diameter. It is estimated that a female oyster will produce over 16,000,000 eggs. The male genital products, or spermatozoa, are many times smaller than the eggs. Each spermatozoon (Pl. III, fig. 1) is made up of a head about  $\frac{1}{10,000}$  of an inch in diameter, pointed at one end and flattened at the other. To this flat base is attached a very slender threadlike tail about 20 times the length of the head. This tail lashes about and moves the spermatozoon around in the water after it has been discharged by the male oyster.

Fertilization of the eggs occurs in the water. The oysters, male and female, lying about over the bottom, at spawning time discharge the reproductive elements into the water where they mingle as chance may bring about. The more numerous the oysters on a particular bed, the greater the chance of the actively moving spermatozoa meeting the eggs. The spermatozoa swarm around the eggs, many about each one, until a spermatozoon penetrates the egg membrane, the head only of the spermatozoon passing on in, the tail dropping off. The material of the head unites with that of the egg, and important changes in the latter are thereby initiated.

The single cell of the egg begins to divide into many cells and to change its form and in the course of from 5 to 10 hours develops into a small oyster larva, which swims by means of fine hairs or cilia on the outside of its body. A shell then begins to develop and soon covers the entire body, so that the larva resembles a tiny hard clam. A definite organ of locomotion also appears, consisting of a disk, known as the velum, borne on the end of a thick stalk which is protruded from between the valves of the shell in front. The disk bears cilia which by their movement enable the larva to swim about rapidly (Pl. III, fig. 4). When the velum is retracted the larva settles to the bottom.

The larva is now about two days old and measures about 0.08 mm. in length. As it increases in size certain elevations, the umbones, can be noted on the upper part of the hinge, one on each side. Shortly one valve becomes much deeper than the other, and the umbo on it much more prominent than that on the right side, and by this characteristic the oyster larva may be readily distinguished under the microscope from the larval form of any other bivalve. The deeper valve is the left one and that by which the oyster later becomes attached. During the advanced stages of the larval form, the left umbo is very conspicuous, jutting back in almost the form of a hook (Pl. III, fig. 3).

The period passed through by the oyster larva from the development of the cilia, a few hours after fertilization, until it "sets" or "strikes" is known as the free-swimming stage. Although the larva swims about freely in the water, being so small, its movements and location at any particular time are largely subject to the tides and currents. The free-swimming period lasts from about 14 to 18 days in the more northern waters and a somewhat shorter time in the southern. The warmer the water the more rapidly development occurs and consequently the shorter the free-swimming period.

At the close of the free-swimming period, when the oyster is about one-third of a millimeter (one seventy-fifth of an inch) long, it "sets" if the proper conditions are present. It attaches itself by the left valve to some surface in the water, a rock, shell, stake, in fact almost any object (Pl. IV).

The first essential is that the surface should be clean and that it should remain so a sufficient length of time to enable the young oyster to firmly establish itself. So long as this condition obtains, the nature of the material seems to matter but little. In most bodies of water the spat fixes itself at all levels from the surface to the bottom but in certain parts of the coast its place of attachment is confined to the zone between high and low water, the midtide mark being the place of maximum fixation.<sup>a</sup>

<sup>a</sup>Moore, H. F. (1897, p. 274.)

Once secured, the swimming organ disappears and the oyster never wanders again of its own volition.

#### GROWTH.

The shell is secreted by the mantle, the membrane lining the shell. Horny material is first deposited over the outer surface of the mantle and to this is added lime, forming the familiar hard shell. As the mantle increases in size with the general growth of the rest of the body, and as it can be extended somewhat from between the edges of the valves, new shell material is added to the inner surface of the valve and to the outer edge. This makes each valve thick in the central portion, sloping to a condition of extreme thinness at the edges. The outer edges of the valves of a rapidly growing oyster are so thin and knifelike that care must be exercised in handling them to avoid cutting the fingers.

The rate of growth of oysters varies widely, depending on temperature, density and food content of the water, season of the year, and other factors. Its growth is more rapid in the warmer southern waters than in the colder northern. In Long Island Sound about four years are required for an oyster to reach a length of 4 to 5 inches, or marketable size. In southern waters that size is reached in two years. Oysters if left undisturbed may attain a length of 8 to 10 inches or more. While the exact age which an oyster may reach can not be definitely stated, oysters have been found which appeared from the number of layers in the shell to be at least 15 years of age.

Oysters which have unrestricted space for growth acquire the normal shape shown in Plates I, XX, and XXI. When crowded together, the shape becomes modified, even greatly distorted at times. Often numerous set will fasten upon a relatively small piece of cultch, and as growth proceeds a crowded cluster of oysters will result. If broken apart by pressure of growth or by artificial means, their shape will improve.

The crowding of oysters reaches its climax upon the "raccoon" oyster beds. Raccoon oysters are usually found in localities where the bottom is soft and the only firm place which offers itself for the attachment of the spat is upon the shells of its ancestors. Temperature and other conditions are favorable, growth is rapid, the young oysters are crowded into the most irregular shapes, the shells are long, thin, and sharp-edged, and eventually the mass of young is so dense that it crowds out and smothers the preceding generations which produced it and offered means for its attachment. Oysters crowded in this excessive manner are poor-flavored, as well as ill-shaped, but both defects are corrected if they be broken apart, as may be readily done, and planted elsewhere.<sup>a</sup>

#### FACTORS OF ENVIRONMENT.<sup>b</sup>

##### TEMPERATURE OF WATER.

The fact that the oyster is found from Cape Cod to Mexico shows that it can become adapted to living in waters of considerable difference of temperature and in certain regions may withstand wide changes during the course of the seasons. In Long Island Sound

<sup>a</sup> Moore, H. F. (1897, p. 275.)

<sup>b</sup> The outline of this section, "Factors of Environment," and of the one following, "Natural Beds," and the details of certain topics therein, specifically stated in each such case, are substantially as prepared by Dr. H. F. Moore, Deputy Commissioner of Fisheries, for an uncompleted revision of his "Oysters and Methods of Oyster Culture" (1897).

the temperature over the oyster beds falls in winter nearly to 32° F., the freezing point, and in summer rises to 72° in deep water and 75 to 78° over the inshore beds. In Chesapeake Bay oysters in certain shallow water beds withstand variation from the freezing point, below 32 to 90° F.<sup>a</sup> In the Gulf of Mexico the usual range of temperature over the oyster beds is from 50 to 90° F. The relation between temperature and the spawning of oysters has been discussed on page 12.

#### DENSITY OF WATER.

The higher the proportion of salt contained in sea water the greater the density. Therefore, it is common practice to estimate the proportion of salt by measuring the density of the water with the salinometer. This consists of a glass bulb with a narrow stem at one end on which are gradings reading from 1.000 to 1.031. The bulb is weighted at the end opposite the stem, so that it will sink somewhat below the surface, leaving the stem projecting from the water. The less salt in the water the less the density and the lower the salinometer will sink. Fresh water is arbitrarily considered as 1.000 and the point on the stem of the salinometer to which the water reaches when the instrument is placed in fresh water is so marked. Grades are marked below that on the stem, the bulb rising higher in the water the greater the density. The highest grade is usually 1.031. For convenience three bulbs are usually used, one reading from 1.000 to 1.011, one from 1.010 to 1.021, and one from 1.020 to 1.031. Common sea water usually reads from 1.025 to 1.026 on the salinometer. Oysters are found in water ranging in density from 1.002 to 1.025, but can not withstand densities lower than 1.007 for indefinite periods. In general they seem to thrive best in densities between 1.011 and 1.022.

Oysters are not usually found out in the main body of the seawater, away from the influence of the fresh water from the streams, where the density is 1.025 or more. It will thus be apparent that oysters have become adapted to a certain range of densities, and natural beds have grown up at points fairly close to shore or in inclosed bays where the salinity of the seawater is modified by the inflowing of fresh water.

#### MUD, SILT, AND SUSPENDED MATTER.<sup>b</sup>

A bottom composed of slightly shifting sands or of very soft mud into which the adult oysters will sink and on which the minute spat can gain no firm support is alike unfavorable to oyster culture and to the development of natural beds. If, however, hard objects be distributed on or above such bottoms they will become collectors of spat so long as they remain clean and free from slime or sediment, and if it be desired to produce permanent beds or to catch the floating spat for the purpose of seeding other beds it is manifest that, the scouring action of the currents being equal, waters containing a minimum of sedimentary matter are to be preferred to those more or less laden with mud.

<sup>a</sup> Moore, H. F. (1897, p. 280.)

<sup>b</sup> Moore, H. F. Proposed revision of "Oysters and Methods of Oyster Culture" (1897).

In this connection a distinction must be drawn between beds used for seed production and those employed in growing and fattening stock for the market. Oysters will frequently grow more rapidly in silt-laden waters, on muddy bottoms, or in their vicinity, than they will elsewhere, as such places are usually more productive of food organisms, owing to the larger amount of dissolved material available for the sustenance of the minute plants which constitute a considerable part of the food of the oyster.

Even adult oysters may be destroyed, however, by heavy deposits of silt such as often result from freshets and crevasses. For the purposes of seed culture or the establishment of self-perpetuating beds the most desirable waters are those which contain an abundance of microscopic vegetation with a minimum of suspended inorganic particles, although an organic slime such as rapidly forms on submerged surfaces in some localities is as effective in preventing the fixation of spat as is inorganic sediment. In many places in Chesapeake Bay and in the bays on the New Jersey coast the sediment, as well as the bottom mud, is largely composed of finely comminuted fragments of seaweeds and other vegetable matter the rapid deposit of which soon covers with a flocculent film the surfaces of all objects exposed to it, excepting when the currents are sufficiently strong to exert a scouring influence. During warm weather this organic deposit is likely to undergo rapid decomposition, the toxic products of which sicken and kill the oysters.

The more or less constant dribbling of fine material upon the bottom has comparatively little effect upon adult oysters, operating mainly to cover the shells and prevent the attachment of spat or to stifle the young oysters after attachment. This rain of fine material occurs almost everywhere but especially where the currents are weak, and it is generally in the latter localities that it is of sufficient volume to be obnoxious.

#### TIDES AND CURRENTS.

The effects of tides and currents upon the development and growth of oysters are quite important. The genital products, cast directly into the water as previously stated, are moved about so that more opportunity is afforded for the contact of the spermatozoa of the male with the eggs of the female.

The free-swimming larvæ are carried to and fro by the tides and currents, and thus when large enough to set are often some distance from where they were spawned. The importance of this fact in the method of oyster culture by planting culch is very great and the matter is discussed under a separate section on page 31.

Tides and currents tend to prevent the fouling of material upon which the larvæ set by washing away silt and débris. In still water, as in an inclosed bay, the suspended débris has an opportunity to settle upon the culch and form a slime and film which prevents the attachment of the larvæ. If the larvæ have attached, the deposit is often sufficient to smother them.

Since the food of oysters consists of microscopic materials found in the water (see p. 19), it follows that currents affect the distribution of the food of the oyster. In still water, nearly all the organisms might settle to the bottom or those in the neighborhood of the

oyster might become exhausted. Currents keep the material agitated and cause a fresh supply to sweep across the oyster beds.

Movement of the water also brings a fresh supply of oxygen to the oyster which aerates the blood by oxygen derived from the water passed through its gills.

#### DEPTH OF WATER.<sup>a</sup>

The known vertical range of oysters under natural conditions is from or near high-water mark to a depth of about 130 feet, the latter extreme occurring over densely stocked and productive beds in Patuxent River, Md. In a large part of the oyster region of South Carolina the natural beds occur almost exclusively between high and low water marks, and some of the beds of Florida are similarly situated, the oysters growing on the aerial roots of mangroves, as they frequently or generally do in Porto Rico and others of the West Indies. In places on the Gulf coast oysters set and grow in limited numbers in the grass on the edges of the marsh prairies above the level reached by many high tides, but in such situations they are frequently killed by freezing.

In the Mississippi delta region a good set is often obtained on cultch planted at or near high-water mark, but the young oysters are removed to deeper water before cold weather arrives.

Elsewhere oysters are rarely planted in this country on bottoms exposed at low water. In most places comparatively shallow depths ranging from 2 to 12 or 15 feet are utilized in oyster culture, but in Long Island Sound the practice has been successfully extended to depths of 60 feet or more.

#### FRESHETS, STORMS, AND ICE.<sup>a</sup>

Freshets occur with more or less frequency in the rivers discharging near the oyster beds of many of the South Atlantic and Gulf Coast States, and with them are to be classed the crevasses or breaks in the levees which sometimes accompany high water in the coastal streams of Louisiana.

The effects of a freshet are twofold. The most immediate effect is that, owing to the vastly increased volume of fresh water discharged, the salinity of the water over the oyster beds is reduced far below the normal and in many cases becomes fresh or practically so for considerable periods. As already stated in another connection, this is often fatal to the oysters already on the beds, and, even when this is not the case, the production of a set is inhibited during the prevalence of the abnormal conditions.

Freshets also carry large quantities of mud and débris scoured from old channels and washed from the land, and as the currents slacken in the bays and estuaries, where the oyster abounds, their carrying power diminishes, and the materials are dropped on the beds. If the deposits so made be deep, the old oysters may be killed, while even a light deposit is sufficient to prevent the attachment of spat until it be again gradually scoured from the shells and other hard bodies on the bottom.

<sup>a</sup> Moore, H. F. Proposed revision of "Oysters and Methods of Oyster Culture" (1897).

It sometimes happens that a freshet of unusual severity, while disastrous in its immediate effects, results eventually in an increased productiveness of the beds. If the disaster be due to a prolonged freshening of the water without an undue deposit of silt, the shells are often left in a much-improved condition. This is apparently due in part to the more active scouring action of currents of more than usual velocity, but mainly to the destruction of the organic slime, which often covers the shells in sea water, and the cultch is thereby left in a more favorable condition for the attachment of spat carried from more or less distant beds. The fresh water also exterminates the drills which feed on the little oysters, and, as Dr. Moore's observations of improved sets under the conditions described indicate that sets usually occur in waters of rather high normal salinity, where the drill ordinarily thrives, it is probable that this action of the fresh water is no unimportant beneficial factor. The oysters, from the nature of their reproductive and developmental characteristics, are able to reestablish themselves much more rapidly than their enemies.

Gales, to have an effect on adult oysters in moderately deep water, must be of extraordinary severity, but they frequently do great damage or exterminate beds in shoal water. The waves sometimes pick up the oysters and throw them on the beach, but more frequently they are destroyed by being buried in situ by sand, seaweeds, and débris piled up by the sea. Cases are known of where well-established beds have been overwhelmed by such deposits and others in which thick strata of sand between layers of old shells indicate a succession of such disasters in the more or less remote history of the beds.

Sometimes the eroding effect of currents and waves will uncover the buried oysters and shells, and the beds will again reestablish themselves through the attachment of young; but in other cases the beds are permanently destroyed. The former is the usual result when the reefs rise rather abruptly from the surrounding bottom, and the latter is frequent when they are but little elevated above the general floor of the sea. Planted beds, which usually lie at the general level of the bottom, are usually permanently covered.

Gales are sometimes agents in the establishment of new beds, carrying oysters and shells to surrounding barren bottoms, where they form a nucleus that gradually develops into economic importance. Certain productive beds at the eastern end of Mississippi Sound, by character and by repute, appear to have been so established.

The free-swimming larvæ are more susceptible to the weather conditions than are the adults, and cold rain storms, which would have no effect on the latter, undoubtedly kill large numbers of the swimming young. This was first noticed by Ryder and has been amply corroborated.<sup>a</sup>

Ice is occasionally destructive to oyster beds quite independently of the factor of temperature. When heavy ice grounds at extremely low tides, it sometimes crushes the oysters or presses them into

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<sup>a</sup> The author and J. S. Gutsell, during the study of the occurrence of free-swimming oyster larvæ in Great South Bay, 1919, found that the average number in 50 gallons of water was 8,339 on July 8. A violent squall and rain followed, together with a drop in temperature of 5° F. On July 11, as soon as collections could be made, the average number had dropped to 3,558 larvæ per 50 gallons of water.

the bottom, and occasionally they freeze fast to the underside of the ice and are carried away when it floats.

#### FOOD OF THE OYSTER.

The food of the oyster consists of microscopic plants and animals and organic detritus growing or found in the water on and above the bottoms on which the oysters lie, or carried to such waters by currents.

A large proportion of the oyster's food is made up of the plant forms which are known as diatoms. There are many species of diatoms, typical forms being shown in text figure 2. Diatoms are found in more or less abundance in almost all waters, varying greatly

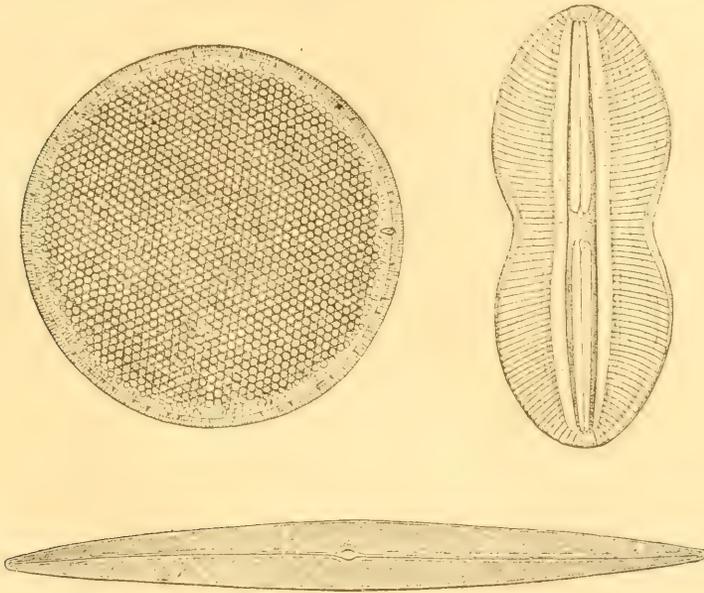


FIG. 2.—Typical diatoms, which make up a large part of the food of the oyster. Magnified about 500 times.  
(After Moore)

in numbers in different places and at different seasons in the same place or in the same season of different years.

Diatoms derive their sustenance from the various organic materials washed down from the land and held in solution in the water. These organic fertilizers consist of decayed and decaying vegetable and animal matter gathered up from the land by the water resulting from rains and carried down streams and rivers to the sea. The food supply of oysters is thus directly affected by the character of the soil adjoining the tributaries leading to the water over the beds, by the kind and amount of forest or other vegetation and animal life on that soil, by the industries carried on there, and by the amount and seasons of rainfall.

While a large portion of the food of the oyster is made up of diatoms, considerable numbers of microscopic animal forms are

also eaten. The recent work of Dr. T. C. Nelson<sup>a</sup> shows that a larger proportion of the oyster's food is of this nature than was formerly supposed. Copepods, or "water-fleas," the free-swimming larvæ of snails and bivalves (including the oyster), worms, rotifers, and protozoa have been found in the stomach of the oyster. These animals, like the plants, are found in greater or less abundance in all waters. A systematic effort to ascertain the food content available for oysters in any particular water should include the determination of the quantities of the suitable animal as well as plant forms present.

Dr. Nelson kept under observation a number of oysters in water shallow enough for a system of wires and levers to be connected with the shells in such a way that the opening and closing of the valves were recorded on a revolving smoked drum or chimograph in the floating laboratory above. It was found that, during the summer months at least, the oysters remained open, and consequently feeding, for 19 to 20 hours out of 24. Feeding is thus evidently a fairly continuous process during the warmer months.

Organic detritus or débris resulting from the decay and disintegration of plant and animal life undoubtedly contributes to the food of the oyster. As the diatoms and other plant forms become broken up some of their fragments are ingested by the oyster, and a certain amount of nutriment is derived therefrom. After death, animal forms disintegrate and release fats, albumens, etc., into the water. It has been found that the fresh-water mussel may make use of such products, and probably the same is true in the case of the oyster.

#### NATURAL BEDS.<sup>b</sup>

##### DEVELOPMENT AND DESCRIPTION.

A natural oyster bed is an area of the bottom on which oysters have become established without the voluntary and intentional agency of man. In law, the term is usually held to include only such bottoms as bear oysters in sufficient quantities to make fishing for them by legitimate methods a means of reasonable livelihood or areas which have formerly been such and whose present character indicates a reasonable likelihood that they may again become productive. The only difference between natural and artificial beds lies in the fact that the latter originate by the intentional act of man, whereas the former arise from natural conditions purely, from accident, or from unintentional human agency incidental to other works and purposes. In most cases the natural beds, and especially the larger ones, have been produced by the operation of factors in which man has no part, and we know nothing of their origin. In a few instances, small beds have been caused by shipwrecks and other accidents; but on the other hand there are many beds, some of them very productive, which have grown on ashes and similar material thrown overboard from vessels and upon shells culled from the live oysters by oystermen and strewn at random over the bottom. Whatever their origins, all oyster beds, if left to

<sup>a</sup> Nelson, T. C. Forthcoming report, N. J. Agricultural College Experiment Station.  
<sup>b</sup> Moore, H. F. Proposed revision of "Oysters and Methods of Oyster Culture" (1897).

themselves will assume the same general physical and biological characters in so far as their environments permit.

The natural beds of the Atlantic and Gulf coast practically all lie like islands in a sea of mud more or less soft. In some places the oysters are in clusters rooted in the mud, in others the substratum is hard to a greater or less depth, but examination will show that this hardness is in most cases superficial, and below it lies mud of a consistency corresponding to that which surrounds the bed. There are a few beds which have grown on rocky bottom, and there is a larger number lying on firm, unshifting sand; but there are few rocky outcrops on the coast south of New England, and most sandy areas tend to shift more or less and engulf such oysters and shells as may be lying on them. The oyster is an inhabitant, par excellence, of the muddy bays, sounds, and lagoons, and in them attains its best development.

In tracing the history of any oyster bed, reference must be made to the nature and characteristics of the young oyster as it develops from the egg. As has been explained on page 13 the embryo oyster is a minute organism endowed with certain feeble powers of locomotion, which are sufficient for awhile to keep it suspended in the water and permit its being carried by the currents. In some cases it may be carried several miles from its parents before the setting stage is attained. The chances are many that when this happens it will lodge on mud and end its story, for so small is the larva at this stage that a mere film of ooze suffices to stifle it. If, however, by rare good fortune it, at this time or just before, comes into contact with a shell, pebble, twig, rocky ridge, or other clean body, whether at the bottom or not, it speedily attaches itself and continues its growth.

So abundant is the supply of larvæ in any prolific oyster region that ordinarily several or many will attach to each square inch of clean surface, and a shell may furnish attachment for a hundred or more. Under such circumstances there soon begins a struggle for existence that is none the less rigorous for being purely passive. As the young oysters grow there is not room for all, and the more vigorous ones, themselves distorted by the crowding, overgrow, stifle, starve, and eventually kill those of slower growth or less advantageously situated. At the end of the first year there has developed a cluster of perhaps from two to a dozen young oysters growing on the original shell, all projecting upward and crowding one another into long, narrow shapes. Upon the projecting mouths of these shells there is another set of spat on the succeeding year, and as this grows some of the survivors of the earlier generation are in their turn crowded and killed. The result of this is that in the course of a few years there is formed a cluster like an inverted pyramid with its apex being gradually driven into the mud by the increasing weight above, while its broad base is made up of several generations of living oysters attached to the dead shells which constitute the middle parts. The oysters around the edge where they have room to grow are often of fair shape and quality, while those more centrally located are irregular, long, narrow, and usually poor, owing to their crowded condition and difficulty in obtaining food.

From the decay of the hinge ligaments of the dead valves, the corroding effect of boring animals, and the solvent action of seawater on the limy shells, these top-heavy clusters tend to break up under their

own weight and under the force of the waves. On hard bottom the disintegrated parts are rolled about and more or less evenly distributed, resulting eventually in the production of other similar clusters scattered at intervals. On soft mud the shells can not roll so readily, and they fall and remain close to the base of the original cluster, where, if not completely engulfed, they form places of attachment for new generations. If the mud be very soft they sink for a short distance and accumulate until they harden the bottom and form a firm support for the shells which fall later, and which in turn are covered with a growth of young.

As these phenomena recur year after year the original single cluster gradually extends around its edges now more or less at the top until it becomes converted into a little bed composed of a dense mass of clusters, with its boundaries sharply defined and limited by the soft mud surrounding it. A number of other clusters have probably been growing simultaneously on the same muddy bottom, and, the areas between becoming narrowed and obliterated, there results a great flat bed made up of a number of smaller patches separated by a muddy network. Where a deep, muddy channel occurs the oyster growth usually stops near the edge of the slope, the shells which would else serve as clutch sinking down into the deep soft ooze. Opposite the mouths of smaller streams, even where there is no such deep channel, the oyster growth is also inhibited, partly by the freshness of the water, but principally and often entirely by the deposit of silt which soon spreads its thin coating over everything lying on the bottom. In some cases the beds may be completely interrupted, but in others they are continuous in their offshore part, passing by and inclosing the unfavorable area as an oval or subtriangular barren, muddy patch surrounded, excepting on its shoreward side, by productive oyster bottom.

It is difficult to say what may have been the condition of the natural beds in Chesapeake Bay before they were disturbed by man, but at the present time they are essentially in the condition so far described, though with their boundaries often ill-defined and the clusters usually smaller and less dense as a result of tonging and dredging. They usually exhibit no great depth of shells, though the bottom is more or less hardened by their accumulation in the underlying mud. They usually extend alongshore, their greatest length in the direction of the currents and their width extending from a couple of feet below low water toward, and often to, the edge of the deep, muddy channels.

In South Carolina and adjacent regions the beds are of essentially the same type, excepting that they are smaller and narrower, and particularly that they are crowded closer to the shores and almost entirely confined to the area between high and low water, a situation impossible in Chesapeake Bay and more northern regions, owing to the killing cold of winter.

Further development in the history of natural oyster beds beyond the stage which has been described results in a gradual thickening of the deposit of shells and the production of a short reef or lump, with a more or less distinct shoaling of water over its top. The living oysters standing vertically in the dense mass, with their growing tips directed upward and kept clean by the currents, present the only available place for spat fixation. Each year the set occurs on preced-

ing generations, raising the living parts of the bed higher above the bottom, while the interstices beneath become filled with old shells, fragments, sand, and mud to form a compact mass. Eventually, in shallow water, the living oysters approach low-water mark or in some parts of the coast rise above it, where their progress is arrested by cold or long periods of exposure to the air.

Each year a set may occur only to be killed in winter, the dead shells, fragments, sand, and mud piling up under wave action, until the crest may become raised to a level several feet above high water, producing a shell island usually surrounded by a more or less dense growth of live oysters. Such islands are not uncommon in the South Atlantic and Gulf States, and they frequently accumulate in time a growth of grass and brush, which more or less obscures their true character. Sometimes the material is thrown up around their edges atoll-like, leaving a depression in the middle in which muddy deposits collect and support a growth of brush. In places where the bottom is composed of very soft mud the sides of these lumps are comparatively steep and soundings will change 1 or 2 feet within a few yards, the difference being due to the depth of shells and oysters.

In open waters, not especially subject to freshets, where the currents are moderate and the silt carried not excessive, such lumps tend to maintain a round or oval outline, with no great difference between the long and short diameters; but where the currents are rapid or the bodies of water constricted, there, as soon as they rear themselves well above the bottom, they show a strong tendency to grow transversely to the tides, especially if the water be silt-laden. Such long, narrow reefs are common in the rivers of North Carolina and in the bays and rivers of Florida, Alabama, Louisiana, and Texas. In James River, Va., and probably in other rivers of the Chesapeake region, the beds, while often showing their greatest extent in the direction of the current, usually have their shoalest parts transversely to it or are made up of a series of transverse shoals and ridges composed of a dense mass of shells and fragments.

The reasons for this transverse development are as follows: The upgrowing reefs form partial dams or obstructions to the flow of the currents, and, in accordance with well-known laws, cause eddies or backwaters on both the side presented to the current and on that sheltered from it, in tidal waters the two being periodically reversed with the reversal of the tide. When the velocity of a silt-laden stream is checked, it deposits part of its load in the slack water, and, under the conditions stated above, mud falls on the upper and lower sides of the reef, while the somewhat accelerated flow around the ends scours the shells and keeps them clean and fit to receive fresh sets of young oysters. These factors operate more energetically the more heavily silt-laden the water, and they would become nonoperative in perfectly clear water. Not only does heavily silt-laden water deposit more mud when its velocity is checked, but it scours more energetically when its velocity is accelerated, the particles of sand and other materials carried in suspension, acting as so many small brushes to rub off such materials as may have previously lodged. The greater volume of water passing the ends of the reef has still two other effects—it brings a large number of swimming larvæ in contact with the shells and it carries more food to the oysters living there. Clean cultch, abundant larvæ, and ample food, three principal factors in

heavy production and rapid growth of oysters, are, therefore, found better fulfilled at the ends of the reef than at the sides lying across the currents. This tendency to transverse growth once established is increased with every increase in the length of the reef, the jetty effect, retarding the flow of water in one place and accelerating it in another, becoming more pronounced.

It frequently happens that reefs similar in general character to those just described begin their development from or close to the shore, usually at projecting points. They grow, of course, principally at their outer ends and extend outward from the shore at right angles to the current, maintaining a nearly uniform width throughout their length.

In the foregoing description of natural beds consideration has been given solely to the oyster itself, but the conditions are always complicated by the presence of other organisms between which and the oyster there are more or less complex biological relations. Some of the minute forms, especially the plants, constitute the oyster food, while many of the larger species either prey actively on the oyster or its young or compete with it in the struggle for food, oxygen, and space in which to grow.

#### DEPLETION.

Until the last 40 years the majority of the oysters taken from Cape Cod to Mexico came from natural oyster beds which covered an area of such great extent that they were regarded as inexhaustible. That this belief is quite erroneous is shown by the fact that on the northern parts of the coast, where the temperature is about the minimum for the support of oysters, the natural beds have disappeared or have become sadly depleted. Those of Massachusetts are greatly exhausted, and few are found in Narragansett Bay. On the Connecticut coast only two beds of importance remain—one in the mouth of New Haven Harbor and one west of Stratford Lighthouse, near Bridgeport. There are very few in New York waters. Many of the beds of Chesapeake Bay are seriously or quite depleted, although many still remain. From that point southward the depletion has not been nearly so great, as the oyster fishery has not been pursued as vigorously and the environment has been such that the oyster reproduced much more abundantly than in the north, where a failure to obtain set is only too common.

In some cases the depletion or destruction of natural beds is the result of natural causes, such as the cutting off of the inlet to a bay or sound and the reduction of the salinity of the water; the covering of the beds with silt, débris, and fresh water during a freshet; the shifting of sand or mud by storms; or the inroads of living enemies.

The greatest enemy to the oyster, however, is man. Most of the depleted condition of the natural oyster beds is the result of careless overfishing by oystermen. The beds are stripped down so completely that not enough adult oysters are left to furnish sufficient spawn to insure a subsequent crop. Although millions of eggs and spermatozoa are produced, those products are thrown into the water, where many of the eggs fail of fertilization; many eggs and larvæ die or are eaten by enemies; and many fall at setting time on soft bottoms and are smothered. The percentage that finally reaches the adult

stage is relatively small. For that reason too complete removal of the adult oysters from a bed destroys hope for an ensuing generation.

During the past 40 years certain methods of oyster culture have been developed, especially in certain regions, whereby new beds have been built up and a constructive system of increasing the oyster supply has been initiated in addition to the negative one of restrictions on fishing, such as close seasons and the like. Biologists have become concerned in this work, and efforts have been made to promote, by experimentation, methods for the improvement of oyster culture.

#### CULTIVATION.

From the table on page 5 it will be seen that about half the oysters produced in the United States are taken from private or planted beds, the rest coming from natural or uncultivated areas. It will also be noted that in New England over 90 per cent of the oysters are produced on planted beds, that in the Middle Atlantic States the natural beds are considerably in excess, and that in the South Atlantic and Gulf States the proportion of natural beds is much higher yet. The table shows, however, that the value of the oysters from the planted beds is nearly twice that of those from the natural. This is due largely to the better quality and shape of the oysters produced by cultivation.

It is intended mainly to set forth here the methods of oyster culture which so far have proved to be commercially successful on the Atlantic and Gulf coasts, together with such suggestions concerning their improvement as biological science has to offer. Since there yet occasionally arise false hopes that the so-called artificial propagation, or the hatching and rearing of oysters in tanks or ponds, as is done in the case of fish, is on the verge of practical accomplishment, it may be well to dispose of this matter before proceeding to the treatment of the successful methods mentioned above.

#### ARTIFICIAL PROPAGATION.

This attempted method of oyster culture can be treated most simply by stating that its perfection and practical application are substantially no nearer solution than when the problem was opened up by Brooks (1880, pp. 10 to 18). He succeeded in artificially fertilizing the oyster eggs with spermatozoa of the male oyster and in rearing some free-swimming larvæ to the age of four or five days. Brooks's methods are in themselves not difficult, and the experiment has been repeated time and again both by biologists and laymen. Owing, however, to the immense practical difficulties of restraining the microscopic larvæ in receptacles or tanks and at the same time providing for a change of water and the introduction of the proper food and removal of waste, no one has succeeded in rearing many of the larvæ until they attach to cultch. It would seem, moreover, impossible to do this on a scale sufficiently large to be of practical application in the oyster industry.

The same statements are true regarding the adaptation of this method, in which attempts were made to substitute for the tanks ponds connected by narrow inlets or ditches with tidewater. While

elaborate designs have been constructed for the manipulation of such ponds and the catching of set on cultch placed in the ponds or the connecting ditches, none has proved to be of any practical value whatever. The principal difficulty seems to have been that, in the effort to confine the set to the pond, too scanty an inlet was provided for the entrance and exit of the tide, and the oysters suffered in consequence. In the cases where efforts were made to catch the set on cultch placed along the connecting canal, if the latter were broad enough to allow sufficient rush of water to keep the cultch clean, most of the set passed out to sea.

Oysters, on the other hand, will reproduce, grow, and fatten in ponds or inlets to which the tide has access in sufficient volume to render the water properly saline, provide the requisite food, and remove the débris. The set from such oysters is at the mercy of the tide; some may be caught in the pond or inlet, and some will be carried outside. In France ponds or "claires" are profitably maintained for the growth and fattening of oysters. The seed oysters placed therein consist of set from outside oyster beds which has been caught on collectors placed in the water along the beach.

While it can not be said that the problem of so-called artificial propagation may not be solved at some future time, for the present it must be emphasized that oyster culturists should base no false hopes on the practical application of this method.

In view of the barren results of 40 years' experiments in this line, it is best to devote attention to the amplification and perfection of methods which have proved to have a certain measure of success and which are applicable to the industry as carried out on such a vast scale in the United States.

#### LEGAL CONSIDERATIONS.

##### PROCURING GROUND.

In order to carry on oyster culture either by catching set or planting seed oysters, it must first be ascertained whether ground for that purpose can be leased or otherwise obtained from the State and, if so leased, whether public sentiment is such that the laws will be respected and enforced. In some States ample provision is made for the rental of oyster grounds and the lessee is protected. Oysters are not taken from his beds any more than corn is taken from a man's cornfield. In other States conditions have been in the past such that protection of leased ground, if attempted at all, was an absolute failure. Considerable improvement is noted, however, in this respect within recent years.

In selection of ground for locating oyster beds care must be exercised to avoid waters into which trade wastes are discharged in quantities sufficient to kill either the free-swimming larvæ or the oyster after it has set. It has been found that certain trade wastes from factories are injurious to oysters if present above certain concentrations. Further, the Federal and State health laws must be borne in mind in order to avoid grounds condemned by health authorities because of pollution by sewage. Stringent laws forbid the use of such grounds for raising or fattening oysters.

## MARKING BEDS.

Some States employ competent surveyors, and oyster beds are laid out with the aid of ranges, such as important natural objects or special signals set for the purpose. The planters then place stakes or buoys along these lines in such a way that each man knows exactly where his boundary line lies. Such practice is to be highly recommended as tending to avoid disputes and litigation.

## METHODS OF OYSTER CULTURE.

Owing to the great size of the oyster beds, to the large number of oysters handled, and to the high price of labor and the relatively low price of the product, it is not practicable in the United States to use the intensive methods of oyster culture employed in European countries, such as France, or in Japan. In those countries, special devices are used for catching the oyster spat and the individual oysters are removed by hand from the collectors and placed on specially prepared bottoms or in ponds for growth and fattening. In the United States, oyster cultivation, in general, is limited to operations which can be carried on by mechanical means on a fairly large scale over areas of considerable size, thousands of bushels of oysters being involved.

Oyster culture in the United States involves two main methods, the catching of spat, or "set," on artificially placed culch and the planting of "seed" oysters. Where oyster culture is practiced one or the other or both of these processes is carried on, depending on the region and the desires of the planter.

## CATCHING OF SPAT, OR "SET."

As stated previously, for some days after hatching the young or larval oyster is free-swimming. At the close of that period, it becomes attached to some fairly smooth, hard surface in the water, usually rocks, shells, etc., on the bottom. Once fixed, it is there for life and never wanders but proceeds to develop and grow. Failing to make such an attachment, it dies. Both while free-swimming and for a time after fixation the oyster larvæ are referred to by oystermen as "set."

Advantage is taken of this habit of the oyster larvæ, and artificial means are employed to increase the area of suitable surface upon which to "catch a set" of young oysters. Various sorts of material are put down to provide a suitable surface upon which the set may become attached. The material used for such a purpose is known as culch. The most commonly used culch is oyster shells, although the light thin shells of other bivalves, especially the "jingle" shells, are sometimes employed. Oyster shells, being available in great quantities from the opened oysters, may be returned easily to the bottoms, thus providing the cheapest, most abundant, and most suitable form of culch for the large beds cultivated by American oyster planters.

After a set is thus obtained on the shells it may be left there to mature into oysters of marketable size, or the shells with the attached set may be taken up and shifted to other beds. This is commonly

done in the fall after setting occurs, but sometimes set is allowed to grow for a year or two and then treated as "seed," which is discussed on page 33.

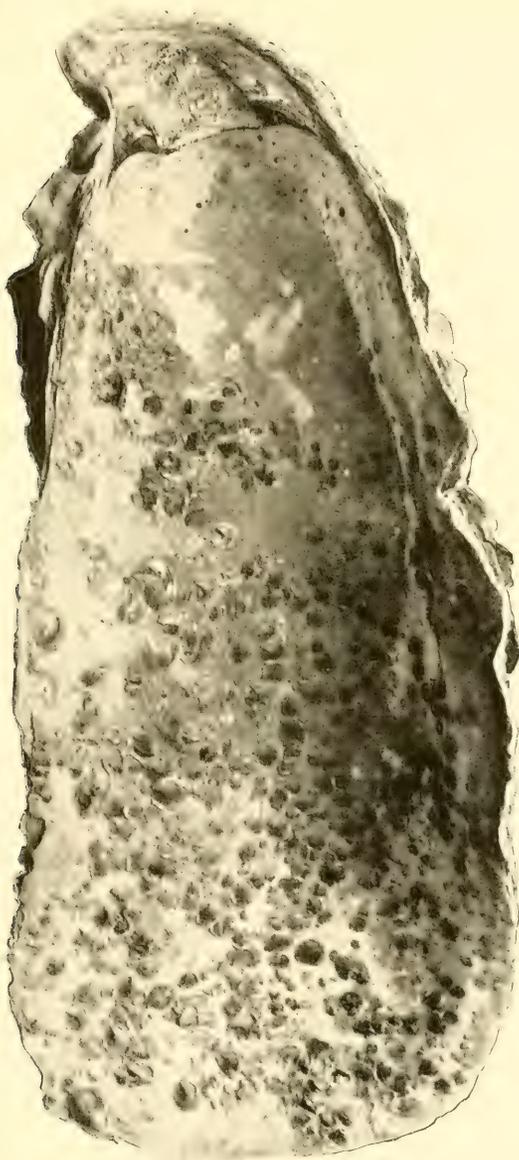
This method of oyster culture is more extensively practiced in Long Island Sound, Narragansett Bay, on the southern side of Long Island, in New Jersey waters, and in Louisiana than elsewhere. The bottoms are cleaned up by dredging from them the old shells, débris, etc. This is done in May, after the close of the season. The shells are put down during the last half of June or the month of July. In Long Island Sound the old rule was to begin "shelling" the day after the Fourth of July. In Louisiana the shells are put down in June, since the oysters spawn earlier there because of the higher temperature of the water.

For shelling purposes in northern waters, the shells are usually loaded upon large scows (Pl. V, fig. 1) and towed out to the grounds by steamers or gasoline boats. Then while the scow is towed slowly back and forth over the beds, the shells are shoveled overboard by men on the scow (Pl. V, fig. 2). If the ground is new and somewhat soft, sufficient shells are put down to form a firm coating such that the upper layers remain clean and exposed above the mud. In any case, enough shells are put down to form a fairly level continuous layer over the bottom.

In northern waters, examination is made about September 1 to 15 to see whether a set has been obtained. Since many factors—such as time of spawning, condition of the cultch, temperature of the water, storms, currents, etc.—enter in to affect the setting, this is the most critical point in the cultivation of oysters by this method and is the one at which the most failures occur. If no set of consequence has fixed on the shells, sometimes they are left until the following season and "harrowed" just before setting time by dragging over them an oyster dredge with the bag removed. This stirs them up and cleans them somewhat, so that often a fairly suitable surface is provided for the attachment of set. Often, however, they are dredged up and heaped upon the ground beside the oyster house. Here they dry, any oyster enemies upon them dying in the meantime, and may be used over again next season. In case a set (by which the oysterman means a sufficient quantity to be of commercial importance) is found upon the shells, they are either left, in order that oysters may develop on that bed, or are shifted to other beds.

The shifting is accomplished by dredging up the shells, set and all, with ordinary oyster dredges or, rarely, by lifting them with tongs. Sometimes the oysters are moved after attaining the age of one or two years, since growth and fattening proceed more rapidly on some beds than on others, due to differences in food content of the water, etc. In certain places oysters become green, and their sale is hindered by the unsightly appearance. When shifted to certain other beds, this color is thrown off in the course of a few months and the oysters are marketed.

The planting of cultch to catch set is mainly performed on "barren" ground, that is, bottoms practically free from oysters. Such ground is leased from the State or purchased outright by the planters. Some States make ample provisions for such procedure, and the lessee or owner has complete protection for his oysters. In other States public sentiment has not supported efforts to provide for leas-



OYSTER SPAT OR SET TWO OR THREE WEEKS OLD ON INSIDE OF  
OYSTER SHELL.

Natural size. (After Moore.)

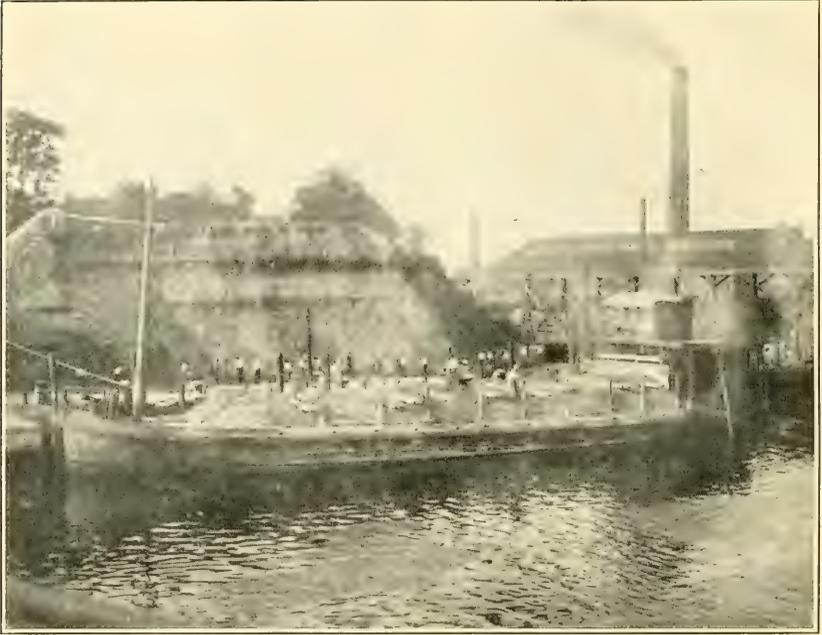


FIG. 1.—LOADING SHELLS ON BOAT FOR PLANTING.



FIG. 2.—PLANTING OYSTER SHELLS IN LONG ISLAND SOUND IN ORDER TO CATCH SET.

The large scow loads of shells are towed by a gasoline boat or steamer,

ing of ground for this purpose and dependence is placed largely on natural beds for the supply of oysters.

In some few cases a State plants a limited amount of cultch upon certain partially depleted natural beds for public benefit. In general, however, the natural beds are staked off and reserved for general public use by the "natural growther" subject to certain restrictions, mentioned elsewhere.

The principal considerations involved in this method of oyster culture are character of the cultch, character and preparation of the bottom, time for planting cultch, the proper location of cultch beds with respect to tides and currents and the spawning oysters, and the location of beds of spawning oysters.

*Cultch.*—While formerly limited use was made in the United States of various forms of cultch—such as tin cans, bits of pottery, brush, pebbles, "jingle" shells, and oyster shells—only the last three materials have proved to be of practical value, and at the present time the cultch used consists almost entirely of oyster shells. A few "jingle" shells are known to be employed at one point in Long Island Sound. Oyster shells are large and afford surface for the attachment of quantities of spat (Pl. IV). As this grows, overcrowding is apt to result, since the shells are too heavy to be broken apart by the pressure of the developing set. This is overcome by breaking apart and culling the clusters thus formed.

The advantages of oyster shells as cultch consist largely in their general adaptability, presenting a smooth surface for the attachment of the set, and their abundance and convenience, since an oyster-shucking house has only to turn about and convert its shell pile into spat collectors by the use of its own boats. At the same time the gradual disintegration of the shells provides lime for the succeeding generations.

"Jingle" shells, or silver shells, belonging to the species of *Anomia*, and scallop shells are thinner and more fragile than oyster shells. Consequently, they make a superior form of cultch, since the pressure of the growing young oysters breaks them apart and the formation of clusters is prevented. Unfortunately, the supply of such shells is so limited that very few are now used.

*Character and preparation of bottom.*—If the bottom at the point where it is desired to plant cultch is sufficiently hard to support it a layer of shells is spread upon it broadcast, as previously described. In case the bottom is soft, it may be prepared by putting down sand or gravel in sufficient quantities to support the shells. Often, however, the bottom is stiffened merely by the use of shells. Sufficient quantities are put down and allowed to sink, until a substratum is formed firm enough to support a layer of cultch several inches or a foot thick above the ground. A bed on which cultch has been placed for several years in succession will gradually be made firmer by the setting of a part of the shells.

*Time for planting cultch.*—Since sea water always contains more or less suspended débris, which gradually settles upon the bottom or any object thereon it follows that cultch will more or less rapidly become coated with a layer of slime or débris. If this becomes too thick the oyster larvæ are prevented from setting upon it. Movement of the water by tides and currents obviates this difficulty somewhat by washing the débris from the cultch. In bodies of water where there

is little movement, especially in inclosed bays or the like, the deposit accumulates upon the shells rapidly. Such waters, while often very desirable for growing or fattening oysters, are for this reason poorly adapted to catching set.

It early became apparent, then, that it would not suffice merely to spread the culch at any season of the year most convenient to the planter. Culch should be put down just as shortly before the bulk of the free-swimming larvæ reaches setting time as it is possible to do it. In general this has been ascertained by experience in the various regions where this method is practiced. For example, in Great South Bay it is planned to complete "shelling" by July 1. In Long Island Sound shelling often begins immediately after the Fourth of July and is completed early in August, individual planters having different ideas as to the best time for planting culch. In Louisiana culch is put down in June.

In the case of the large oyster firms, owing to the great quantity of shells handled, it is impossible to concentrate all the shelling into a few days preceding setting time. Such firms often require a month or six weeks in which to complete the process. The best that can be done is to make this period coincide with the weeks immediately preceding setting time.

The proper time of year for planting the culch has been fixed approximately at certain seasons for each locality, largely by experience derived from the results of some years' practice in this method. The appearance of the adult spawning oysters is noted at intervals each year and the time of planting varied a few days or weeks one way or the other. The aim has mainly been to have the culch down before any appreciable quantity of spawn has been thrown out by the oysters.

It has been thought until relatively recently that the oyster larvæ set within 3 or 4 days after the spawn was thrown out. It is now known that from 14 to 18 days elapse in New Jersey waters and northward, and a somewhat shorter period in the warmer waters of the Southern States. With this longer period in mind, it will be seen that the time of setting is at least two weeks subsequent to the throwing out of the spawn. In case the spawning period is extended over several weeks, the problem is complicated. In the more northern waters, especially in Long Island Sound, the spawning period has been found to be short, hardly more than two weeks in length, the bulk of the spawn being thrown out in the course of a few days. In such case, keeping in mind the two weeks free-swimming period of the larvæ, it is possible to judge the time of putting down culch quite accurately.

Since seasonal variations affect the time of spawning, it follows that no exact date which will hold good for each year can be set for planting culch. As a result of a survey of the free-swimming larvæ made by the Bureau of Fisheries, it was found that the setting time of the bulk of the larvæ in Long Island Sound in 1918 occurred during the week of August 10 to 17. In 1919 there was no setting time in Long Island Sound, since no larvæ developed to setting size, owing, doubtless, to the abnormally low temperature of the water. In 1919, in Great South Bay, setting began about July 1, but the bulk occurred July 15 to 17. These data were secured by following the development and movements of the free-swimming larvæ by

means of examinations of samples of water of definite volume taken in various places from day to day.<sup>a</sup>

This method consisted essentially in noting the number and size of free-swimming larvæ found in samples of water taken daily over the oyster beds by pumping 50 gallons through a net or bag of No. 20 bolting silk. By the study of a considerable number of samples taken each day the general abundance and size of the larvæ could be ascertained and the setting time predicted several days ahead.<sup>b</sup> As the larvæ approach setting time, with the accompanying increase in size, the left valve of the shell becomes very prominent, as stated on page 13. This renders them readily distinguishable from other bivalve larvæ, and it is easy, after a little practice, to recognize them under the microscope.

It would seem that the advent and development of the larvæ could be noted by this means each season. The State commissions could hire a biologist for a month to make the examinations or train one of their own members to do the work. The development and movement of the larvæ could be followed in a few representative places in the waters of the State and exact information relative to setting time ascertained and imparted to the oyster planters. After a few years it would be found that the time varied within certain fixed limits, and examinations would need to be made only to learn the variation within that period for the particular year.

*Location of cultch beds.*—The different oyster planters have determined by experience the locations at which beds of cultch are placed. After a term of years each man has found the portion of his ground on which cultch may be placed with what seems the most likelihood of getting a set. Individual planters have their own views as to the proper position of the cultch in relation to the beds of spawning oysters. Sometimes beds of cultch and of oysters are placed side by side; sometimes several are located alternately. Some planters place a certain number of spawning or "mother oysters" about in groups on the cultch bed.

Since the free-swimming larvæ are carried about by the tides and currents, it becomes of importance to follow in each locality the movements of the larvæ in order to ascertain as nearly as possible the place in which they will set. This involves a study of the tides and currents and the directions in which and the distance to which they carry the larvæ in any particular bay, cove, or river mouth. Accurate knowledge of these facts would enable one to state where the cultch should be placed in relation to the spawning oysters. Since the tides and currents depend on the contour of the bottoms and coasts, they are the same from year to year, unless disturbed by storm. The data, once accumulated by perhaps two or three years' study, would have permanent value.

Investigations calculated to ascertain the advantages of such knowledge of the movements and points of aggregation of the free-swimming larvæ were carried on in 1919 by the United States Bureau of Fisheries, using Great South Bay, Long Island, as a testing

<sup>a</sup> Churchill, E. P. Jr., and Gutsell, J. S. Reports on Investigation of Oyster Larvæ in Long Island Sound, 1918 and 1919, and Investigation of Oyster Larvæ of Great South Bay. (Contains methods.) Forthcoming reports, U. S. Bureau of Fisheries.

<sup>b</sup> Dr. T. C. Nelson (1916), in his study of the occurrence of free-swimming oyster larvæ in Little Egg Harbor, N. J., was able to ascertain the relative abundance of the larvæ in different areas and to predict the setting date about 10 days in advance.

ground.<sup>a</sup> The method of examining samples of water for numbers of larvæ described on page 31 was employed. It was found to be possible to ascertain from day to day during the spawning season, lasting, roughly, from June 5 to July 17, the number of larvæ per gallon of water at various representative stations in the bay. In this way the points of aggregation of the greatest numbers of larvæ were determined and charted on the map. Beds of shells had been placed at various points in the bay. The quantity of set caught on the different beds substantiated predictions based on the data derived from the study. The heaviest set was obtained from the beds located at the points in the bay where there had been the greatest accumulation of larvæ. To be specific, it was found that the tide caused the larvæ to accumulate along the channel from about Ocean Beach on Fire Island Beach to the inner United States channel buoy, in the direction of Sayville, Long Island. Cultch beds should be placed along this channel where the bottom is or may be made suitable.

By the use of methods such as just described the distribution of oyster larvæ could be worked out for any particular region. The possibilities of this procedure have been discussed above in connection with the recommendation that such lines of investigation be undertaken for the various oyster waters, perhaps by State authorities.

*Location of spawning beds.*—Oftentimes the catching of set depends as much on the location of the spawning oysters as on the position of the cultch. Both are important, and sometimes the best results can be accomplished only by the providing of the proper relationship between the two. Spawning beds should be placed where conditions are most favorable for spawning, at the same time putting the cultch at a point where the larvæ from the bed will be carried back and forth across it by the tides or be accumulated over it by eddies or cross currents.

For example, in Great South Bay, Long Island, which is large and shallow, the oysters are placed about over the bay at various points where they grow and fatten best, the catching of set from them being a matter of rather secondary importance in this locality. As a matter of fact one place is as favorable as another for the spawning of the oysters, the bay being of fairly uniform depth and salinity. As stated above, the larvæ accumulate in the channel, and cultch should be placed there.

In Long Island Sound a different condition prevails. The catching of set has been a large feature of the oyster industry there. Cultch beds were planted at greater or lesser distances offshore or in the lower part of the mouths of rivers. Owing to a recent failure of the set there, investigations have been made by the United States Bureau of Fisheries during 1917, 1918, and 1919. It has been found that in the past the bulk of the set consisted of larvæ from natural oyster beds in the shallow waters of bays, coves, and river mouths, where the water became warm relatively early in the season and the spawning occurred early enough for the larvæ, carried out by the currents to shell beds in deeper waters, to develop, set, and acquire a fair size before the close of the short summer season

<sup>a</sup> Churchill, E. P. Jr., and Gutsell, J. S. Investigation of Oyster Larvæ in Great South Bay. Forthcoming report, U. S. Bureau of Fisheries.

of that locality. These inshore beds are practically exhausted now, and dependence is being placed for set upon the oysters planted in deeper water offshore. The deeper water warms up slowly, and the oysters spawn so late that the crest of the warm season is over before setting occurs and very little set is obtained from them. In Long Island Sound spawning beds should be placed in the shallow inshore waters to take the place of the original natural beds. Cultch beds should be placed where they have been heretofore, outside or in the lower part of the mouths of rivers outside or alongside the oyster beds.

In this connection, as stated earlier, the fact that certain waters are contaminated with factory trade wastes must be borne in mind. It has been found that the upper waters of certain harbors in Long Island Sound contain such a concentration of trade wastes that oyster larvæ are at once killed by it. No adult oysters are now found in such waters. As these wastes are carried out nearer to the mouths of the harbors they are diluted and are at least not so immediately fatal to the oysters, but ultimately the effect is certainly harmful. Some of the wastes also probably contribute to the green discoloration of the meats of oysters found in certain beds. Vigorous efforts should be made to require the reclamation of trade wastes by the factories and to prevent their discharge into waters otherwise fitted for the maintenance of sea-foods.

*General desirability of planting cultch.*—The method of oyster culture by means of catching set on planted cultch is the most promising one at present. Small seed oysters may be placed on bottoms where, due to improved conditions, they will grow faster, acquire a more desirable shape, and thus bring a better price. But by putting down cultch in places where there was none before set may be caught which otherwise would have perished. By this method the actual number of oysters is increased. This method should be developed further in some such manner as suggested above and brought into more general use.

At several points on the Atlantic and Gulf coasts no cultch is planted, the shells being burned for lime or used in building roads. In some of these places the oyster beds are becoming seriously depleted. This is especially true of Chesapeake Bay. Investigations carried on there by the United States Bureau of Fisheries during 1919 showed that, while there were abundant free-swimming larvæ during the spawning season, the vast majority of these perished from lack of cultch upon which to attach themselves. It would seem highly desirable to cease disposing of the shells for lime or road building and to clean up the oyster bottoms and plant the shells on them to catch set. The general improvement of the oyster beds and the consequent increase in revenue from them would far outweigh the relatively small amount now received for the shells as at present handled.

#### PLANTING SEED OYSTERS.

In the method of oyster culture by planting seed the start is made with small or "seed" oysters instead of shells. Such seed oysters may vary in size from set of a few months' growth, about the size of one's finger nail, to oysters of nearly marketable size in some cases.

They are usually, however, small oysters attached to old shells or other material upon which they originally caught. Sometimes, if fairly large, the individual oysters are removed from the old shells or the clusters broken up before planting. Seed may be bought or taken by the planter from his own or natural beds.

Very little seed is now taken from Chesapeake Bay and planted in Long Island Sound, although the importation of "southern" oysters and seed was formerly an extensive practice. The oyster beds of Maurice Cove in Delaware Bay are kept up by the planting of seed taken from the natural beds in the bay. Seed oysters are planted in Chesapeake Bay to some extent and in York River, Va. To a lesser extent the planting of seed oysters is carried on in other States. In many of the Southern States the clusters of small "coon" oysters are broken apart and used for seed. Such coon oysters grow in abundance along the shores and naturally are so thickly crowded together that they acquire a long, narrow shape and are quite indifferent oysters. If the clusters are broken apart and the oysters put down on suitable beds when an inch or two long, they grow into fair-shaped, marketable oysters in about a year in southern waters. Seed oysters are planted at various times of the year, depending on the local conditions, in some places in the fall, in others in the spring.

A number of oystermen make a business of taking shells bearing set from natural beds and selling it to the large planters to be placed on their leased beds as seed. No shells are planted upon natural beds, except by the State in certain cases, the set attaching to shells left by the death of adult oysters, or to rocks, débris, etc. The material bearing the set is taken from such natural beds by the use of tongs (Pl. XI) or by light dredges lifted by hand or hand windlasses on a sailboat (Pl. XV, fig. 1).

In nearly all States it is illegal to use other than a sailing vessel on natural beds and in most instances the dredge must be lifted by hand or by a hand windlass, although sometimes it is lawful to lift the dredge with a donkey engine on deck of a sailing boat. The purpose of restrictions on the use of steam and power in dredging is to limit dredging on natural beds to the use of the less efficient apparatus in order to conserve the supply of oysters. In most States such "natural growth" may not be taken from the beds during certain of the summer months, the purpose being not to disturb the beds during spawning and setting time.

In northern waters it requires from four to five years for an oyster to reach marketable size (a length of from 4 to 5 inches, measured in the shell). In Chesapeake Bay three years is sufficient, while in the South marketable size may be attained in two years. Oysters grow more rapidly in the warmer waters.

In oyster culture by the method of planting seed the main considerations are the kind of seed, character of the water, food supply, bottom, sowing the seed, and caring for the beds.

*Seed.*—Seed oysters vary in size from the set just caught that season and taken up in the fall, when it is about the size of a finger nail, to oysters which will attain marketable size within a few months after planting. The majority of the seed, however, is not more than 1½ inches long. It is obtained from "natural growers" who make a business, as stated above, of taking seed oysters from natural beds and selling them to planters, or by the planter himself gather-

ing them directly from the beds. In many places the larger planters buy of the "natural growers", since steam vessels and heavy dredges, such as are owned by the large oyster companies, are not allowed to work on the natural beds. The "natural grower," with less capital, can afford to maintain a vessel and some hand dredges and profitably sell to the large oyster company, which in turn obtains seed more cheaply than it could by supporting its own sailing vessels and crews. In States where such a system is practiced, the natural beds are set aside by the State for the "natural grower" with limited capital.

The material dredged from the natural beds usually contains old shells, rocks, and débris, in addition to the oysters. Sometimes the whole is bought at a reduced price, but usually the desirable material is culled out and the clustered oysters broken apart as far as possible.

*Water.*—As a general rule seed oysters should not be obtained from warm waters and put down in those excessively colder. If this be done, it will usually be found that their growth is checked for some time and that a certain percentage die. After a time, however, they become accustomed to the reduced temperature and renew their growth.

In general, the warmer the water the more rapid the growth of the oysters. This is due both to the greater abundance of food material and to the fact that the bodily activities of the oyster proceed more rapidly when the organism is warmed to a relatively high temperature.

The density of the water should be between 1.007 and 1.023. Although oysters are found both in water of lesser and of greater densities, they do best within the limits stated.

*Food.*—The character of the food of the oyster is discussed on page 19. In order to profit by planting oysters, a sufficient quantity of food for them must be assured. Often certain waters and bottoms are suitable for catching set on cultch, but do not possess a sufficient food supply to enable the oysters to grow and fatten rapidly. Other grounds furnish an abundant food supply, but the water is so loaded with débris that cultch and set are soon covered. Hence in many cases cultch beds are placed in waters of the former character, and the set is caught and later transferred to waters containing more food.

Care must be exercised not to place more oysters on the ground than can be supported by the supply of food present. On the average about 500 bushels of seed are sowed per acre. The food content of the water varies greatly from place to place and from time to time in the same place. It is affected to some extent by the amount of material brought from the land by the streams and rivers. This again is dependent on the rainfall. As previously stated, diatoms make up a considerable part of the oyster's food and diatom growth is affected by materials washed down from the land. A period of excessive drought causes a falling off in the diatom content of the water.

It would be well if a systematic biological study could be made of the food content of the water over prospective oyster grounds. In order to do this samples of water of definite amounts should be strained through No. 20 silk bolting cloth and the number and

amount of food organisms and material ascertained microscopically.<sup>a</sup> Estimate is usually made per liter, which is about equal to a quart. If it were found from a series of examinations that the food content of the water were conspicuously low, it is obvious that the grounds in question would not be desirable for the planting of oysters.

*Bottom.*—The bottom is cleaned of débris by dredging. If firm enough to support the oysters, no further preparation is needed. If soft, the surface is hardened by putting down shells, sand, or gravel, deposited uniformly so that there are no holes in the surface as finally prepared.

*Sowing the seed.*—The seed oysters are removed from the original bed by the use of tongs or dredges and are planted in much the same manner as shells by being shoveled from boats or scows (Pl. V, fig. 2) towed back and forth over the grounds. About 500 bushels per acre are usually planted, though the amounts vary widely with local conditions. The oysters are spread uniformly, so that they may not lie in heaps and cause some to fail to receive the proper amount of food or to be crowded and thus grow irregularly.

*Care of beds.*—The beds are generally left untouched after planting, except for combating enemies in some cases (see below) and shifting certain of the oysters, if desired, to other grounds for final preparation for market. The oysters to be shifted or sold directly are taken up by the use of tongs and dredges. After the oysters have been removed from the beds the grounds are cleaned up by dredging, when they may be used again for planting cultch or seed.

#### PROTECTION AGAINST ENEMIES.

The more important enemies of the oyster will be described briefly and the methods, if any, of combating each set forth.

##### STARFISH.

There are two species of starfish which may be classed as oyster enemies. These are the common star, *Asterias forbesi*, and the purple star, *Asterias vulgaris*. The starfish opens an oyster by inclosing it with the arms or rays (Pl. VI, fig. 1), which are provided with rows of suckerlike feet on the lower side, and exerting a constant outward pull on the valves of the shell, until the oyster is exhausted and the valves are allowed to gape at the ends. The starfish then protrudes its stomach from the mouth, which is on the lower side of the central disk, inserts it between the valves of the oyster shell, and sucks in and digests the meat. The set and 1 and 2 year old oysters are more subject to the inroads of the starfish, because of their smaller size and weaker adductor muscle; but the larger starfish prey on oysters as much as 3 years old.

In certain waters the starfish are very destructive to oysters, often invading and cleaning out a whole bed before the planter is aware of their presence. This is true of New England waters and those immediately to the southward. They are unknown in Chesapeake Bay and constitute a menace to oysters only in the regions mentioned in the preceding sentence. In Narragansett Bay and Long Island Sound it has been necessary to fight them very vigorously.

<sup>a</sup> This method will suffice to determine the great bulk of the food available in the water and is usually sufficient for practical purposes. The material in actual solution in the water, which probably contributes only a small percentage of the food of the oyster, can be determined only by chemical analysis.

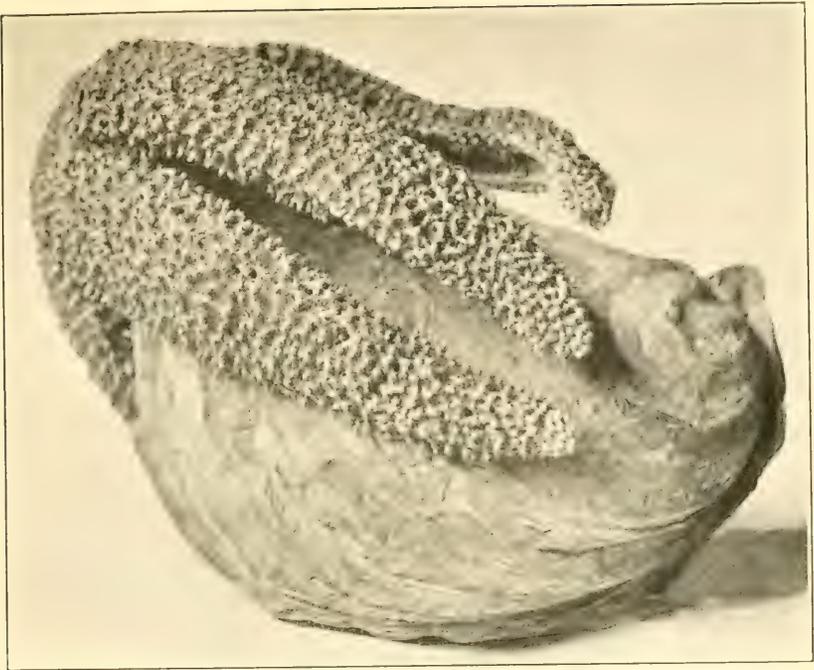


FIG. 1.—STARFISH ATTACKING AN OYSTER.  
(Photo from Dr. H. M. Smith.)



FIG. 2.—PHOTOGRAPH OF OYSTER SHOWING THE TURBELLARIAN WORM  
KNOWN AS THE WAFER OR "LEECH."

The worm has fastened itself upon the oyster and appears as a dark wrinkled body in about the center of the oyster meat. Natural size. (After Danglade.)



FIG. 1.—USUAL STYLE OF "STAR MOP" USED FOR EXTERMINATING STARFISH IN LONG ISLAND SOUND.

The stars become entangled in the brushes as they are dragged over the bottom. The mops are then raised and plunged into vats of hot water on deck to kill the starfish.



FIG. 2.—"DISH-PAN" FORM OF STAR MOP, USED IN LONG ISLAND SOUND.

The only practical method of destroying the starfish so far devised is by the use of the "star mop" (Pl. VII, fig. 1). This usually consists of an iron bar about 10 feet long, to which are attached 8 or 10 large mops or brushes of heavy rope-yarn about 4 feet long. The bar moves on small wooden iron-tired wheels as it is dragged over the bottom by a chain attached by three drag bars arranged as shown in the figure. The chain passes through a pulley attached to a stout post amidships, and the mop is raised and lowered in the same way as a dredge. The starfish cling to or become entangled in the mops and are brought to the surface when the apparatus is lifted. Two mops are usually used, one on each side of the boat. A long narrow vat is generally placed inside the gunwale on each side of the boat. These vats are kept filled with water which is heated by steam from the boiler circulated through pipes in the vats. Each mop with its burden of "stars" is dropped into the hot water. This is the most rapid and efficient method of killing the starfish and removing them from the mops. Sometimes only one vat is used, placed across the deck before the cabin, and each mop is swung around and lowered into it by means of a small crane.

In Plate VII, figure 2, is shown a special form of star mop, the "dishpan," devised for use on a rocky bottom. The toboggan-shaped body consists of two pieces of boiler iron, the larger one  $4\frac{1}{2}$  by 2 feet and attached to the triangular smaller one by four rings bolted on as seen in the figure. This allows some independence of movement of the two parts. The mops are the same as used with the other form of apparatus. This mop slides over the rocks more readily than the wheeled bar, the brushes falling down between the rocks and catching the stars. This style of mop, however, is heavy and awkward to handle and is not extensively used.

"Starring" must be kept up whenever any considerable number of the enemy appears and should be of a cooperative nature. It is of little avail for a planter to attempt to keep his beds free from starfish, unless his neighbor does likewise.

#### DRILL.

There are at least four species of snail-like molluscs known to oystermen as drills or screw borers. One of these, *Urosalpinx cinereus* (text fig. 3), attaining a length of about an inch, is found abundantly from Massachusetts to the east coast of Florida. The eggs are laid in small, yellowish, vase-shaped, leathery capsules,<sup>a</sup> deposited in clusters on objects in the water. Another species is *Thais lapillus*, about the size of the preceding. It is found from the east end of Long Island northward. Other species of drills (often called borers, snails, whelks, or conchs) are *Thais haemastoma* (Pl. VIII, top) and *Thais haemastoma floridana*. These sometimes reach a length of 3 inches. They are found on the Gulf coast, where they are often very destructive to oyster beds. The eggs are laid in tubular capsules about a half inch long, attached by the ends to



FIG. 3.—*Urosalpinx cinereus*, the oyster drill of the Atlantic coast. Natural size. (After Moore.)

<sup>a</sup> Moore, H. F. Proposed revision of "Oysters and Methods of Oyster Culture" (1897).

shells and other objects in the water (Pl. VIII, center). Masses of these capsules are often found covering oyster shells so thickly that there is danger of smothering the oysters. From their reddish-purple color these masses are often referred to as "red grass."

The various species of drill possess a rasplike apparatus which can be protruded from the mouth. With this they bore a hole through the shell of the oyster (Pl. VIII, bottom) and suck out the contents. Drills destroy many young oysters, their thin shells being relatively easily penetrated. After the oyster becomes older its shell is heavy enough to resist the effort of the drill.

In Long Island Sound it has been found that about the most practical method of lessening the numbers of this enemy is the following: The teeth are removed from an ordinary oyster dredge, and a bag with meshes of an inch or less is put on in place of the usual coarser one. After the oysters have been taken off the bed for market or shifting, the specially equipped dredge is used and everything left—shells, drills, débris, etc.—is dredged up

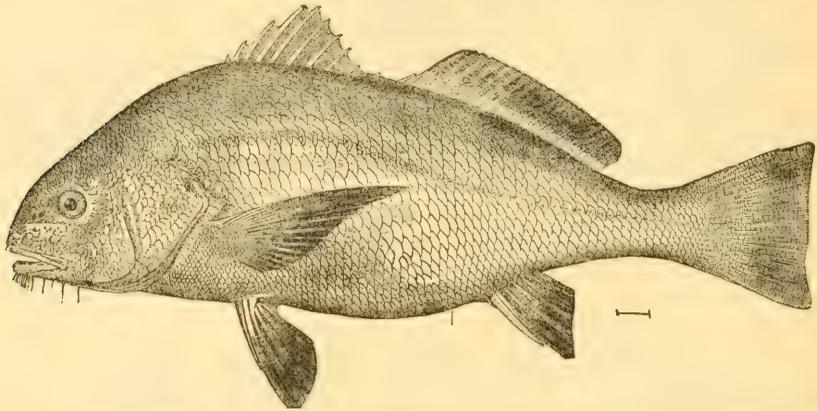


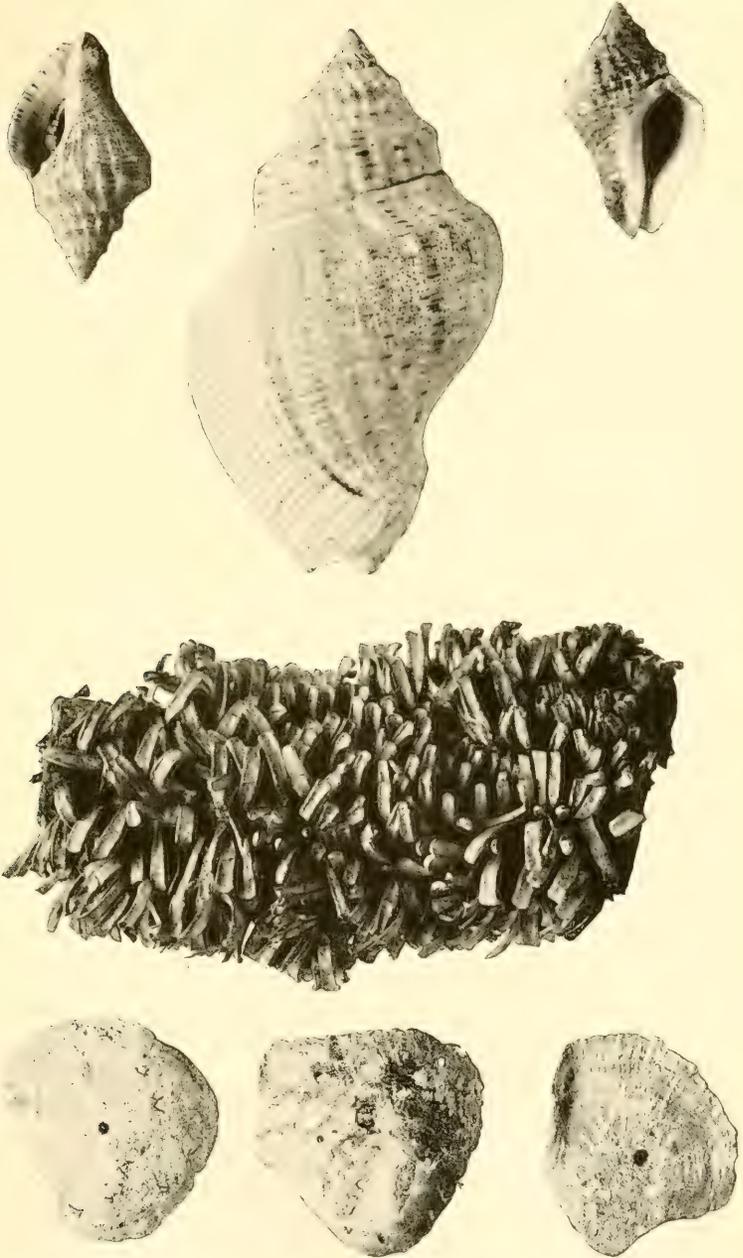
FIG. 4.—*Pogonias cromis*, or drum fish. At times this fish destroys large numbers of oysters. (After Jordan and Evermann.)

and dumped ashore to dry. The drills die, and a good deal of the material may then be used as cultch.

#### DRUMFISH.

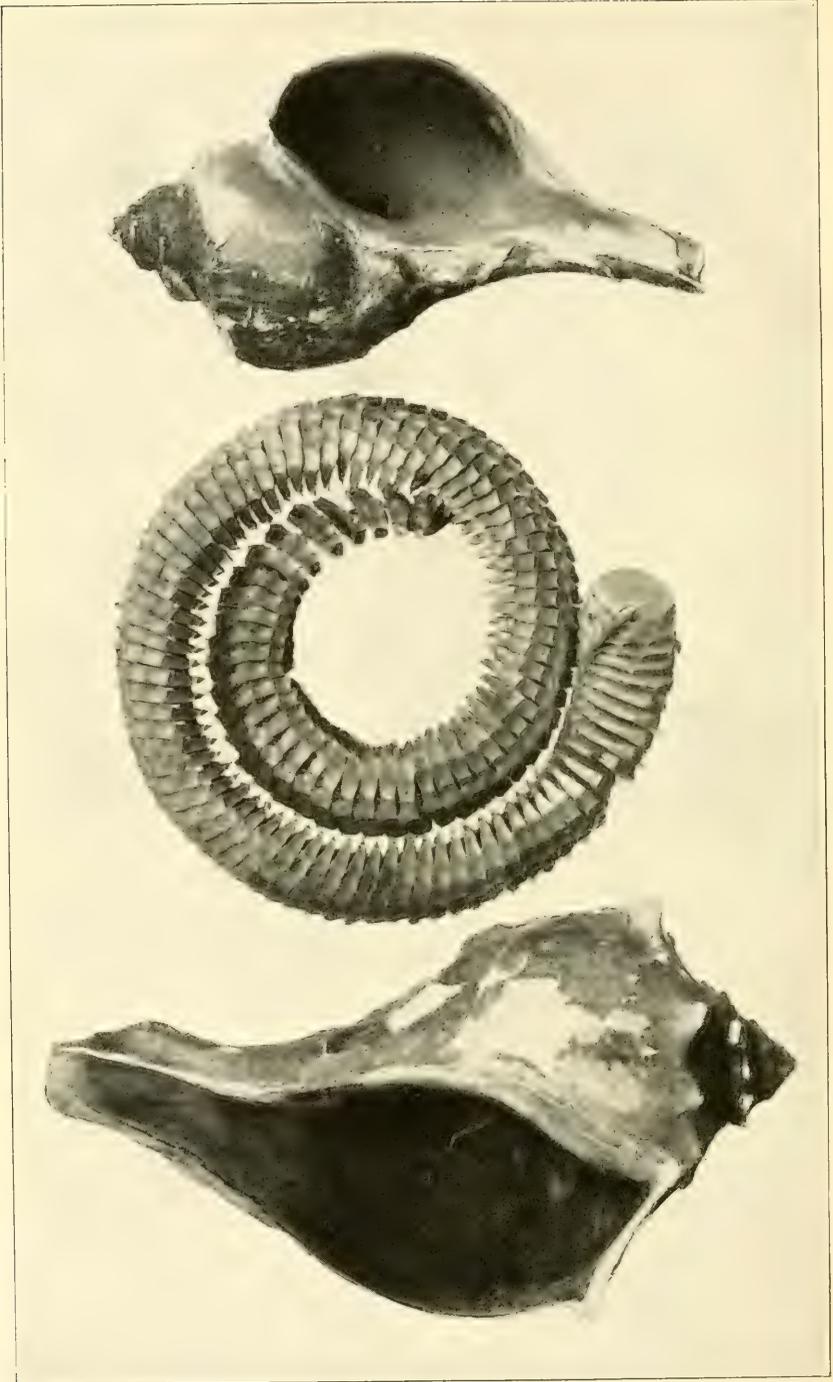
The fish known as the "black drum," *Pogonias cromis* (text fig. 4), is found at intervals of time and place from New Jersey to Texas and is often very destructive to oyster beds. It attains a length of several feet and has a heavy body with large stout teeth. The oysters are crushed, shell and all, by these strong teeth, the younger thin-shelled ones being, of course, especially subject to the depredations of the drumfish. These fish go in schools and their attacks are spasmodic, often whole oyster beds being cleaned out in a short time and then, again, no drumfish being seen for several months or years.

Efforts have been made to kill or frighten away such fish by the explosion of dynamite, but no particular success has been achieved. In southern waters, especially in Louisiana, where oyster beds lie in shallow water and there is not much tide, it has been found practi-



TOP, BORERS OR "DRILLS" (THAIS HAEMASTOMA) OF THE GULF COAST;  
CENTER, SO-CALLED "RED GRASS," THE EGG CASES OF THE BORERS;  
BOTTOM, OYSTER SPAT DRILLED BY BORERS.

Natural size. (After Moore and Pope.)



CONCHS. TOP, CHANNELLED CONCH OR WHELK, *BUSYCON CANALICULATUM*;  
CENTER, STRING OF CAPSULES CONTAINING EGGS OF KNOBBED CONCH;  
BOTTOM, KNOBBED CONCH OR WHELK, *BUSYCON CARICA*.

cable to fence the beds with chicken wire strung on posts set in the bottom.

## CONCH.

This is also a snail-like mollusc, comprising several species, some of which attain a length of from 5 to 6 inches. *Busycon carica* and *Busycon canaliculatum* (Pl. IX) are the most common. The eggs are deposited in flat parchmentlike capsules about an inch in diameter and strung together by a cord along the side to form a loosely spiral chain a foot to a foot and a half in length. This is cast free from the animal and left to the mercy of the waves. It has been found<sup>a</sup> that the conch opens an oyster by inserting the edges of its own shell between the valves of the oyster when it gapes (text fig. 5) and then introducing its proboscis and eating the meat. Conchs do not occur, however, in sufficient quantities to destroy many oysters. No definite means of combating them are employed, although those taken when dredging are usually killed.

## MUSSEL.

Mussels, the common edible species, *Mytilus edulis*, and other species, of the Atlantic waters, and *Mytilus hamatus* (Pl. X, fig. 1), of the Gulf coast, are bivalves which, shortly after hatching from the egg, attach themselves to material on the bottom by a slender thread or hair called the byssus. As development goes on the number of hairs is multiplied and they become shorter and stouter until the adult mussel, at a length of 2 to 4 inches, is very firmly attached by these threads. The mussels multiply rapidly, and dense beds are sometimes formed over the oysters, tending to smother the latter. Since the mussels feed upon essentially the same materials as do the oysters, there is always danger of a greater or less exhaustion of the food supply.

In Long Island Sound the mussel is attacked in the following manner: The mussel spawns and "sets"—that is, attaches by the byssus—perhaps a month or more before the oyster. Advantage is taken of this fact, and when evidences are found of an alarming number of young mussels on the oyster beds, they are "harrowed" by dragging over them an ordinary dredge with the bag removed or open at the back. This process crushes and destroys the majority of the tiny mussels without injury to the adult oysters. If this process is carried out on a bed planted with shells to catch a set, no harm is done, as the oysters have not yet spawned, and there is consequently no oyster set on the shells.



FIG. 5.—Conch opening an oyster. About one-half natural size. (After Colton.)

<sup>a</sup> Colton, H. S. How Fulgur and Sycotypus eat Oysters, Mussels, and Clams. Proceedings, Academy of Natural Sciences, Philadelphia, Vol. LX, 1908, pp. 3-10, 5 pls. Philadelphia.

## BORING SPONGE.

Boring sponge (*Cliona celata*) is the term applied to a yellow sponge which begins its existence by boring (Pl. XXI, lower left figure) in the shell of the oyster, where it forms small tunnels, in which it lives. The shell is gradually honeycombed, and the oyster becomes weak and thin from the effort to seal up the openings where the tunnels penetrate the shell completely. The sponge also spreads over the outside of the shell and often smothers the oyster by its very size. No means of protection against the sponge can be suggested, but fortunately it does not occur in sufficient numbers in most regions to prove a serious menace.

## BORING CLAM.

The boring clam (*Martesia cuneiformis*, *M. smithii*, and *M. corticaria*) is a species of clam which enters the shell of the oyster by boring a small round hole and excavating in the substance of the shell, at the inner end of the hole, a hemispherical cavity (Pl. X, fig. 2) in which it then spends its life, often attaining a length of three-eighths of an inch. The clam usually does not penetrate the shell entirely and does not feed upon the oyster. It attains its food through the external opening. It does comparatively little damage to the oyster.

## WAFER OR "LEECH."

This is a turbellarian worm (Pl. VI, fig. 2) of undetermined species which on several occasions has destroyed large numbers of oysters in the vicinity of Cedar Keys, Port Inglis, and Tampa, Fla. This worm is nearly flat, more or less circular in outline, and is about three-fourths of an inch long. It finds its way between the valves of the oyster and feeds upon the meat, eventually killing the oyster. It flourishes in water of fairly high salinity, and its ravages are checked by lowered temperatures. No method of combating it can be suggested other than a careful working of the beds and the use of new air-dried cultch and fresh seed stock.

## TAKING OYSTERS FROM THE BEDS.

Oysters are commonly taken by the use of hand tongs, patent tongs, dredges lifted by hand or hand windlasses, or dredges raised by engines or hoisters turned by the engine of the boat. These forms of apparatus and the boats on which they are used are described below.

## TONGS.

Ordinary hand oyster tongs are shown in Plate XI, figures 1 and 2. There are two long, flat, smooth, wooden handles about 3 inches wide and nearly 1 inch thick, bolted, riveted, or pinned together with a wooden pin, scissors fashion, about  $4\frac{1}{2}$  feet from one end (see figures), leaving the long ends for handles. To the short end of each shaft is secured at right angles a light iron bar, about  $3\frac{1}{2}$  feet long, bearing teeth, while above this bar are five or six still lighter bars or heavy wires parallel to the bar and attached to the shaft. The ends of the bars or wires are fastened together by short wires. The arrange-



FIG. 1.—MASS OF MUSSELS ATTACHED TO OYSTERS.  
(After Moore.)

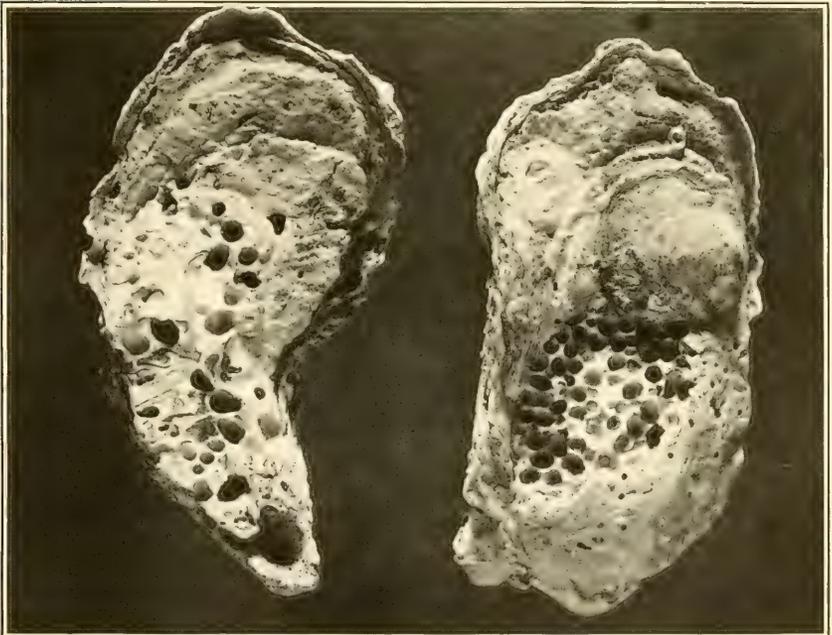


FIG. 2.—OYSTER SHELLS SHOWING PITS AND CHAMBERS MADE BY BORING CLAM.  
(After Moore.)



FIG. 1.—TONGING OYSTERS, WORKING THE TONGS ON THE BOTTOM.  
(Photo from Prof. E. N. Cory, Maryland State University.)

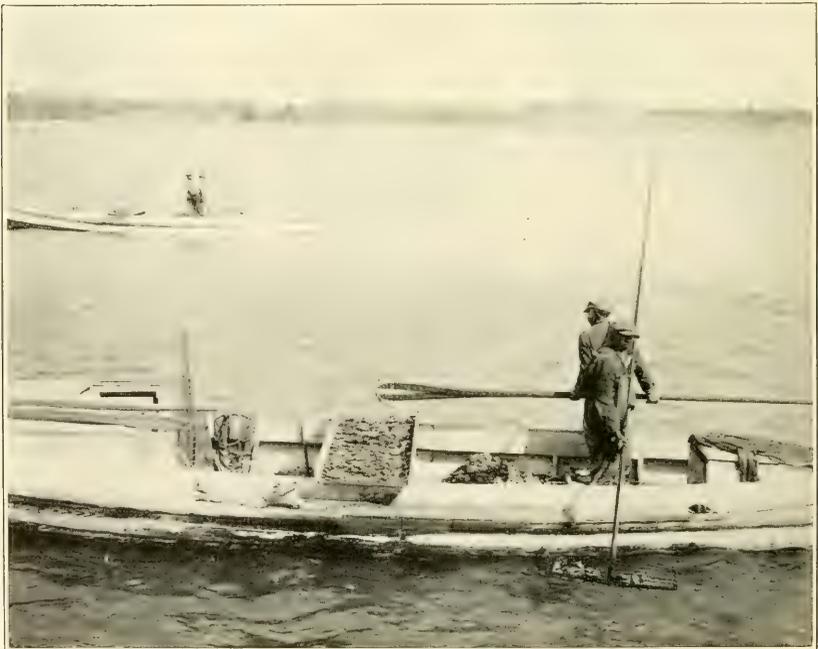


FIG. 2.—TONGING OYSTERS, LIFTING AND EMPTYING THE TONGS.  
(Photo from Prof. E. N. Cory, Maryland State University.)

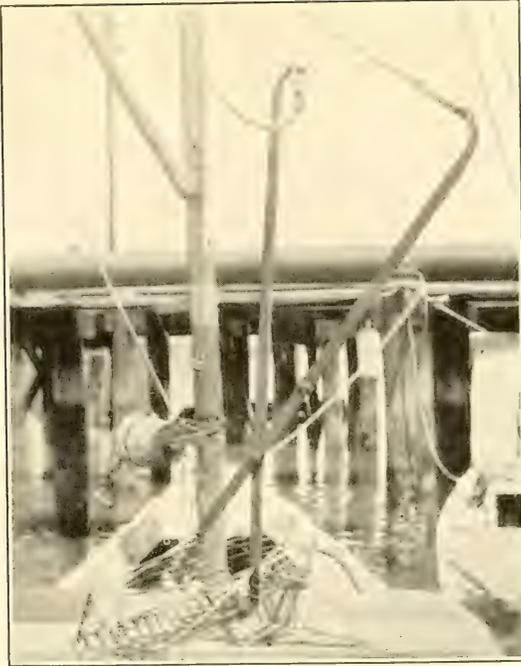


FIG. 1.—PATENT TONGS, USED TO SOME EXTENT IN TAKING OYSTERS IN THE LOWER PART OF CHESAPEAKE BAY.



FIG. 2.—UNLOADING OYSTERS BY MEANS OF A CRANE OPERATED BY A DONKEY ENGINE IN THE SMALL BUILDING AT THE RIGHT.

(Photo from Prof. E. N. Cory, Maryland State University.)



FIG. 1.—SMALL SAILING BOAT USED IN TONGING OYSTERS IN QUINNIPIAC RIVER, CONN.



FIG. 2.—SMALL SAILING BOAT USED IN TONGING OYSTERS IN RIVERS ON THE COAST OF ALABAMA.

ment on each shaft is made with the teeth sloping inward, and when the handles are closed the two are brought together, the whole forming a basketlike affair,  $3\frac{1}{2}$  feet long by about 8 or 10 inches deep. In operation (Pl. XI, fig. 1), the handles are worked scissors fashion, and the teeth forced under the oysters retained in the basket, which is then lifted (Pl. XI, fig. 2). Oyster tongs vary in length with the depth of water in different localities. In some places, as in the Rappahannock River, oysters are tonged with such apparatus from a depth of at least 20 feet.

#### PATENT TONGS.

Patent tongs are used quite extensively in Virginia and but very little elsewhere. From Plate XII, figure 1, it will be seen that their general construction is similar to that of hand tongs, except that the handles are of iron, about 6 feet long and provided with an eye at the end for the attachment of ropes for lowering and raising the tongs. The basket of the tongs is of considerably heavier material than in case of the hand tongs. Patent tongs are employed in water too deep to admit of the use of ordinary tongs and are raised and lowered by a spool or windlass, as in Plate XII, figure 1. While being lowered the tongs are locked open by the short hook seen on one of the handles just above the center pin. When they strike bottom, the consequent release of the weight of the baskets on the handles allows the hook to become disengaged. The tongs are then "jigged" by jerking upon the rope several times, causing the teeth to sink more deeply, and then lifted by the windlass.

#### SMALL TONGS AND NIPPERS.

In very shallow water of perhaps 2 to 4 feet in depth small tongs are often used. These consist of two wooden handles about 7 feet long, arranged as in the case of the ordinary tongs, but with only a single bar on each about 10 inches long, each bar being provided with teeth. This instrument is much lighter and more convenient to use in shallow water than ordinary tongs, especially where only a few barrels of oysters are desired. Such tongs are sometimes called "nippers." In other regions the term "nipper" is applied to a device of a similar nature, except that, instead of ending in a toothed bar, each handle terminates in a narrow blunt blade, thus forming true pincers or nippers, with which single oysters can be taken or dislodged from rocks or pilings.

#### TONGING BOATS.

In Plate XIII, figures 1 and 2, and Plate XIV, figure 1, are shown various styles of tonging boats. Plate XIII, figure 1, shows a small boat used on Long Island Sound; and Plate XIII, figure 2, a small tonging boat at Bayou Labatre, Ala. Plate XIV, figure 1, shows the type of tonging boat used at Apalachicola, Fla. These boats often carry an auxiliary gasoline engine besides the sails. Such a boat with engine is seen in the figure, returning with a load of oysters which have been obtained by tonging. Boats of this sort often have a shallow hold into which oysters are piled until full, after which they are heaped on deck. Plate XII, figure 1, shows a boat equipped with patent tongs.

On the small boats, in compliance with State law, the oysters are culled on a board placed across the boat, as in Plate XI.

#### DREDGES AND DREDGING BOATS.

The hand dredge is shown in Plate XV, figure 1. It consists essentially of two triangles made of three-fourths inch iron bar, joined at the apices, and the bases separated about 18 inches by curved bars, as seen in the figure at left. It usually measures 4 or 5 feet in width. The base of the lower triangle consists of a bar about  $1\frac{1}{2}$  inches thick, to which are welded teeth about 3 inches long, set about 3 inches apart. To a ring at the apex of the dredge a rope or wire cable is attached, by which the dredge is lowered and raised, either by hand or by the hand windlass. Plate XVI, figure 1, shows a small dredging sloop or "skipjack" under sail on Chesapeake Bay, the dredge on the port side being lifted and the hand windlass visible beyond it. In some States, as Maryland, somewhat heavier dredges than this are operated by the use of a donkey engine placed on the deck of a sailing vessel (Pl. XVII, fig. 2). Plate XVI, figure 2, shows such a dredging schooner at work. These vessels are propelled entirely by sails, it being illegal to dredge with other than sails as motive power; the engine merely operates the dredge.

From one to three dredges are usually operated from each side of the boat, each dredge being raised and emptied in turn. Plate XVII, figure 1, shows the dredge being thrown overboard and the roller over which the chain moves in lowering and raising it. After the full dredge is lifted it is allowed to rest on the roller and is emptied by pulling the bag forward (Pl. XVII, fig. 2), thus turning it wrong side out and dumping the oysters on deck. The dredge is then dropped overboard again. The oysters are culled on deck and then shoveled into the hold or onto the pile on deck.

A yet heavier and stouter form of dredge (Pl. XV, fig. 2) is used where dredging with power boats is allowed. It will be seen to resemble the other patterns, except that it is largely made of heavy, flat, iron bars, about 2 inches wide and nearly 1 inch thick and firmly braced. The lower part of the bag is of iron mesh instead of cotton. Dredges of this sort measure from 5 to 7 feet in width and hold 12 to 15 bushels of oysters (one oyster company uses larger ones holding nearly 30 bushels; these are emptied by mechanical means). These dredges are raised and lowered by a heavy chain which passes through a pulley on a stout post in the midline forward and then down to the hoister in the hold. The hoister is turned by the engine of the boat. Plate XIV, figure 2, shows the arrangement of rollers, pulleys, post, and dredges on a gasoline power dredging boat. In Long Island Sound large steamers are often used for dredging on leased beds. One company has two steamers each carrying three dredges on a side, six in all, each with a capacity of nearly 30 bushels. These two steamers are each about twice as large as any other oyster steamer in the world, having a capacity of 8,000 bushels (Pl. XVIII, fig. 2).



FIG. 1.—SMALL SLOOP USED IN TONGING OYSTERS NEAR APALACHICOLA, FLA., RETURNING WITH LOAD OF OYSTERS. SHOWING OYSTER CANNERIES IN BACKGROUND.

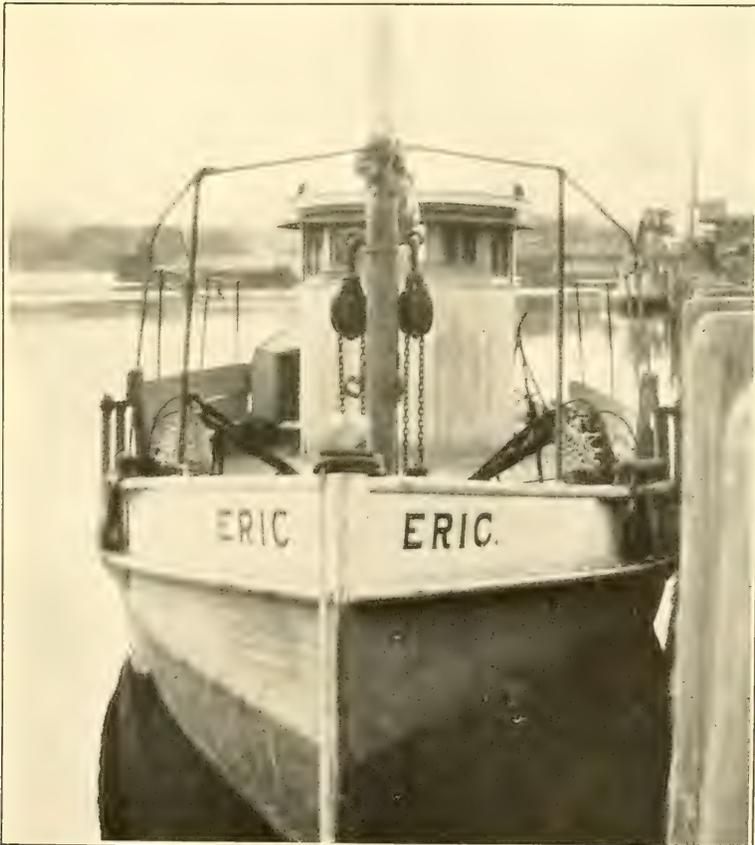


FIG. 2.—GASOLINE BOAT USED IN DREDGING OYSTERS IN LONG ISLAND SOUND.

In the center is the post to which are attached the pulleys through which pass the chains leading to the dredges on each side. When the dredges are being raised and lowered, the chains move over the rollers on the gunwale.



FIG. 1.—HAND DREDGES AND WINCHES FOR HOISTING THEM.

(Photo from Prof. E. N. Cory, Maryland State University.)



FIG. 2.—MACHINE-HOISTED DREDGE USED IN TAKING OYSTERS.



FIG. 1.—SMALL SLOOP OR "SKIP-JACK" USED IN DREDGING OYSTERS IN CHESAPEAKE BAY.

The dredge shown lying on the roller is raised and lowered by the hand windlass over which the man is stooping. (Photo from Prof. E. N. Cory, Maryland State University.)



FIG. 2.—OYSTER-DREDGING SCHOONER IN CHESAPEAKE BAY.

(Photo from Prof. E. N. Cory, Maryland State University.)



FIG. 1.—LOWERING THE DREDGE.

(Photo from Prof. E. N. Cory, Maryland State University.)



FIG. 2.—EMPTYING THE DREDGE.

In this case the dredge has been lifted by a donkey engine, part of which may be seen at the right.  
(Photo from Prof. E. N. Cory, Maryland State University.)



FIG. 1.—OYSTER FLEET OPERATING FROM CAMBRIDGE, MD., LYING IN HARBOR. Cambridge is only one of the several important oyster centers on Chesapeake Bay. (Photo from Prof. E. N. Cory, Maryland State University.)



FIG. 2.—ONE OF THE TWO LARGEST OYSTER STEAMERS IN THE WORLD, BOTH OWNED BY A NEW ENGLAND COMPANY.

Three dredges lifting 30 bushels each are operated on each side. The capacity of the steamer is 8,000 bushels per day. (Photo from H. C. Rowe Co.)



FIG. 1.—LARGE OYSTER HOUSE AT PROVIDENCE, R. I., SHOWING DREDGE BOAT UNLOADING OYSTERS AT RIGHT AND ELEVATOR TO SHELL PILE AT LEFT.



FIG. 2.—UNLOADING OYSTERS FROM THE BOAT AT ONE OF THE LARGE OYSTER HOUSES BY MEANS OF A BELT CONVEYER.

## UNLOADING AT WHARF.

In most cases the oysters are shoveled from the hold or deck into large measures or buckets and hoisted to the wharf by a rope passing over a pulley and operated by hand or by a crane with a donkey engine as motive power, as in Plate XII, figure 2. The buckets are emptied onto the wharf and the oysters removed later in wheelbarrows; or into wheelbarrows and the oysters rolled into the shucking room on a level with the wharf, or sometimes to a storage room on an upper floor (Pl. XII, fig. 2). Some large oyster companies have arrangements whereby the buckets are lifted directly into the storage room, and some have an elevator, the end of which may be lowered into the boat and the oysters shoveled onto an endless belt or other carrying device (Pl. XIX, fig. 2).

This carrier transports the oysters directly to the storage room or drops them into another endless bucket-chain carrier which does so. In case the oysters are to be canned they are dumped from the buckets, which have lifted them from the boat, directly into cars, which are then pushed into the steamers inside the cannery.

## FLOATING.

Brief mention may be made of the practice whereby, in some localities, oysters, after being taken from the beds, are "floated" for a time before being used. This process is accomplished by spreading the oysters out in a large shallow barge or float so constructed that, while resting at the surface, water may freely circulate through it, the oysters thereby being covered at all times. Such floats vary considerably in structure, often consisting of a rectangular framework some 12 or 15 feet wide by 20 to 30 feet long, made of four large timbers 15 or 18 inches in diameter, with a bottom of boards laid so that cracks are left between them. The float may be towed to the desired point and anchored either before or after the oysters are placed in it.

The floating is usually undertaken for one of two purposes—purification and cleaning of the oysters or temporary storage. In certain regions oysters from beds which are exposed to sewage are floated in waters of a certain degree of saltness designated by the health authorities until any possible impurities contained are thrown off. In such salt water the oysters do not become bloated, as they would if floated in fresh. Oysters are also sometimes floated in order that they may free themselves from sand or dirt contained in the intestinal tract.

Some companies maintain floats such as described in which a temporary stock of oysters may be kept a day or two in order to have a supply on hand to fill extra orders or to tide over a shortage caused by failure to obtain sufficient stock directly from the beds, for any cause, such as the breakdown of a boat or formation of heavy ice over the beds. In this case the floats are placed by the oyster house in water of about the saltness of that over the beds.

The practice of floating oysters in fresh water of creeks and rivers for the purpose of "fattening" has largely died out or been suppressed by health authorities. The oyster did not fatten in such circumstances, but merely enlarged itself by absorbing creek water which the consumer paid for at oyster prices.

## PREPARATION FOR MARKET OR SHIPMENT.

Oysters are usually shipped in three general conditions—in the shell; shucked, on ice; and canned.<sup>a</sup> The building where oysters are handled in either or both of the first two conditions is referred to as an oyster house or, in some sections, especially to distinguish it from a cannery, as a “raw house” or “raw-oyster house.” If oysters are canned, the plant is known as a cannery. Plate XIX, figure 1, shows the front view of a large oyster house. Oyster houses are provided with a wharf of some sort, so that the boats may be unloaded directly, as described above.

## IN THE SHELL.

Oysters are shipped in the shell usually in barrels, sometimes in sacks, without ice, although for long distances a refrigerator car is often used. In many cases, especially for shorter hauls or transportation by river boats, the barrels are not headed, a piece of heavy gunny-sack being fastened over the top of the barrel. A considerable export trade in oysters to England is carried on from the waters of New York and New England. These oysters go in barrels holding 3 bushels and one-half peck, headed up. Only the best-shaped, selected oysters are used for the export trade.

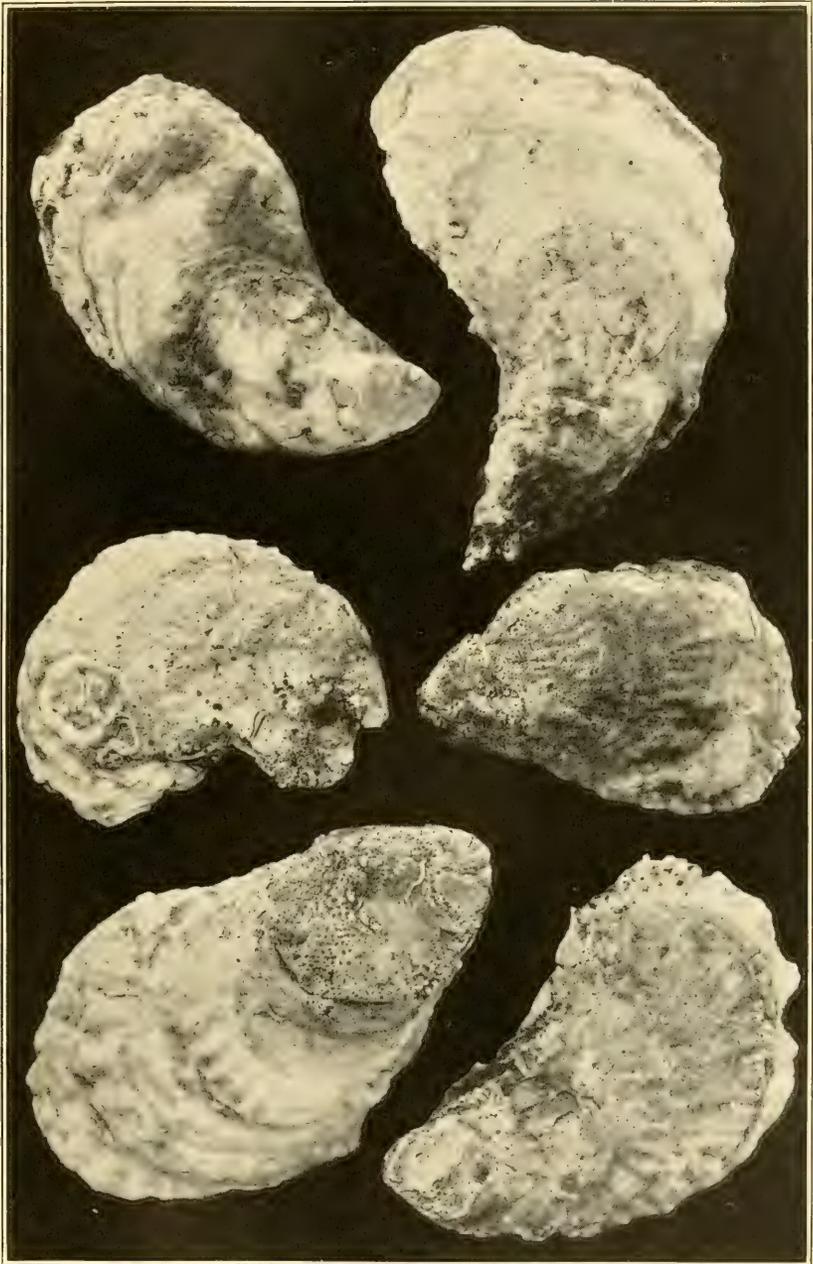
A large number of oysters are thus handled in the shell, since oysters on the half shell have found a place on the menu of the leading hotels and restaurants. For this purpose oysters from certain beds have come to be esteemed as most desirable. These have acquired trade names by which they are universally known and which are derived from the locality from which the oysters are taken. The best-known examples are the Blue Points from beds near Blue Point, a cape on the south side of Long Island; Cotuits, from Cotuit Harbor, Mass., and Lynnhavens, from Lynnhaven Bay, Va. There is a growing tendency to look upon these terms merely as trade names and to employ them to designate any oyster answering the requirements of size and shape of these oysters, regardless of the waters from which they were taken.

Blue Points (Pl. I) are small oysters, about 3 to 4 inches long by 2 to 2½ inches in width. They are rather rounded in form and the shells are fairly smooth. The meats are small and of very delicate flavor, making these oysters very acceptable when served raw on the half shell. For this reason Blue Points have acquired a wide reputation. Lynnhavens (Pl. XX) and Cotuits (Pl. XXI) are larger oysters than Blue Points and of more angular shape. Because of their fatness and flavor they have become highly esteemed.

Oysters are shipped in the shell to points on the Pacific coast both for the market and for planting as seed or for fattening. In 1915, over two-thirds of the 156,104 bushels of oysters produced on the Pacific coast were raised from transplanted eastern oysters.<sup>b</sup>

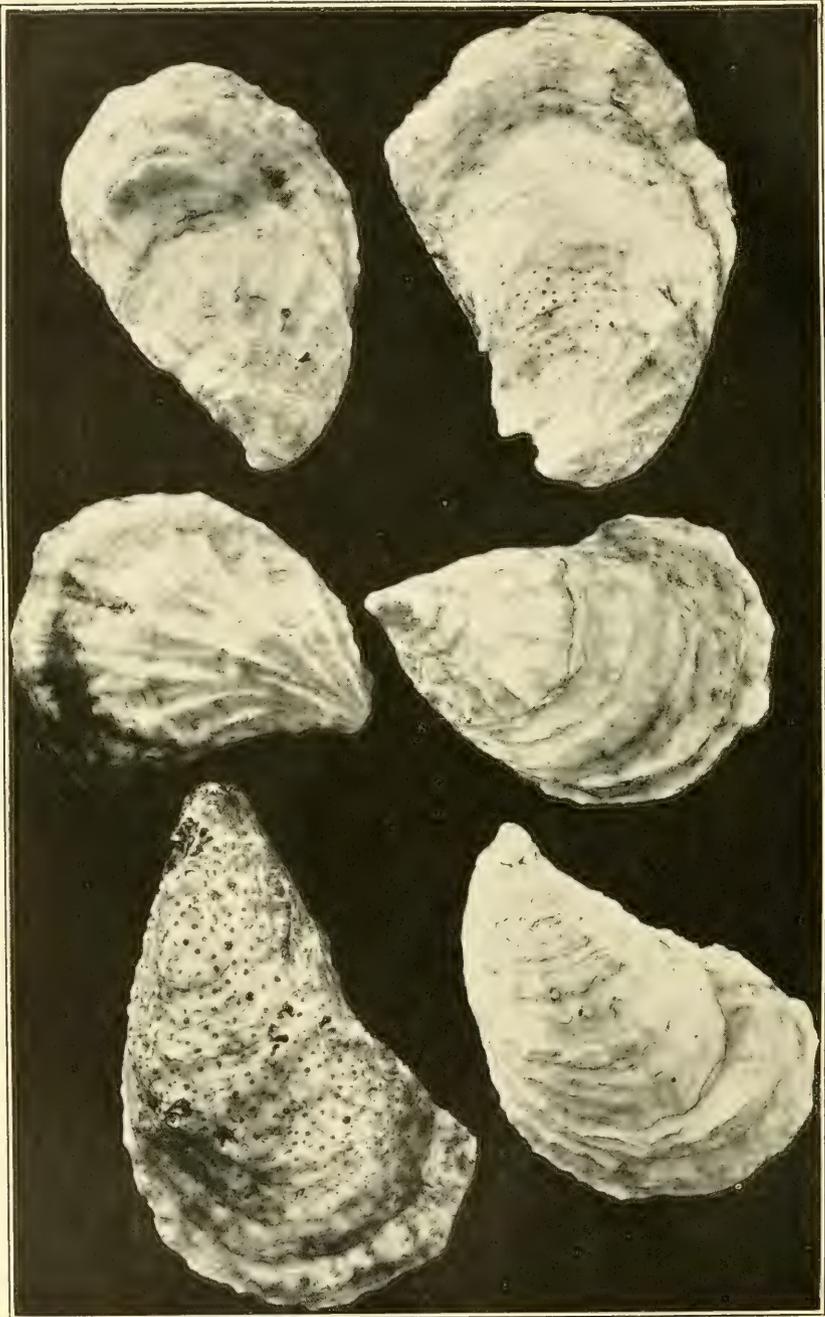
<sup>a</sup> One firm puts out an oyster powder made by extracting in a vacuum the moisture from oyster meats. This powder is sold in small vials packed in pasteboard cartons and is used in making broths and soups. So far as the writer is aware, only one firm puts such a product on the market.

<sup>b</sup> Radcliffe, L. Fishery Industries of the United States. Report of the Division of Statistics and Methods of the Fisheries for 1918. Appendix X, Report, U. S. Commissioner of Fisheries, 1918, 167 pp. Washington, 1919.



"LYNNHAVENS," FROM LYNNHAVEN BAY, VA.

About one-half natural size.



"COTUITS," FROM COTUIT HARBOR, MASS.

About one-half natural size.

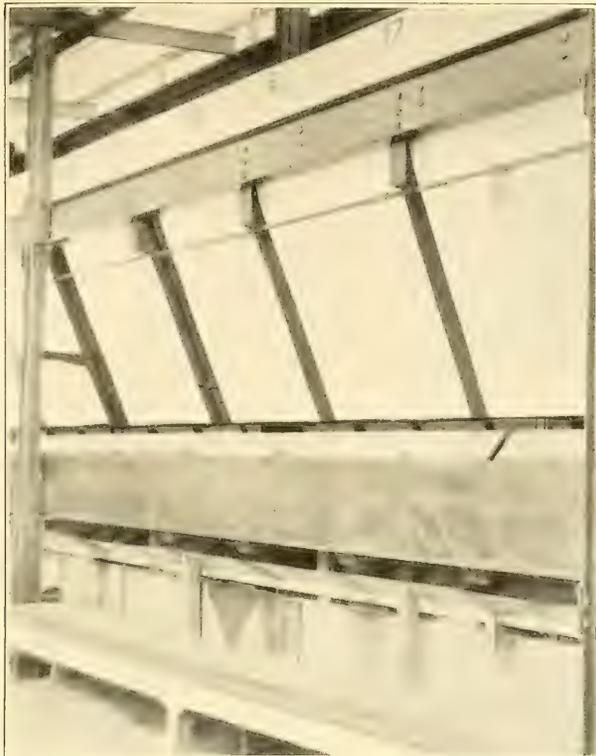


FIG. 1.—SHUCKING TABLE IN LARGE OYSTER HOUSE.

The oysters come down from the storage room above and out the bottom of the V-shaped chute. The worker stands on the bench and places the oyster to be opened on the small block on the edge of the table.



FIG. 2.—WASHING FRESH OYSTER MEATS ON "SKIMMING BOARD."

(Photo from Prof. E. N. Cory, Maryland State University.)

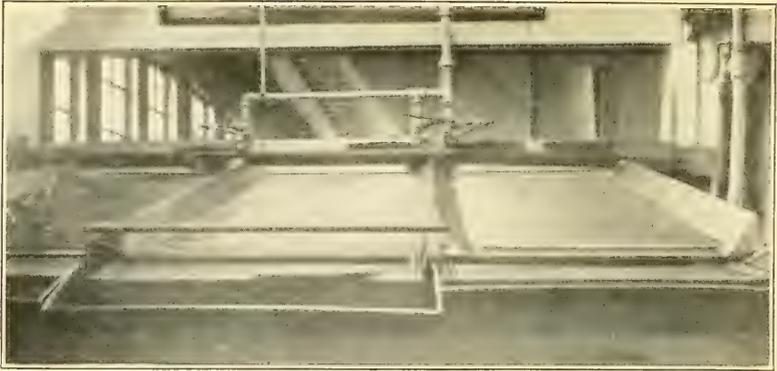


FIG. 1.—"RIFFLE" OYSTER WASHER, ON WHICH FRESH OYSTER MEATS ARE WASHED PREPARATORY TO BEING PACKED ON ICE.



FIG. 2.—SEVERAL STYLES OF CONTAINERS USED IN SHIPPING OYSTERS. Shucked oysters are placed in metal or glass containers, which are packed in the boxes or tubs with cracked ice about them.

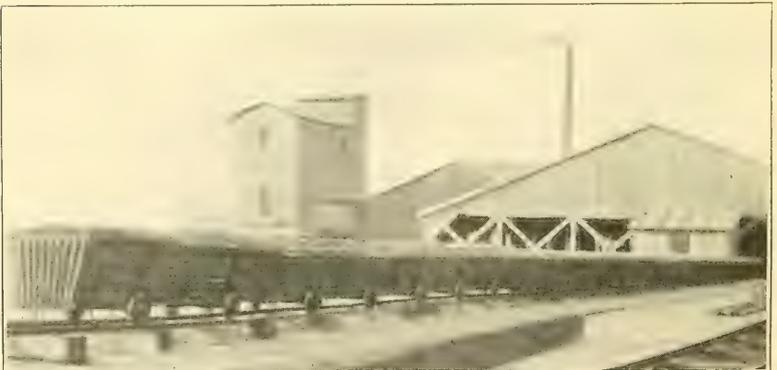


FIG. 3.—FIFTEEN CARS OF OYSTERS READY TO BE RUN INTO THE OYSTER CANNERY.

Each car holds 20 bushels, making 300 bushels in all. The capacity of this cannery is 1,500 bushels per day.

## SHUCKED, ON ICE.

The process of opening an oyster and removing the "meat" is known generally as "shucking." For this purpose the oysters are conveyed to tables or stalls of various sorts in the oyster house. In the smaller establishments this is done by wheelbarrow and shovel; in the larger, the oysters are first taken to a storage room, as described above, and then let down through chutes to the individual stalls of the shuckers. Plate XXII, figure 1, represents a shucking table in one of the large oyster houses. The shucker stands on the bench before the table. The oysters fall down the slanting chute to the narrow table along the edge of which are seen the blocks on which the shucker places the oyster to open it. The shells are thrown through small chutes in the table and fall into the trough seen below, whence they are removed by a mechanical carrier.

The process of shucking requires considerable skill and strength of hand and wrist. Various methods are employed and several slightly differing styles of opening knives. Some shuckers first break off the "bill" or tip of the shell with a small hammer, insert the knife into the opening thus made, and cut the large muscle holding the shell together. Others scorn such aid, since it takes longer, and by steady pressure force the knife between the shells at the tips or the side. A skilled shucker moves his hands so rapidly the eye can hardly follow the movements. A heavy mitten is worn on the left hand, which grasps the oyster, the shell being very sharp on the edges. A fair day's shucking is 10 to 12 gallons.<sup>a</sup> If the oysters are in good condition, "fat," 12 gallons or a little more may be shucked. The average yield of shucked oysters from a bushel in the shell varies greatly with the condition and quality of the oysters. If the oyster meats are full and plump, they are spoken of as "fat" and the yield is greater than when "poor"; that is, the meat thin, watery, often semitransparent. A fair average yield is from 6 to 8 pints per bushel.

The "meats" are thrown into a galvanized-iron measure, which in some cases is perforated to allow the drainage of excess liquor. In some houses, however, the measures are not perforated and are partially filled with water into which the oysters are placed as shucked. When the measure is full it is taken to the measuring window and the oysters measured or weighed. The shucker sometimes receives a ticket, but in many cases the individual scores are marked up on a board by the weighing window and payment made weekly. In the smaller oyster houses the shells are thrown by the shucker to the floor and later removed in wheelbarrows. In many such houses each shucker stands in a sort of movable wooden stall placed before the table. This stall is 18 or 20 inches wide and about waist-high, being open at the rear so that the shucker may step in and out readily. Such stalls keep the accumulating piles of shells from encroaching on the space where the worker stands and also afford something against which he may lean while working. In some of the larger houses, where the shells are not thrown on the floor, the stalls are used merely to satisfy the shuckers who have

<sup>a</sup> Many, however, shuck more than this amount. The author knows of one man in particular, at Hampton, Va., who opened 26 gallons a day. Since his score was marked up and pay given for this amount, this record is authentic.

become accustomed to their use in smaller places and find it less tiring to work while standing in such a stall.

Shuckers are paid by the gallon; during the winter of 1919-20 the price was \$0.35 to \$0.40 per gallon. Some large firms in New England employ Portuguese for shucking; in places farther south many Negroes are used for this work. Both men and women are often employed; especially is this true where colored labor is used.

After being shucked the oysters are spread out on washing tables. These are usually comparatively simple in form, as seen in Plate XXII, figure 2, are made of galvanized iron, and measure about 5 feet long by 2½ wide, the bottom being perforated to allow the water to drain off and supported on a wooden framework, as shown in the figure. Some of the larger firms use more or less elaborate washing tables, some being of the "rifle" style (Pl. XXIII, fig. 1). This consists essentially of a sloping zinc platform with ridges or elevations across it which retard the oysters as they are washed down it. The oysters receive several washings, usually in fresh water from the tap. In some States, however, the law requires that the washing be done with salt water of a certain strength in order that the oysters may not be bloated by the absorption of fresh water. In the larger houses, after receiving a preliminary washing on tables similar to that in Plate XXIII, figure 1, they are carried by a gentle stream of water down narrow runways to tanks on a lower floor (Pl. XXIV, fig. 1). These are made of galvanized iron and are about 5 feet square by 15 inches deep. Here they receive two washings, in some cases compressed air being blown from pipes through the water in which the oysters are standing. This is thought by those using it to remove more thoroughly the fine particles of dirt or bits of shell. The excess water is allowed to drain off in the last tank, and the oysters are then packed in various sorts of containers, as the tin cans in the figure, which are then packed in ice.

Usually the oysters are divided, according to size, into three grades: Standards, the smallest; Selects, the next; and Counts, or Extra Selects, the largest. The usual containers are tin cans, as shown in Plate XXIII, figure 2, of a capacity of 1, 3, or 5 gallons. The oysters are packed into these without any other liquor than that remaining after the excess has been drained off, as stated above. The cover is put on, often secured by a string passed over the top and attached to lugs on each side. The cans are packed in ice singly in boxes (Pl. XXIV, fig. 2), or several together in a barrel. Sometimes metal containers, shown at right in Plate XXIII, figure 2, are used. These are packed in a bucket carrier with ice about them. The figure also shows the 5-gallon size tin can, the bucket carrier, the short boxes containing tin cans, and a bottle container with paste-board cap, holding one-tenth gallon. Thirty bottles are packed in a flat, wide box (see figure), with ice over their tops, and a wooden cover is nailed on.

#### CANNING OYSTERS.

Oysters were first canned at Baltimore in 1820, and the expression "cove oyster," which now seems synonymous with canned oysters, was originally given to the small oysters found in the coves on the west bank of Chesapeake Bay between Baltimore and the mouth of the Potomac.<sup>a</sup> The industry has spread rapidly in the last 20 years.

<sup>a</sup> Smith, H. M. Oysters: The World's Most Valuable Water Crop. National Geographic Magazine, March, 1913, p. 258. Washington.

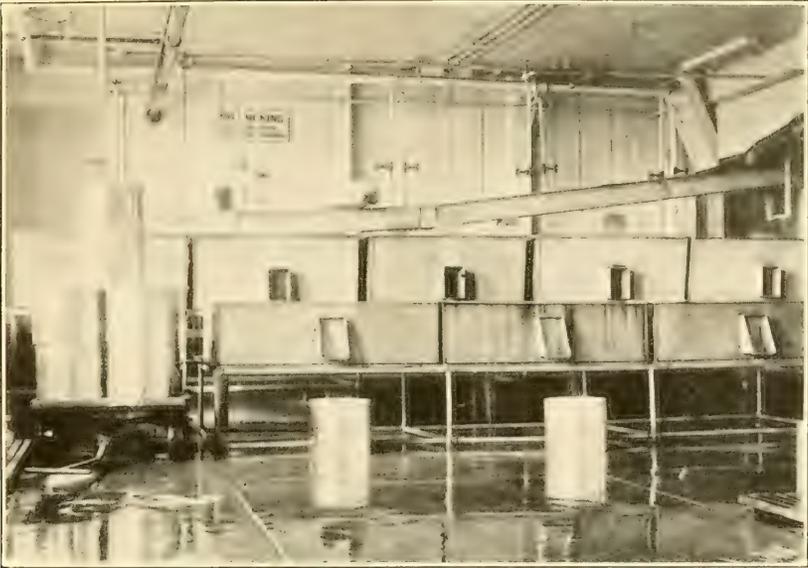


FIG. 1.—TANKS FOR WASHING SHUCKED OYSTERS.

The oyster meats come down the metal trough from the floor above. After washing they are placed in the tin cans.



FIG. 2.—PACKING FRESH OYSTER MEATS IN ICE FOR SHIPMENT.

(Photo from Prof. E. N. Cory, Maryland State University.)

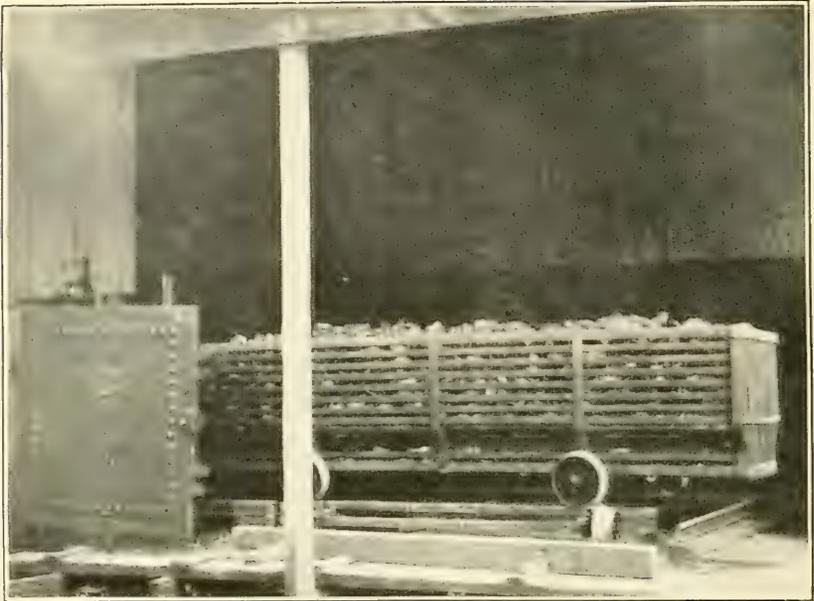


FIG. 1.—CAR OF OYSTERS READY TO BE RUN INTO STEAMER.



FIG. 2.—INTERIOR OF OYSTER CANNERY; OPENING STEAMED OYSTERS.

(Photo from Prof. E. N. Cory, Maryland State University.)

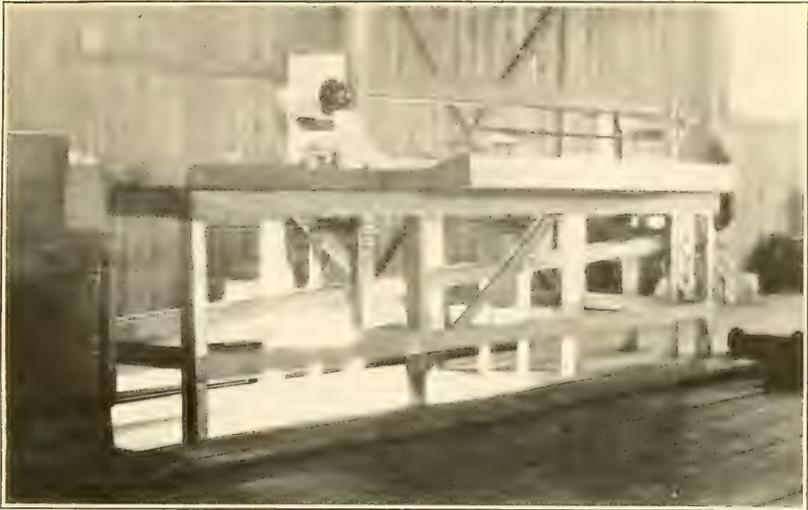


FIG. 1.—INTERIOR OF OYSTER CANNERY, SHOWING TABLE ON WHICH THE OYSTERS ARE PUT INTO THE CANS.

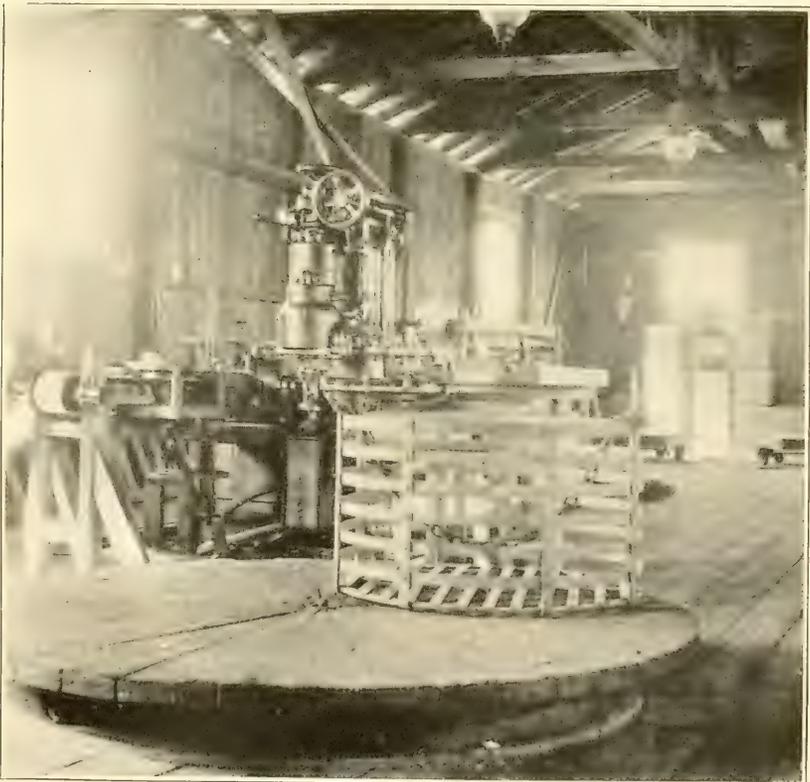


FIG. 2.—INTERIOR OF OYSTER CANNERY, SHOWING PACKING TABLE, CAPPING MACHINE, AND BASKET IN WHICH THE FILLED CANS ARE "PROCESSED."

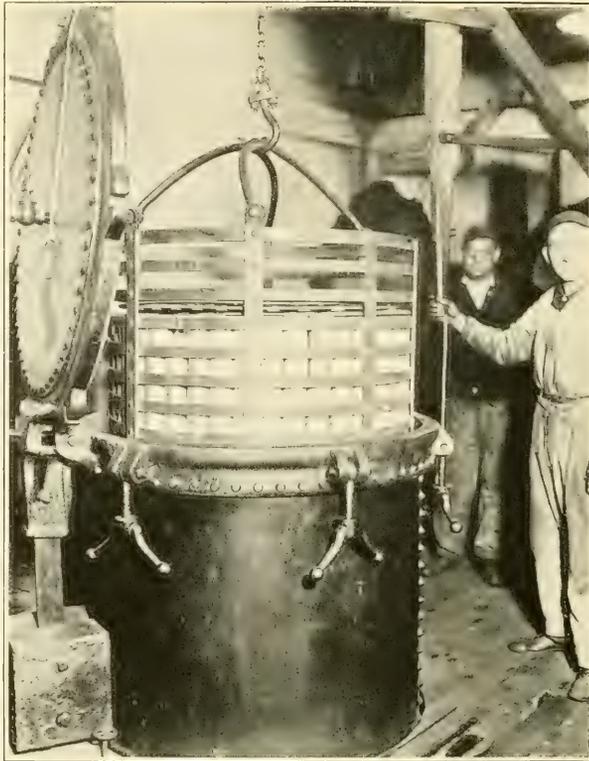


FIG. 1.—LOWERING A BASKET OF CANNED OYSTERS INTO THE KETTLE OR STEAMER TO BE "PROCESSED."  
(Photo from Prof. E. N. Cory, Maryland State University.)

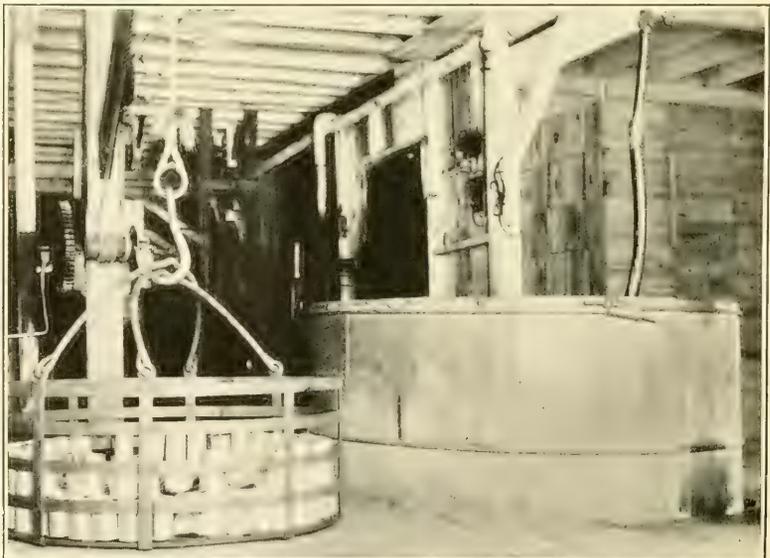


FIG. 2.—BASKET OF CANNED OYSTERS, AFTER HAVING BEEN "PROCESSED," READY TO BE LOWERED INTO THE "COOLER," AT RIGHT, WHERE RUNNING WATER IS PASSED ABOUT THE CANS.

There are now 15 canneries in Baltimore, which city still leads in number of canneries; 16 in Mississippi, 12 being at Biloxi; 18 in Georgia, 4 at Savannah, 4 in and about Brunswick, and others at smaller points; about 12 in South Carolina; 7 in North Carolina; 6 or 7 in Louisiana; and 4 or 5 in Florida.

Oyster canneries, like raw houses, are located on the water front with a wharf at which the oysters are unloaded from the boats. Plate XIV, figure 1, shows a view of an oyster cannery. At most canneries the oysters are unloaded from the boat in large tubs or buckets, as previously described, and dumped directly into cars 10 or 12 feet long, made of iron strips, basket-fashion, as in Plates XXIII and XXV. The cars are then pushed on a track into the building. Plate XXIII, figure 3, shows a line of 15 loaded cars, 20 bushels in each car, 300 bushels in all. The capacity of this particular cannery is 1,500 bushels per day.

The cars of oysters are run into rectangular iron steamers, which are often long enough to accommodate 3 cars at once. Steam is passed through for from 3 to 10 minutes, depending on the thickness of the shells. The cars are then pushed on out the other end of the steamer, sometimes being afterwards switched to another track or another room by the aid of the device shown in Plate XXV, figure 1. The short piece of track upon which the car rests is also provided with wheels, and the whole is rolled onto a lower track running at right angles to the first.

The steamed oysters are then opened directly from the cars by shuckers or openers standing alongside (Pl. XXV, fig. 2). Each worker has a metal bucket, which is suspended by a hook to the side of the car. The buckets are perforated to allow the escape of excess liquor. A knife is used, but no such skill or strength is required as is necessary in the case of raw oysters, since the steamed oysters have been killed by the process and the shells are gaping and easily separated. When a worker's bucket is filled, it is taken to the weighing window, payment being by weight, where either the money or a ticket is received. Both men and women, and often children over the legal age, do this work. In Alabama and Mississippi the workers are largely of the Slavic races. In those States many of the canning firms furnish quarters for their labor, often wood and water being included.

After being weighed, the oysters are washed two or three times with tap water in vats or on tables and then carried in buckets to the packing table (Pl. XXVI, fig. 1). The general construction of such a table is shown in the figure; it is made of wood, of convenient height, and about 12 feet long by 6 wide in the wider part and 3 in the narrower. The packing is usually done by women or girls, who stand along the sides of the table. The empty cans are supplied the packers from boxes behind them, or often a supply is placed along the edge of the table on which the oysters are piled. The packers at the farther end (see figure) of the table fill the cans almost full, placing the oysters in with the hands. They then put the cans in the rack or trough extending along over the table. The bottom of this is an endless belt which moves the cans forward until they are stopped by the crossbar at the nearer end of the trough. One packer stands on each side of the table, which is narrower here, takes the partially filled cans from the trough, one at a time, places them on the balances

seen in the figure, and fills them up until the correct weight is reached. So far in the process there is practically no liquor in the can. Cans varying in capacity from 3 to 10 ounces are usually packed. The cans are then placed on another belt, which carries them along the trough to the left under a length of perforated pipe from which hot brine drops into the cans.

The belt then takes them to the capping machine (Pl. XXVI, fig. 2), where the cover is put on. This is commonly done by the crimping process, although some firms still use the method of sealing the cover on with solder. The machine shown in the figure crimps the covers on 58 cans per minute.

After leaving the capping machine the cans are placed in large circular iron baskets, about 4 feet across, and lowered into a cylindrical metal processing tank (Pl. XXVII, fig. 1). In these tanks the cans are heated by steam to a high temperature for a short time, after which they are removed and lowered into a circular wooden tank or cooler (Pl. XXVII, fig. 2), and cooled with running water. The baskets of cans are then wheeled on tracks to the labeling and packing room (Pl. XXVIII, fig. 1), where the labels are pasted on by girls or women. The finished product is then packed in boxes, this work being done by men (Pl. XXVIII, fig. 1).

#### DISPOSITION OF OYSTER SHELLS.

In the larger oyster houses the shells are usually dropped by the shucker through a chute leading from the table down to a wide endless belt or a trough through which passes an endless scrape carrier. These devices carry the shells outside and up an elevator (Pl. XXIX, fig. 1) or an inclined plane (Pl. XXVIII, fig. 2). The carrier continues over the shell heap, sometimes being inclosed, and drops the shells at certain points, which may be varied as the pile grows (Pl. XXVIII, fig. 2). In other oyster houses, especially the smaller ones, the shells are removed in wheelbarrows, which are rolled on planks up the side or across the top of the pile (Pl. XXIX, fig. 2).

The shells are used for culch, as previously described; for making lime, which is placed on soil as a fertilizer; for poultry grit; for making shell roads; and for ballast for railroad track beds. In Plate XXIX, figure 1, is shown a kiln in which the shells are being burned to make lime, a pile of the burned shells appearing in the foreground. The interior of the kiln is cone-shaped at the bottom. The shells are deposited in the kiln by the elevator, a certain amount of fine coal being mixed in as fuel. The fire in the lower part of the kiln is kept burning constantly, and the burned shells are shaken out through the grate at the bottom. The shells are then allowed to air-slake, and the lime is sold for fertilizer. The burned shells bring about \$8 per ton. About a ton is put on an acre. A ton of burned shells increases in bulk to about a ton and a half during the slaking process. A ton of the slaked lime sells for \$6.50.

Crushed shells are used for poultry grit. The shells are first dried in a direct-heat rotary drier similar to that used in factories where fertilizer is made from menhaden. The degree of heat applied depends entirely on the percentage of moisture in the shells; the greater the moisture the higher the temperature required. It is essential that a close observance be kept during the drying process, in order to regulate the temperature, as shells may be damaged by too much



FIG. 1.—INTERIOR OF OYSTER CANNERY; LABELING AND BOXING CANS OF OYSTERS.

(Photo from Prof. E. N. Cory, Maryland State University.)

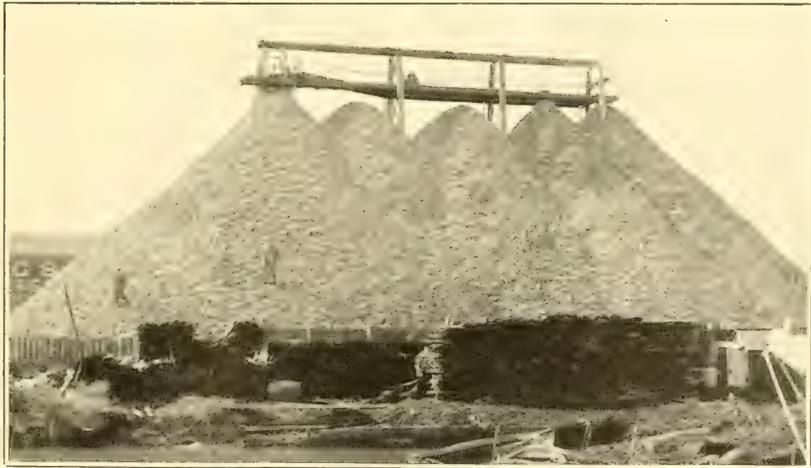


FIG. 2.—SHELL PILE OF A LARGE OYSTER COMPANY, SHOWING CONVEYER FOR CARRYING SHELLS FROM SHUCKING TABLE TO THE PILE.

(Photo from J. S. Darling and Son.)



FIG. 1.—KILN FOR BURNING OYSTER SHELLS TO MAKE LIME, SHOWING SHELL HEAP IN BACKGROUND AND PILE OF LIME IN FOREGROUND.

(Photo from Prof. E. N. Cory, Maryland State University.)



FIG. 2.—LOADING OYSTER SHELLS INTO CAR FOR USE IN BUILDING ROADS.

heat. If the temperature is too high, the shells are likely to turn yellow, and if they are not sufficiently dried they may become soft. If they have been sheltered from the weather and are thoroughly dry the drying process may be dispensed with. After passing through the drier they are carried by a conveyer to the crusher and from there to the screen, which is usually of the revolving type and made of various-sized mesh to separate the crushed shells into several grades or sizes.

In Plate XXIX, figure 2, shells are being loaded on cars for road making. In some cases the shells are partially crushed before being put on the roads; in other cases they are put on whole and are worn down by the traffic. Plate V, figure 1, shows shells being loaded on a scow for planting to catch set.

The shell heaps are cleaned up annually. Most of the shells are used for one of the above purposes. The shell piles shown in the figures convey but a faint notion of the actual vast bulk of the oyster crop taken annually from the waters of the United States.

#### LEGAL REGULATIONS.

In each State in which there is an oyster industry there are certain regulations for its conduct, provided by State law and administered by officers and inspectors, appointed in nearly all cases by a State fish or oyster commissioner or president of a State conservation commission.

The regulations, while necessarily differing widely to meet the varying conditions, usually provide for a system of surveying and staking off with conspicuous buoys or markers the various beds leased or owned by the planters and the "natural" beds, the latter being those which have grown up naturally and which are open to the public. In some States, where there are many leased or privately owned beds, this surveying is very carefully attended to, and accurate maps of the oyster beds are provided. In others, especially those in which there are few or no leased beds, the surveys are poorly cared for, and no maps are kept.

The legal season in which oysters may be taken for market is usually restricted to the months of September to April, inclusive. The oyster is thus not interfered with during the spawning season, which occurs in the summer.

A cull law is usually provided by which oysters under a certain size— $2\frac{1}{2}$  or 3 inches generally—may not be taken except for seed, but must be thrown back on the beds from which lifted. Some States allow only sailboats and hand dredges to work on natural beds, as in Long Island Sound; some forbid dredging of any sort, all oysters being taken with tongs; some allow dredging only on leased beds; some, only in water of a certain depth; and some allow engine-driven dredges to be used on boats propelled by sails.

In most States only a legal resident may take oysters from the waters, and a license fee must usually be paid. In some cases oysters can not be shipped from the State in the shell, except for seed. This compels the establishment of oyster houses within the State and the retention of capital in that State. In others, as Louisiana, the oysters may be shipped out in the shell, but a tax per bushel must be

paid to the State by the shipper. Some States require no license fee, but the dealer pays a tax per bushel or gallon for oysters sold. This nominally throws the tax on the dealer instead of the oysterman.

Most States make provision for leasing bottoms for the cultivation of oysters at a small rental, \$0.25 to \$1 or \$2 per acre, for a term of years, the number of acres per person being limited. Provision is usually made that the natural beds may not be leased, but must be left open to the public. In some of the southern States there is very little interest in leasing beds, there being sufficient oysters found on the natural beds. In such States there is little or no planting done, except a limited amount by the State in the effort to build up certain natural beds.

The health authorities of most of the States provide certain regulations requiring that oyster beds be located at safe distances from sources of contamination, such as sewers, etc., and that oysters must pass certain rigid inspection tests for bacterial content before being placed on the market. The Federal Government also inspects oysters which enter into interstate commerce.

There are many other minor regulations peculiar to the different States and growing out of special conditions prevailing in each. The details of these may be secured from the State shellfish commissions of the various States.

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For the benefit of those desiring more detailed information relating to the American oyster of the eastern coast than could be given in a publication of this sort, there is appended the following brief list of literature. This includes only some of the more important researches on this subject, together with certain recent papers which show the present trend of oyster investigations.

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# ALASKA FISHERIES AND FUR INDUSTRIES IN 1919

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By **WARD T. BOWER**  
*Agent, Alaska Service*

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Appendix IX to the Report of the U. S. Commissioner of Fisheries for 1919



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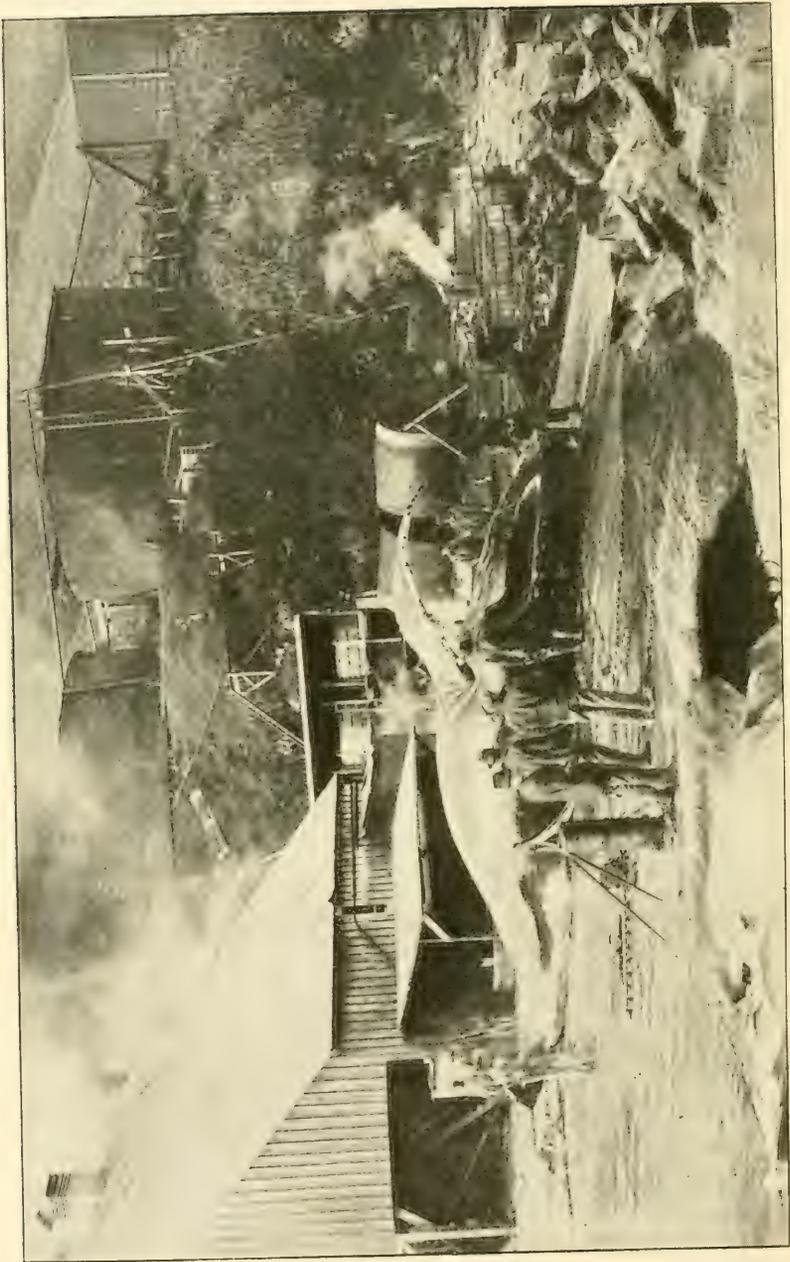
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SHORE WHALING STATION, AKUTAN, ALASKA.

# ALASKA FISHERIES AND FUR INDUSTRIES IN 1919.

By WARD T. BOWER, *Agent, Alaska Service.*

## INTRODUCTION.

The activities of the Bureau in Alaska, administered through the Alaska service, paralleled in large degree operations of previous years. There were some notable expansions, however, along certain lines of the work. In this connection mention may be made of the additional attention given to patrol of the fishing grounds for the purpose of enforcing the laws and regulations. Through the detail of certain vessels, the Navy Department cooperated and aided materially in this phase of the work. The number of stream watchmen to enforce the fishery laws at certain important centers was augmented. The success attending this line of work in 1918 warranted its expansion and further application in 1919.

Another phase of the work was the collection and compilation in systematic form of detailed statistics of the various fisheries of Alaska. The annual census of salmon ascending Wood River for spawning was taken. A special investigation of the salmon fishery in central and western Alaska and one of various problems in connection with the Copper River fishery were made. Following hearings held by the Bureau at Seattle in November, 1919, salmon-fishing operations were made subject to an order issued by the Secretary of Commerce under date of December 23, 1919, applicable to most of the salmon streams in Alaska.

The work of indicating by means of markers the areas within which commercial fishing operations are limited or prohibited received considerable attention in 1919. A few markers had been put in place in previous years, but recent departmental orders have increased greatly the number of localities in which fishing operations are limited or prohibited; this means that much additional work in marking stream mouths must be undertaken as soon as possible.

Inspections of the private hatcheries operated in accordance with the act of June 26, 1906, were made. Hatchery operations under the division of fish culture were carried on at the two principal stations of the Bureau located at Afognak and McDonald Lake, the latter formerly having been designated as the Yes Bay station.

The scope and magnitude of the work in connection with the fur-seal fisheries was in keeping with that of 1918 when regular commercial sealing operations on a considerable scale were resumed. The take of fur-seal skins at the Pribilof Islands in 1919 aggregated 27,821 pelts, having an estimated value of about \$2,000,000. A census of the fur-seal herd was made and a special investigation was conducted with a view to developing, if possible, improved

methods of taking and curing sealskins. The by-products plant erected on St. Paul Island in 1918 for the reduction of seal carcasses into fertilizer and oil was operated rather experimentally in 1919; it will be operated along more extensive lines in 1920.

While the natives of the Pribilofs make return to the Government in services for supplies of food, clothing, fuel, and shelter furnished them, it is necessary that the purchasing, transportation, and distribution of the major part of such supplies be attended to by the Bureau. In the matter of transportation in 1919, the Bureau received great assistance from the Navy Department, also from the Coast Guard. Acknowledgment is hereby made of the courtesies thus afforded.

The enforcement of the law for the protection of fur-bearing animals throughout Alaska received attention. In addition, the collection and compilation of statistics in regard to shipments of furs from Alaska by individuals and companies and the leasing of certain islands in Alaska for fur-farming purposes received appropriate attention.

Two sales at public auction of sealskins and one of fox pelts, taken on the Pribilof Islands, were held at St. Louis in 1919 by the selling agents of the Bureau.

The author of this report is greatly indebted to Assistant Agent E. M. Ball for compilation of statistics of the fisheries and preparation of accompanying text. Acknowledgment is also made to H. D. Aller for assistance in the preparation of text for the section regarding the Pribilof Islands, and to H. J. Christoffers for work on statistics regarding the seal herd.

#### REGULAR EMPLOYEES, ALASKA SERVICE.

During the year 1919 the following regular employees have been identified with the Alaska service of the Bureau:

##### REGULAR EMPLOYEES IDENTIFIED WITH THE ALASKA SERVICE IN 1919.

Name.	Position.	Headquarters or chief place of duty.
Ward T. Bower.....	Chief agent.....	Washington, D. C.
Edward M. Ball.....	Assistant agent.....	Cordova.
Harry J. Christoffers.....	.....do.....	Seattle.
Ernest P. Walker.....	Inspector.....	Juneau. (Resigned Dec. 15, 1919.)
Calvin F. Townsend.....	.....do.....	Fairbanks. (Promoted Dec. 20, 1919, from assistant agent.)
Shirley A. Baker.....	Assistant agent.....	Dillingham. (Reinstated Feb. 20, 1919, after military duty. Promoted Dec. 20, 1919, from warden.)
Harry C. Fassett.....	Agent and caretaker.....	St. Paul Island. (Resigned Aug. 15, 1919.)
A. H. Proctor.....	.....do.....	St. Paul and St. George Islands.
Charles E. Crompton.....	.....do.....	St. George Island. (Promoted Aug. 16, from school-teacher, St. George Island.)
Henry D. Aller.....	Storekeeper.....	St. George and St. Paul Islands.
G. Dallas Hanna.....	.....do.....	St. Paul Island.
Henry H. Stromberger.....	Physician.....	St. Paul Island. (Resigned July 5, 1919.)
Charles E. Johnson.....	.....do.....	St. George Island. (Resigned July 15, 1919.)
Frank H. Gunn.....	.....do.....	St. Paul Island. (Appointed July 6, 1919. Services discontinued Nov. 1, 1919.)
John J. Richstein.....	.....do.....	St. Paul Island. (Appointed Nov. 6, 1919.)
William M. Murphy.....	.....do.....	St. George Island. (Appointed July 27, 1919.)
Herschel Silverstone.....	Assistant to agent.....	St. Paul Island. (Appointed Aug. 12, 1919.)
George Haley.....	School-teacher.....	St. Paul Island.
Cora Giles Haley.....	.....do.....	St. Paul Island. (Resigned Sept. 30, 1919.)
Lois L. Proctor.....	.....do.....	St. Paul Island. (Appointed Oct. 1, 1919.)

## REGULAR EMPLOYEES IDENTIFIED WITH THE ALASKA SERVICE IN 1919—Continued.

Name.	Position.	Headquarters or chief place of duty.
Edward C. Johnston.....	School-teacher.....	St. George Island. (Appointed Aug. 16, 1919.)
Henry C. Scudder.....	Warden.....	Juneau. (Reinstated Jan. 1, 1919, after military duty.)
Fred H. Gray.....	.....do.....	Wrangell.
Christian L. Larson.....	.....do.....	Chicken. (Resigned June 30, 1919.)
Lemuel G. Wingard.....	.....do.....	Naknek.
Philip R. Hough.....	.....do.....	Juneau. (Appointed Apr. 15, 1919.)
Michael J. O'Connor.....	.....do.....	Haines.
Hans Bied.....	Master steamer Roosevelt.....	Seattle. (Resigned June 18, 1919.)
Edwin Hofstad.....	Master steamer Osprey.....	Cordova.
Jesse L. Nevill.....	Master patrol vessel.....	Auklet.
George Naud.....	.....do.....	Murre.
Albert K. Brown.....	Clerk.....	Washington, D. C.
Mary S. Haines.....	.....do.....	Do.
William P. Rasin.....	.....do.....	Do.
Marguerite McBride.....	.....do.....	Do.
E. Elaine Bell.....	.....do.....	Seattle.
Gladys M. Gamlen.....	.....do.....	Do.

## REGULAR EMPLOYEES AT GOVERNMENT HATCHERIES IN ALASKA IN 1919.

Location and name.	Position.
<b>Afognak:</b>	
Edwin Wentworth.....	Superintendent.
Harry J. Heuver.....	Foreman.
Russell Noyes.....	Fish-culturist.
Fred R. Lucas.....	Do.
Albert L. Carlton.....	Apprentice fish-culturist. (Transferred Nov. 15, 1919, to McDonald Lake station.)
Alfred Nelson.....	Apprentice fish-culturist.
William M. McFarland.....	Apprentice fish-culturist. (Promoted Jan. 27, 1919, from apprentice fish-culturist, Clackamas, Oreg. Transferred July 15, 1919, to Puget Sound stations.)
Thomas H. Morton.....	Apprentice fish-culturist. (Transferred Sept. 15, 1919, from McDonald Lake station.)
F. J. Stewart.....	Cook.
<b>McDonald Lake:</b>	
C. H. Van Atta.....	Superintendent.
Calvin D. Ryan.....	Foreman.
C. N. Blystad.....	Fish-culturist. (Promoted Feb. 28, 1919, to scientific assistant, Homer, Minn.)
William L. Stiles, jr.....	Fish-culturist. (Promoted May 16, 1919, from apprentice fish-culturist, Baird, Calif.)
J. H. Tierney.....	Fish-culturist. (Resigned Oct. 20, 1919.)
Albert L. Carlton.....	Fish-culturist. (Promoted Nov. 16, 1919, from apprentice fish-culturist, Afognak, Alaska.)
William A. Cagle.....	Apprentice fish-culturist. (Transferred May 15, 1919, to apprentice fish-culturist, Clackamas, Oreg.)
Clarence Houts.....	Apprentice fish-culturist. (Appointed Aug. 1, 1919.)
William O. C. Owen.....	Apprentice fish-culturist. (Transferred Mar. 15, 1919, from fish-culturist, Leadville, Colo. Resigned Apr. 30, 1919.)
Thomas H. Morton.....	Apprentice fish-culturist. (Reinstated June 20, 1919. Transferred Sept. 14, 1919, to apprentice fish-culturist, Afognak, Alaska.)
Everett V. Campbell.....	Apprentice fish-culturist. (Appointed Sept. 27, 1919.)
Hugh Coppinger.....	Apprentice fish-culturist. (Appointed Jan. 27, 1919. Resigned Sept. 30, 1919.)
M. T. Tierney.....	Cook. (Resigned Oct. 6, 1919.)
Stella A. Campbell.....	Cook. (Appointed Oct. 7, 1919.)

## FISHERY INDUSTRIES.

As in corresponding reports for previous years, the Territory of Alaska is here considered in the three coastal geographic sections generally recognized as follows: Southeast Alaska, embracing all that narrow strip of mainland and the numerous adjacent islands from Portland Canal northwestward to and including Yakutat Bay; central Alaska, the region on the Pacific from Yakutat Bay westward, including Prince William Sound, Cook Inlet, and the southern coast of the Alaska Peninsula, to Unimak Pass; and western Alaska, the north shore of the Alaska Peninsula, including the Aleutian Islands and Bristol Bay and the Kuskokwim and Yukon Rivers.

Detailed reports and statistical tables dealing with the various fishery industries are presented herewith, and there are also given the important features of certain subjects which were the objects of special investigation or inquiry.

### WATERS CLOSED TO COMMERCIAL FISHING.

Section 6 of the act approved June 26, 1906, for the protection and regulation of the fisheries of Alaska, is as follows:

SEC. 6. That the Secretary of Commerce may, in his discretion, set aside any streams or lakes as preserves for spawning grounds, in which fishing may be limited or entirely prohibited; and when, in his judgment, the results of fishing operations in any stream, or off the mouth thereof, indicate that the number of salmon taken is larger than the natural production of salmon in such stream, he is authorized to establish close seasons or to limit or prohibit fishing entirely for one year or more within such stream or within five hundred yards of the mouth thereof, so as to permit salmon to increase: *Provided, however,* That such power shall be exercised only after all persons interested shall be given a hearing, of which due notice must be given by publication: and where the interested parties are known to the Department they shall be personally notified by a notice mailed not less than thirty days previous to such hearing. No order made under this section shall be effective before the next calendar year after same is made: *And provided further,* That such limitations and prohibitions shall not apply to those engaged in catching salmon who keep such streams fully stocked with salmon by artificial propagation.

Pursuant to the provisions of this section, action was taken in 1919 in regard to the waters of southeast and central Alaska, and also in regard to certain waters tributary to Bering Sea.

Under date of September 24, 1919, announcement was made of a hearing to be held in respect to the district extending from Cape Spencer on the east to Cape Sarichef on the west, and northward on Bering Sea to Cape Newenham. The text of the announcement was as follows:

It having been recommended that the Secretary of Commerce set aside all lakes and streams as preserves for spawning grounds and limit or prohibit commercial fishing for salmon and other commercial fishing in the prosecution of which salmon are taken or injured in all such streams and lakes and all waters tributary thereto and within 500 yards of the mouths of such streams, in all waters of Alaska flowing into the Pacific Ocean between the longitude of Cape Spencer on the east and the longitude of Cape Sarichef on the west; also in all such waters tributary to Bering Sea between Cape Sarichef and Cape Newenham, notice is hereby given, under the provisions of section 6 of the act of Congress approved June 26, 1906, entitled "An act

for the protection and regulation of the fisheries of Alaska," that a hearing to determine the advisability of limiting or prohibiting fishing operations in the above-described waters will be held at the office of the Bureau of Fisheries, 1217 L. C. Smith Building, Seattle, Wash., on November 20, 1919, at 10 o'clock a. m., at which time and place all persons interested will be heard.

Under date of October 24, 1919, announcement was made of a hearing to consider the desirability of amending the order of December 21, 1918, affecting waters of southeast Alaska east of the longitude of Cape Spencer. The text of the announcement is as follows:

It having been recommended that the Secretary of Commerce amend the order of December 21, 1918, effective January 1, 1919, limiting and prohibiting fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in certain waters of southeastern Alaska east of the longitude of Cape Spencer, to include all streams more than 500 feet in width, notice is hereby given, under the provisions of section 6 of the act of Congress approved June 26, 1906, entitled "An act for the protection and regulation of the fisheries of Alaska," that a hearing to determine the advisability of further limiting fishery operations, or of modifying existing limitations on such operations, in the waters in question will be held at the office of the Bureau of Fisheries, 1217 L. C. Smith Building, Seattle, Wash., on November 25, 1919, at 10 o'clock a. m., at which time and place all persons interested will be heard.

Following the two hearings on November 20 and 25, 1919, the Department, under date of December 23, 1919, promulgated the following order:

Hearings having been given at Seattle, Wash., November 20, 1919, and November 25, 1919, respectively, after due notice in accordance with law, for the purpose of determining the advisability of limiting or prohibiting fishing in certain waters in Alaska, and to amend or modify the order of December 21, 1918, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in all herein-after-described waters of Alaska be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. Waters east of the longitude of Cape Spencer.

(a) All fishing is prohibited in all salmon streams and their tributaries and lakes.

(b) All fishing, except with purse seines and drift gill nets, is prohibited within 500 yards of the mouths of all salmon streams.

(c) All fishing with purse seines and drift gill nets is prohibited within 200 yards of the mouths of all salmon streams, and all fishing with purse seines and drift gill nets as well as with all other apparatus is prohibited within 500 yards of the mouths of Chilkat River, Chilkoot River, Anan Creek, Hetta Creek, Sockeye Creek, and Naha Stream.

2. All fishing is prohibited in all salmon streams, their tributaries and lakes, and within 500 yards of the mouths of such streams, flowing into the Pacific Ocean or Bering Sea between Cape Spencer and Cape Newenham, except as follows:

(a) Fishing is permitted in Bering River below a line extending at right angles across Bering River from a point approximately 800 feet northwesterly from the mouth of Gandil River.

(b) Fishing is permitted in Copper River and its tributaries in accordance with the terms of the order promulgated December 20, 1918, which order is continued in full force.

(c) Fishing is permitted at Karluk beyond the zone 100 yards outside the mouth of Karluk River where it breaks through Karluk Spit into Shelikof Strait.

(d) Fishing is permitted in Ugashik River below a line extending at right angles across the Ugashik 500 yards below the mouth of King Salmon River.

3. The driving of salmon downstream and the causing of salmon to go outside the protected area at the mouth of any salmon stream are expressly prohibited.

4. This order does not apply to persons taking salmon with rod, hand line, or spear for their personal or family use and not for sale or barter.

5. The waters of the Afognak Reservation are covered by Presidential proclamation of December 24, 1892, and the regulations promulgated by authority thereof are not modified or affected by this order, but remain in full force.

6. All previous orders of the Secretary of Commerce imposing limitations or prohibitions upon fishing in the waters covered by this order, except as hereinbefore indicated, are hereby superseded.

7. This order became effective January 1, 1920.

Limitations and prohibitions upon fishing are applicable in the waters of the Yukon and Copper Rivers by virtue of previous orders of the Secretary of Commerce. Limitations have been placed upon fishing by Executive order or proclamation in the following additional waters: Afognak Reservation, Aleutian Islands Reservation, Yes Bay and Stream, and the Annette Island Fishery Reserve.

#### **STREAM IMPROVEMENT.**

In recent years the Bureau has done some work in regard to the removal of obstructions and natural barriers from streams in Alaska to permit breeding salmon to reach previously inaccessible spawning grounds. Not much was done along this line in 1919, as there was a shortage of funds and personnel, and for the further reason that the Alaska Legislature had provided for a Territorial fish commission, one of the functions of which was the removal of natural obstructions from salmon streams. The Bureau has been glad to relinquish this phase of the work to the Territory. It is hoped that efforts may be pushed vigorously, as there is a splendid field which promises big returns in the way of conserving the supply of salmon. Employees of the Bureau have been directed to cooperate with the Territorial fish commission in these operations.

#### **STREAM WATCHMEN.**

Supplemental to the patrol work of the Bureau as carried on by the regular employees stationed in Alaska, temporary employment was given to a few men in the southeast and central districts as stream watchmen. The general plan was to place these men at certain important streams or localities during the salmon season to prevent encroachments upon areas closed to commercial fishing. As far as means permitted this was done in 1919. The greatest merit of the service lies in the prevention of raids on the schools of salmon as they congregate at the mouths of the streams. It will grow in value in proportion to the number of streams which may be thus guarded.

Stream watchmen were employed in southeast and central Alaska as follows: In southeast Alaska, A. Burks Summers, Cyrus B. Johnson, Ernest F. Goodner, C. C. Combs, Edward Fay, Walter Campen, Lester Campen, George W. Mock, and E. J. Hunsacker; in central Alaska, Kenneth C. Cole on Prince William Sound and Cook Inlet, Newt Casperson at Miles Lake and Abercrombie Canyon, Kristof Lahz at Eshamy Bay, W. E. Baumann at Afognak, and John J. Folstad at Karluk. In addition, Joseph A. Bourke, a Territorial officer, detailed through courtesy of Governor Riggs, assisted in the work on the Copper River and Prince William Sound.

The fifteen persons above named, together with the regular employees of the Bureau, constituted a larger force than had been engaged any season previously in fishery protective work in Alaska.

## ALASKA FISHERY INTELLIGENCE SERVICE.

This service, inaugurated in 1917, whereby the prices paid for fish at Seattle and Ketchikan were supplied by telegraph to a number of towns in Alaska, was continued through the year 1919. Expressions of appreciation have been received, and the information is believed to be of value to the fishermen. It is planned to continue the service.

## FISHERY PATROL.

## BUREAU PATROL BOATS.

A successful patrol of the waters of Alaska in the interest of the fisheries is contingent upon the ability of the officers of the law to reach any region at any time. Suitable boats are the means by which such work can be accomplished. To meet the situation, the Bureau maintains and operates a small fleet of vessels in Alaska, admittedly inadequate for the work, but being enlarged as rapidly as possible with funds available. This fleet is supplemented by the charter of privately owned boats for occasional trips and short periods.

Of the Bureau's vessels, the steamer *Osprey* has long been the mainstay of patrol work in southeast Alaska. In June, it was transferred to the central district, where the growing needs of the service demanded the presence of such a boat.

The *Murre* and *Auklet* remained in the southeast district and were regularly employed during the active fishing season from June to October. The *Puffin*, formerly attached to the *Roosevelt* as ship's launch, rendered some service in the vicinity of Juneau and the Taku River. It was sent north from Seattle under its own power early in July, but owing to engine trouble did not reach Ketchikan until almost a month later and then only by shipment on a freight steamer from a Canadian port. After certain alterations are made the *Puffin* can be used to advantage in stream-protective work.

Three small launches were chartered for a few days in central Alaska for patrol work in the Copper River and Cook Inlet sections.

The *Swan* was used on the Yukon River, particularly in patrolling the waters of the delta where Yukon commercial fishing was centered in 1919. Assistant Agent Townsend covered about 4,000 miles with the *Swan*, from Fairbanks to the mouth and return to Nenana, where the vessel was hauled out for the winter.

Under authority of Executive order of May 24, 1919, in regard to the disposition of vessels no longer needed by the Navy Department, three vessels which had been used as scout patrols off the New England coast, were transferred to the Bureau for service in Alaskan waters. Two of these vessels, the *Cobra* (S. P. 626) and the *Calypso* (S. P. 632), were turned over to the Bureau at Quincy, Mass., in July. In October the *Wachusets* (S. P. 548) was also secured at the same place. All of these vessels were towed by the Bureau's steamer *Phalarope* to the Woods Hole station. Subsequently the *Cobra* and *Calypso*, renamed *Petrel* and *Merganser*, respectively, were towed by the *Phalarope* to the Norfolk Navy Yard, where on October 3 they were placed aboard the U. S. S. *Neptune* for transportation to the Pacific coast. The vessels reached the Puget Sound Navy Yard early in

1920. The *Wachusetts*, since named the *Fulmar*, is still at the Woods Hole station.

The *Petrel* was built in 1917, is 53 feet in length, and is equipped with a 350-400-horsepower Dusenbergl motor, which is said to give a maximum speed of 25 miles. Fuel capacity is 600 gallons. The vessel originally cost \$14,000.

The *Merganser*, which was built in 1909, is 43 feet in length, and is equipped with a 20-horsepower Alco engine. Fuel capacity is 100 gallons and speed 9 miles an hour.

The *Fulmar* was built in 1914 and is 101 feet in length and 17 feet in breadth. It is equipped with a 120-horsepower Nisco Diesel engine. The vessel measures 65 tons gross burden.

It is planned to detail the *Petrel* and *Merganser* for duty in southeastern Alaska, and the *Fulmar* for service in the more exposed waters of central Alaska. It will be necessary to make alterations on all of these vessels before they are ready for service. The work will be undertaken as soon as funds are available. It is anticipated that the *Petrel* and *Merganser* will be available for duty before the end of the fishing season of 1920.

MILES CRUISED AND COST OF OPERATION OF CERTAIN FISHERY PATROL BOATS OF THE BUREAU.

Name.	Miles cruised.	Cost of fuel.	Cost of repairs, etc.	Subsistence of crew.	Total cost.
Auklet <sup>a</sup> .....	6,444	\$812.10	\$1,404.41	\$344.50	\$2,561.01
Murre <sup>a</sup> .....	5,436	782.65	1,261.75	336.60	2,381.00
Osprey <sup>b</sup> .....	4,303	2,188.60	1,354.03	1,027.20	4,569.83
Total.....	16,183	3,783.35	4,020.19	1,708.30	9,511.84

<sup>a</sup> In commission about 6 months.

<sup>b</sup> In commission about 10 months.

NAVAL VESSELS.

In 1918 the National Council of Defense through its representatives in Juneau requested the Secretary of the Navy to send vessels to Alaska to assist in enforcing the fishery laws of the Territory. In the same year, after an extended cruise in Alaskan waters, Lieut. Commander Driggs, United States Navy, commanding officer of the U. S. S. *Brutus*, in a report to the Secretary of the Navy, pointed out that wastes of salmon had occurred in western Alaska, particularly Bristol Bay, and that the present law was inadequate to protect the fisheries properly. To meet the situation as thus represented the Secretary of the Navy ordered the U. S. S. *Vicksburg* and two submarine chasers to Alaska in 1919 to patrol the fishing grounds during the period of greatest fishing activity. The *Vicksburg* with subchasers *No. 309* and *No. 310* proceeded to Juneau early in the season. Toward the end of May subchaser *No. 309* was detailed to patrol duty in southeast Alaska, while subchaser *No. 310* accompanied the *Vicksburg* to Cordova for similar duty in central Alaska, arriving there shortly after the 1st of June.

In accordance with arrangements made with the Navy Department for the placing of fisheries agents on these boats, Warden H. C. Scudder, of the Bureau's force in southeast Alaska, was detailed to

the *Vicksburg* and was transported to Ikatan, where he remained while the vessel went on to Bristol Bay. The *Vicksburg's* stay in western Alaska was comparatively short, due to the small run of salmon and the early closing of the canneries. The return voyage began early in July and Mr. Scudder was picked up and brought back to Juneau. En route the *Vicksburg* called at Cordova on July 18 to convoy subchaser No. 310 back to Juneau. Subchaser No. 310, which was detailed to central Alaska, made one short inspection trip around Prince William Sound and into Valdez for the Bureau and afforded transportation to Assistant Agent E. M. Ball to Kodiak, but from there was at once ordered to Yakutat in the matter of a disturbance over fishing rights of the Indians and was of no further assistance to the Bureau in the central district. Representatives of the Bureau in southeast Alaska were on a number of occasions afforded transportation on the subchasers No. 309 and No. 294. The latter replaced No. 309 late in July. The U. S. S. *Marblehead* was also in the southeast district for a short time in connection with the fish-trap piracy situation.

#### VIOLATIONS OF FISHERY LAWS AND REGULATIONS.

The case against the Alaska Pacific Fisheries, which company was indicted in October, 1918, on 15 counts for failing to close properly several of its traps during weekly close seasons in July and August, 1918, was called for trial at Juneau on June 14, 1919. Motion by the defense for a continuance being denied, evidence was presented by the Government on five counts of the indictment in respect to traps at Grindall Point, Cleveland Peninsula, South Vallenar Point, Stone Rock Bay, and Cape Chacon. The jury returned a verdict of guilty. The court thereupon imposed a fine of \$1,000 for each of the five counts, which with the costs of \$177.20 made a total of \$5,177.20 paid by the Alaska Pacific Fisheries for the unlawful operation of the traps in question. The remaining 10 counts were dismissed owing to the absence of an important witness for the Government.

Another case against the Alaska Pacific Fisheries involving the construction in 1917 of a floating trap within the prohibited lateral distance of a trap at Village Point, Icy Strait, belonging to the Thlinket Packing Co., was also brought to trial on June 14, 1919, after many postponements. The company, being denied a further continuance, pleaded guilty to the charge and paid a fine of \$100 plus costs amounting to \$753.80.

During the weekly close season on August 23, 1919, a trap of the Alaska Pacific Fisheries on Chichagoff Island was found in full fishing order. Complaint being entered before the United States commissioner at Juneau on September 15, the company pleaded guilty and was fined \$200 and costs.

On September 22, 1919, Hugh Whitelaw and Gus Starkloff were found fishing in Staney Creek on the west coast of Prince of Wales Island. Whitelaw was brought before the United States commissioner at Ketchikan on October 23, when he pleaded guilty and paid a fine of \$10 and costs of \$3.13. Starkloff was indicted but not apprehended during the year.

On October 15, 1919, a complaint was filed in the United States commissioner's court at Juneau, charging the Deep Sea Salmon Co. with the operation of two floating traps on the west shore of Port Althorp on Sunday, August 24, 1919. The company pleaded guilty and paid a fine of \$400 and costs.

The grand jury sitting at Juneau in September, 1919, indicted William Brady, Pat Brady, George Paul, and Sam Goldstine for unlawful fishing with a seine in a creek flowing into Gambier Bay. On December 9 the case was dismissed by the court, as it was shown that the fishing was on the tide flats outside the stream.

The Petersburg Packing Corporation was fined \$200 and costs in the United States commissioner's court at Ketchikan on October 23 for failure to close properly its trap at Point Colpoys on Sunday, August 17, 1919.

On Sunday, August 3, a trap of the Sunny Point Packing Co. was found only partially closed. A true bill was returned against the company on October 23 at Ketchikan, to which a plea of guilty was entered on October 29. A fine of \$100 and costs was imposed.

During the weekly close season on the night of August 2 a trap of the Anacortes Fisheries Co. at Lemesurier Point was found fishing. The matter was reported to the grand jury at Juneau, which on September 15 indicted the company and both trap watchmen. The case was tried at Ketchikan on October 20 and resulted in a conviction. A fine of \$150 was imposed against the company and \$25 against each of the two watchmen.

An indictment was returned at Juneau on September 15 against the Alaska Herring & Sardine Co. for constructing a trap in Wilson Cove, Chatham Strait, within 500 yards of the mouth of a stream, this being contrary to the closing order of December 21, 1918. The case was dismissed upon transfer to Ketchikan, the company agreeing not to reconstruct the trap.

On July 30 Pete Knutsen and Ole Knutsen were fishing in Petersburg Creek with a gill net set almost entirely across the stream. They were indicted at Juneau September 15 on two counts, one for fishing within the creek and one for fishing in the estuary at the mouth of the creek. The case was tried at Ketchikan and resulted in a conviction on the second count. On November 15, 1919, a motion for a new trial was filed.

Complaint was filed on October 10 in the United States commissioner's court at Ketchikan against Chris Selness, an alien, for fishing in violation of the law. In the course of the trial it was shown that Selness avoided the draft for military service by surrendering his declaration papers and that he was being paid wages as a fisherman at the time of the alleged unlawful fishing. The jury regarded him as a partner in the fishing business and accordingly found him guilty as charged. He was fined \$500. The case was taken to the district court on appeal and set for trial at Ketchikan on October 23. After the court ruled that the defendant could fish for wages, the case was dismissed on motion of the United States attorney.

On Sunday, August 3, a fish wheel, marked "McBride & Co. No. 2," was found in operation on the Taku River. Complaint was filed before the United States commissioner at Juneau on September 10 against H. C. McBride, A. H. Humphries, and William Strong.

Humphries, appearing for all defendants, pleaded guilty and paid a fine of \$100 and costs.

On September 13 William Strong was also indicted as an alien, it being alleged that he was a Canadian who had not declared his intention of becoming a citizen. This case is still pending.

On September 16 the grand jury indicted the George T. Myers Co. for fishing with a trap near Pinta Cove on Sunday, July 20. On September 17 the company pleaded guilty and was fined \$250 and costs.

On September 15 the same grand jury indicted the Sanborn-Cutting Co. for fishing on Sunday, August 10, with a floating trap north of Mole Harbor on the west shore of Seymour Canal. When the case was called for trial on September 22 the company was convicted and fined \$150 and costs.

Three traps belonging to P. E. Harris & Co. on the west shore of Admiralty Island were found in fishing order on Sunday, July 20. One of the same traps was also fishing during the close period on Monday, August 18. A complaint, covering four offenses, was filed against the company in the United States commissioner's court at Juneau. A plea of guilty was entered and a fine of \$800 and costs was paid.

In June, 1919, Jacob Hollingstad, John Saarikoski, Kusti Joki, and Peter Peterson were accused as aliens of a violation of the act of June 14, 1906. Hollingstad, Saarikoski, and Peterson had taken out their first naturalization papers more than seven years before, but had made no subsequent attempt to attain full citizenship. Saarikoski and Joki were each fined \$100 and costs, amounting to \$6.20. Hollingstad, having claimed exemption from military duty as an alien, was fined \$150 and costs of \$9.20; Peterson pleaded guilty and was fined \$100. Another alien named Dahl was also apprehended for fishing after the expiration of his first papers. Upon entering a plea of guilty at Ketchikan he was fined \$5 and sentenced to purchase thrift stamps to the value of \$100 before September 1.

Nels Peterson was found fishing with a gill net in Chilkat Inlet during the weekly close season on September 1. His boat and net were seized and turned over to the United States marshal. On September 10 a complaint was filed before the United States commissioner at Juneau, to which Peterson pleaded guilty; he was thereupon fined \$200 and costs, which being paid, his boat and net were returned to him.

On September 10 a complaint was executed before the United States commissioner at Juneau, charging the Pacific American Fisheries with failure to close one of its traps on Chichagoff Island on July 20 and August 17, failure to close two traps on the east shore of Excursion Inlet on August 17, and further, for having constructed a trap on the east shore of Excursion Inlet within 500 yards of the mouth of a salmon stream. The company pleaded guilty to all five counts and paid a fine of \$750 and costs.

On September 15 the Northwestern Fisheries Co. was fined \$200 and costs for the faulty closing of a trap on the south shore of Icy Strait west of Point Augusta on Sunday, August 17.

The Astoria & Puget Sound Canning Co. was charged on September 15 in the United States commissioner's court at Juneau with not

properly closing two traps in operation on the shore of Icy Strait on July 20 and August 17, and for having constructed a trap in False Bay, Chatham Strait, within 500 yards of the mouth of a salmon stream. The company pleaded guilty and paid a fine of \$600.

In answer to a complaint filed before the United States commissioner at Juneau, Libby, McNeill & Libby pleaded guilty to having failed, on July 20, to close its trap located on the south shore of Icy Strait, and paid a fine of \$200 and costs.

In September the Hidden Inlet Canning Co. was indicted for constructing a trap in Peril Strait near False Island, within the prohibited distance of a salmon stream. The case had not been disposed of at the close of the year.

The cases against the Carlisle Packing Co. and the Canoe Pass Packing Co., indicted at Valdez in October, 1918, for having driven and constructed certain fishing appliances on the tide flats between Mountain Slough and Cape Whitshed on the western side of the Copper River delta, came on for trial at a term of the district court at Cordova the latter part of September, 1919. The Government alleged that the Carlisle Packing Co. had driven three fish traps along the shore indicated, and to each of them a similar appliance was constructed and attached leaving no endwise space between the two structures: and that the Canoe Pass Packing Co. had driven one such appliance. The companies set up a defense that each of these structures as thus joined constituted but a single trap. Trial by jury being waived by both companies, the testimony was heard on September 25 by District Judge Charles E. Bunnell, who found them guilty as charged in the indictment. On September 30, the Carlisle Packing Co. was fined \$450, or \$150 for each double trap, and the Canoe Pass Packing Co. paid a fine of \$150. The costs of the trials followed the judgments in both cases.

At the Valdez term of the district court in October, 1919, the cases of the Alaska Packers Association and the Alitak Packing Co. came up on appeal from the court of the United States commissioner at Kodiak. Each company was tried at Alitak in September, 1918, for the construction of a trap on Moser Bay within the prohibited lateral distance of another trap, the two traps in controversy being owned by the companies named. Trial in the lower court resulted in a fine of \$1,000 and the costs against each company. The case of the Alitak Packing Co. was tried first at Valdez and resulted in a conviction. It was fined \$500, or one-half of the amount of the fine imposed at Kodiak; costs of the trials in both courts were added, amounting to \$563.90. The Alaska Packers Association was acquitted, the testimony in the case clearly showing that at the time the construction of its trap was begun there was not then any other fixed fishing appliance within 600 yards laterally of its structure nor was any in process of construction. A memorandum decision was given in the Alitak case on October 24, 1919, by Judge Bunnell which, because of its peculiar interest to all operators of fish traps, is quoted here in full.

The evidence in this case as per stipulation filed for and on behalf of the United States by the district attorney and for and on behalf of the defendant corporation by its attorney of record consists of all the testimony taken before H. H. Beck, commissioner and ex-officio justice of the peace at Kodiak, Kodiak Precinct, in the case of the United States of America v. Alitak Packing Co., No. 563 in the lower court, and the United States of America v. Alaska Packers Association, No. 539 in the lower

court; also the testimony of E. M. Ball, called by the Government upon trial had in the district court. Both the Government and the defendant waive trial by jury and the defendant admits its corporate existence.

The facts in the case are easily determined. Moser Bay is an arm of Alitak Bay on the southwesterly shore of Kodiak Island. At the place where the Alaska Packers Association constructed its trap the distance from shore to shore is about 2 miles. On the 4th day of May, 1918, the Alaska Packers Association began driving a trap off the north shore of Moser Bay at a point about 3,000 feet from the shore and on a line nearly at right angles with the shore or beach line. The "heart," "pot," and "spiller" were first completed and several hundred feet of the "lead" were driven before the defendant corporation began the construction of a trap easterly from the Packers' trap. The defendant began the construction of its trap at a point about 900 feet from the shore and on a line nearly at right angles with the shore or beach line. Construction work was begun by the defendant on the 4th of June. The same general plan of construction was adopted by both the Packers and the defendant and both drove from deep water toward the shore. The defendant's trap was completed on about the 15th day of June. The Packers' trap with the exception of about 600 feet of the lead nearest the shore was completed on the 7th of June. The work was not continuous, though practically so, the witness Seaborg, "the boss trap man," testifying:

"We drove pretty much every day, that is, after the ship was discharged. That is, that when we got through with the lighter I drove a few piles, working at it every day a little."

The work of driving the last 600 feet of the "lead" was completed on the 18th of June. This 600 feet of "lead" swings to the east, toward the defendant's trap, and the shore end is about 150 feet nearer the shore end of defendant's "lead" than it would have been had it continued to the shore on the same line with the rest of the "lead." The distance between the shore end of the Packers' "lead" and the shore end of the defendant's "lead" is 952 feet. The distance from the westerly side of the "pot" of defendant's trap to the "lead" of the Packers' trap calculated by a line running at right angles to the "lead" of the defendant's trap is considerably less than 600 yards.

The defendant defends on the theory that when it began the construction of its trap it was not within 100 yards endwise of any other trap or fixed fishing appliance and therefore when the Packers' "lead" was driven to a point 100 yards distant from a line drawn from the outside end of defendant's trap at right angles to defendant's "lead" and extending westerly across the course of the Packers' "lead," the Packers must cease further construction in order to keep within the provisions of section 262 of the Compiled Laws of Alaska. Section 262 provides:

"It shall be unlawful to lay or set any drift net, seine, set net, pound net, trap, or any other fishing appliance for any purpose except for purposes of fish culture, across or above the tide waters of any creek, stream, river, estuary, or lagoon, for a distance greater than one-third the width of such creek, stream, river, estuary, or lagoon, or within 100 yards outside of the mouth of any red-salmon stream where the same is less than 500 feet in width. It shall be unlawful to lay or set any seine or net of any kind within 100 yards of any other seine, net, or other fishing appliance which is being or which has been laid or set in any of the waters of Alaska, or to drive or construct any trap or any other fixed fishing appliance within 600 yards laterally or within 100 yards endwise of any other trap or fixed fishing appliance."

The position taken by defendant is unique, but it is not tenable. Congress has said that the waters of any creek, stream, river, estuary, or lagoon shall not be fished with a fixed fishing appliance for more than one-third of the distance across or above the tide waters of such creek, stream, river, estuary, or lagoon; that a trap or fixed fishing appliance shall not be driven or constructed within 600 yards laterally or within 100 yards endwise of any other trap or fixed fishing appliance. It is argued that no right to continue to drive or construct is initiated by beginning to drive or construct. It is true that the statute specifies no period of time within which the trap or fixed fishing appliance must be completed, but the failure to so specify can not be held to mean that no time shall be given. The very nature of the language employed, "to drive or construct," as applied to the thing to be driven or constructed does not contemplate a completed structure by a single act. Construct means to put together the constituent parts of (something) in their proper place and order; to build; to form; to make, as to construct an edifice; and the spirit and intent of the statute is fully complied with when a trap or fixed fishing appliance once begun and under process of construction is being driven and constructed with such speed as existing conditions reasonably permit. To have fixed a definite period of time irrespective of weather conditions and unavoidable delays would have been equally as objectionable. I take it Congress was not attempting to place a bonus upon specially adapted equip-

ment and speed in trap construction. No time is fixed for beginning work, nor when it must be finished. In this case it probably would not make much difference, for the defendant and the Packers are both undoubtedly able to enter a race on "trap" construction on equal terms, but if it is determined that the statute looks forward to, in fact invites, a race in trap construction, it is easy to be seen that an independent fisherman will never be able to construct a trap if formidable competition seeks to render his efforts useless.

Time, however, is not the only yardstick by which the rights of the trap builder are to be measured. Under the provisions of the statute the length of a trap or fixed fishing appliance must not be greater than one-third of the width of the creek, stream, river, estuary, or lagoon across which it is driven or constructed, and when the builder of a trap begins his trap at a point offshore and at a distance therefrom less than one-third of the width of the stream or estuary across which he is driving or constructing his trap, it must be held that within a reasonable limit of time he alone has the right to determine how far he will continue to drive and construct his lead toward the shore. I find the defendant guilty as charged in the complaint.

The Canoe Pass Packing Co. and the Northwestern Fisheries Co., jointly indicted at Valdez in October, 1918, were tried before the district court at that place in October, 1919. These companies were accused by the grand jury of unlawful fishing in Miles Lake by the use of set nets at less than the distance interval prescribed by the regulations affecting fishing in the Copper River, the indictment covering four counts against each company. The trial began October 20, and two days later the jury returned a verdict of guilty on all counts of the indictment. Motion for a new trial being made and denied on October 24, the court imposed a fine of \$1,000 against each company, or \$250 for each count. The costs of the trial, amounting to \$307.30, were paid by the two companies.

The Abercrombie Packing Co., similarly indicted in 1918, was put on trial October 23. It was alleged in the indictment that the nets of this company were set within the prohibited lateral distance of those nets of the Northwestern Fisheries Co. and the Canoe Pass Packing Co., which were proved by the preceding trial to have been unlawfully placed. It therefore followed that the conviction of those companies virtually amounted to an acquittal of the Abercrombie Packing Co., which, from all the evidence presented, was the first to set its nets at the three points in question. Accordingly the court instructed the jury to return a verdict of not guilty on three counts of the indictment, whereupon the remaining count was dismissed upon motion of the United States attorney, as the evidence was insufficient to convict.

On Sunday, June 15, a trap of the Moore Packing Co., at Knowles Head, Prince William Sound, was found in full fishing order, and on the following day complaint was filed before the United States commissioner at Valdez against the company and the trap watchman. When the matter came to trial the company pleaded guilty solely on the ground that it was responsible for the acts of its employees. In this case the watchman was uncertain about the day of the week, having once closed the trap and then reopened it. A fine of \$100, and costs amounting to \$46.30, was imposed against the company. The case against the watchman was dismissed.

On July 10, John Roach, Harry Hendrickson, E. Carlson, and W. T. Wiseman, all fishermen of the Alaska Salmon Co., were caught fishing in Wood River, a stream closed to commercial fishing. They were arrested and brought before the United States commissioner at Dillingham on July 30 for trial. Roach and Carlson, fishermen from San Francisco, pleaded guilty, and a fine of \$250 and costs of \$20

was imposed against each. Hendrickson, a local fisherman, also pleaded guilty and was fined \$100. Wiseman, a prospector in Alaska who sometimes earned a grubstake by fishing, demanded a trial by jury. The case against him was dropped, as it would have been difficult to have found 12 men in that section who could qualify as jurors. This is the second time that any prosecutions have been made in the Bristol Bay district. The first occurred in 1914.

#### FISH PIRACY.

In the fishing season of 1919 southeast Alaska was the scene of an attempt by a lawless element to carry on salmon-trap piracy. Some traps were raided and robbed during the absence of the watchmen, or through their intimidation, but these depredations were mainly unsuccessful, though one company reported the loss of 60,000 salmon from this cause. The situation was sufficiently serious to occasion the operators no little concern and also to engage the active attention of the law-enforcement agencies in the Territory. Vessels of the Navy, Coast and Geodetic Survey, Forest Service, and Bureau of Fisheries were authorized by the several departments represented to take summary action in dealing with the evil. The governor of Alaska and the Department of Justice, through the United States marshal and his deputies, took a large part in the suppression and punishment of this lawlessness. Some prosecutions were made and convictions secured, but piracy was brought to an end chiefly by an organized patrol under Federal and Territorial authorization and the cooperation of several packing companies.

It would seem that the companies operating traps might evolve a plan of self-protection to prevent a recurrence of this disorder, for the theory is fundamentally correct that if the salmon obtained through piracy can not be sold or disposed of at a profit, the raiding and robbing of traps will cease.

#### TERRITORIAL LEGISLATION.

By an act approved May 1, 1919, the Legislature of the Territory of Alaska amended sections 1 and 2 of the Territorial revenue act of May 3, 1917, chapter 74, Laws of Alaska, 1917. The changes include the imposition of a tax on the output of clam canneries, herring canneries, and whale-oil plants; an increase of 1 cent a case on all species of salmon canned and in addition a tax on the net income of salmon canneries; and increased rates on various salted products. The act as it applies to fisheries is as follows:

SECTION 1. That any person, firm, or corporation prosecuting, or attempting to prosecute, any of the following lines of business in the Territory of Alaska shall apply for and obtain a license, and pay for said license, for the respective lines of business, as follows:

\* \* \* \* \*

6th: Fisheries:

(a) Clam canneries: Two cents per case;

(b) Herring canneries: Two cents per case;

(c) Salmon canneries: Five and one-half cents per case, on Kings and Reds or Sockeyes; three and one-half cents per case on Medium Reds; and three cents per case on all others.

In addition to the above tax, salmon canneries shall pay one per cent of their net annual income. By "net" income is meant cash value of the pack of the cannery, less operating expenses, and repairs and betterments actually made. No deduction

shall be made as an operating expense on account of depreciation of machinery, interest on bonds or money borrowed, or other taxes paid.

(d) Fish traps, fixed or floating: one hundred dollars per annum, so-called dummy traps included;

(e) Salteries: Ten cents per one hundred pounds on mild cured Red King Salmon;  
Five cents per one hundred pounds on mild cured White King Salmon;  
Ten cents per one hundred pounds on salted Codfish;

Two and one-half cents per one hundred pounds on all other salted and mild cured fish, except Herring.

7th: Cold Storage Plants: Doing a business of one hundred thousand dollars per annum or more, five hundred dollars per annum; doing a business of seventy-five thousand dollars per annum and less than one hundred thousand dollars, three hundred and seventy-five dollars per annum; doing a business of fifty thousand and less than seventy-five thousand dollars per annum, two hundred and fifty dollars per annum; doing a business of twenty-five thousand and less than fifty thousand dollars per annum, one hundred and twenty-five dollars per annum; doing a business of ten thousand dollars and less than twenty-five thousand dollars per annum, fifty dollars per annum; doing a business of four thousand and less than ten thousand dollars per annum, twenty-five dollars per annum; doing a business of under four thousand dollars per annum, ten dollars per annum.

The "annual business" under this section shall be considered the gross amount received for the product and for storage of produce for others.

8th: (a) Fish oil works using herring in whole or in part in the manufacture of fish oil, two dollars per barrel. (b) Fertilizer and fish meal plants manufacturing fertilizer and fish meal in whole or in part from herring, two dollars per ton.

17th: Whale Oil Plants or Stations: One dollar per barrel.

#### TERRITORIAL LICENSE TAX.

Information has been received from the Territorial treasurer of Alaska in respect to tax collections made for the fiscal year ending December 31, 1919, under the several fisheries schedules of the Territorial tax law. The following statement is of date of May 22, 1920:

#### FISHERY LICENSE TAXES COLLECTED BY TERRITORY FOR THE FISCAL YEAR ENDED DEC. 31, 1919.

Schedule.	Division No. 1.	Division No. 2.	Division No. 3.	Total.
Salmon canneries.....	\$96,592.52	\$2,442.03	\$68,228.57	\$167,263.12
Herring canneries.....	1,288.44		683.58	1,972.02
Clam canneries.....			288.56	288.56
Salteries and mild-cure plants.....	3,431.90	50.30	3,191.47	6,673.67
Fish traps.....	52,600.00		23,000.00	75,600.00
Cold-storage plants.....	1,525.00		510.00	2,035.00
Fish-oil works and fertilizer and fish-meal plants.....	2,287.55			2,287.55
Whale-oil plants.....	7,731.00		16,680.00	24,411.00
Total.....	165,456.41	2,492.33	112,582.18	280,530.92
Additional tax <sup>a</sup> .....				20,770.67
Grand total.....				301,301.59

<sup>a</sup> Additional tax of 1 per cent of their annual net incomes collected from salmon canneries (not possible to segregate by divisions).

The Territorial treasurer, in reporting collections as above, made the following comment:

Several of the smaller salmon-cannery concerns have not yet made payment of their 1919-pack taxes; however, as the amount involved is not large and as it may be some time before payment is made, it is not deemed advisable to longer delay in furnishing your department the desired data.

Referring to collections under Schedule "Clam canneries," same are not yet complete for the year, but the amount involved is only a matter of possibly \$200 or there-

abouts. Fish-saltery taxes will continue to come in for some time yet, but any such taxes now delinquent are all for small sums.

In addition to amount reported in above statement under Schedule "Fish-oil works and fertilizer and fish-meal plants," the sum of \$6,492 was also collected under said schedule; however, such item is not included in statement for the reason that it is being held on special deposit owing to unsettled litigation regarding the schedule in question.

#### TERRITORIAL FISH COMMISSION.

At the session of the legislature early in 1919 provision was made for a Territorial fish commission to consist of five members. The sum of \$80,000 was appropriated for its work. The governor is chairman of the commission and the remaining four members are appointed by him for terms of two years, subject to confirmation by the Territorial Senate.

The work of the commission in 1919 was more or less preliminary in nature. A superintendent of hatchery operations was appointed and other employees secured, and fish-cultural operations were capably conducted at Juneau. This work was largely the outgrowth of operations of the Alaska Fish & Game Club, an organization made up of local sportsmen and persons interested in the conservation of the fisheries, both from the point of view of the angler and the commercial producer. Other plans of the commission include the improvement of salmon streams for spawning purposes by the removal of obstructions; allotments of funds were made for this work in the southeast, central, and western districts.

Late in the year members of the Territorial fish commission participated in a conference at Seattle to consider the advisability of framing additional legislation in respect to the fisheries of Alaska.

#### PREDATORY BIRDS.

From time to time it has been reported that certain birds in Alaska feed very largely on the eggs and fry of salmon and other food fishes and that their depredations are of such magnitude as to threaten seriously the supply of fish, especially salmon. Practically all birds in this category are protected by international agreement under the Migratory Bird Treaty and therefore can not be killed lawfully except by specific order. After due consideration of the facts, the Secretary of Agriculture issued an order on October 24, 1919, authorizing the killing of certain birds at fish hatcheries. The order is as follows:

#### ORDER PERMITTING THE KILLING OR TRAPPING OF CERTAIN BIRDS, AT FISH HATCHERIES, FOUND TO BE INJURIOUS TO VALUABLE FISH LIFE.

Information having been furnished the Secretary of Agriculture that grebes, loons, gulls, and terns, mergansers, and certain species of the heron have become, under extraordinary conditions, seriously injurious to and destructive of fishes at fish hatcheries in the United States and Alaska, and an investigation having been made to determine the nature and extent of the injury complained of, and whether the birds alleged to be doing the damage should be killed; and, if so, during what times and by what means, and it having been determined by the Secretary of Agriculture that the birds above mentioned have become, under extraordinary conditions, seriously injurious to and destructive of fishes at fish hatcheries in the United States and Alaska, and that such birds found committing the damage should be destroyed;

Now, therefore, I, D. F. Houston, Secretary of Agriculture, pursuant to authority in me vested by the Migratory Bird Treaty Act of July 3, 1918, and agreeably to Regulation 10 of the Migratory Bird Treaty Act Regulations approved and proclaimed July 31, 1918, do hereby order that the owner or superintendent, or a bona fide employee of a public or private fish hatchery in the United States or in Alaska, for the

purpose of protecting the fishes at such hatchery, may shoot or trap the following birds at any time on the grounds and waters of such hatchery:

Grebes (Colymbidæ), locally also called water-witches or hell divers.

Loons (Gaviidæ).

Gulls and terns (Laridæ), the latter commonly also called sea swallows.

Mergansers (Merginæ), commonly also called sheldrakes or fish ducks.

The following species of the heron family (Ardeidæ)—

Bittern (*Botaurus lentiginosus*), locally also called shitepoke, stake driver, thunder pump, etc.

Great blue heron (*Ardea herodias*), locally also called blue crane, Poor Joe, cranky, etc.

Little blue heron (*Florida cærulea*), locally also called scoggins.

Green heron (*Butorides virescens*), locally also called shitepoke, fly-up-the-creek, scouck, etc.

Black-crowned night heron (*Nycticorax nycticorax navvius*), also known as gros bec, quawk, qua-bird, etc.

Every bird killed or trapped pursuant to the permission contained in this order, and every part thereof, including the plumage and feathers, shall be totally destroyed as promptly as possible, and shall not be possessed, transported, or shipped in any manner outside of the grounds and waters of the hatchery where killed or trapped except for the purpose of destruction as herein directed: *Provided, however,* That such birds or parts thereof may be shipped or transported, as a gift but not for sale, to public museums and public scientific and educational institutions, and all packages containing such birds or parts thereof so shipped or transported shall be plainly and clearly marked so that the name and address of the shipper and the nature of the contents may be readily ascertained on an inspection of the outside thereof.

#### ALEUTIAN ISLANDS RESERVATION.

Permits for fishery operations in the Aleutian Islands Reservation, which were effective at the end of 1918, continued through the season of 1919, with the exception that permit No. 23, granted November 1, 1917, to the Kuskokwim Fishing & Transportation Co., for cod and salmon operations at Trident Bay, was canceled on May 12, 1919. The company advised that its efforts had been a failure and it had abandoned the location. Six additional permits were issued during the season of 1919, which, with the 20 granted previously which remain effective, make a total of 26 permits outstanding at the end of the calendar year 1919.

#### PERMITS FOR FISHERY OPERATIONS IN ALEUTIAN ISLANDS RESERVATION GRANTED DURING CALENDAR YEAR 1919.

No.	Date.	Grantee.	Location and scope of operations.
36	Jan. 13	O. K. Quean.....	Commercial fishery operations; erection of cannery prohibited.
37	Feb. 7	H. O. Wick.....	Tigalda Island. Cod station.
38	Mar. 25	T. R. Gawley.....	Dora Harbor, Unimak Island. Cod station.
39	Apr. 12	Standard Fish Co.....	Bay of Islands, Adak Island, and Chernofski Harbor, Unalaska Island. Commercial fishery operations; erection of cannery prohibited.
40	Sept. 5	Buckley Livestock, Fisheries & Transportation Co.	Chernofski Harbor and Kuliliak Bay, Unalaska Island, Cod and salmon operations; erection of cannery prohibited.
41	Sept. 6	Lars Mikkelsen.....	Six locations on Unalaska Island, Akun Island, and Tigalda Island. Cod stations.

Two permits for grazing purposes within the Aleutian Islands Reservation were granted jointly by the Departments of Agriculture and Commerce in 1919. The permit granted to Andrew C. Smith on July 5, 1917, for grazing on Umnak Island was canceled, and a similar permit issued to the Buckley Livestock, Fisheries & Transportation Co., which company has taken over his interests in the

reservation. The two permits previously granted the Buckley Livestock, Fisheries & Transportation Co. and Emil Ittner for grazing on Unalaska Island and Amaknak (Dutch Harbor) Island, respectively, remained effective in 1919.

JOINT PERMITS IN ALUTIAN ISLANDS RESERVATION GRANTED IN CALENDAR YEAR 1919.

Date.	Grantee.	Purpose and location.
Mar. 8	H. O. Wick.....	To graze stock and sheep on Tigalda Island.
Oct. 13	Buckley Livestock, Fisheries & Transportation Co.	To graze live stock on Umnak Island.

**AFOGNAK RESERVATION.**

The Afognak Fishery Reservation was established in 1892 by proclamation of President Harrison. All commercial fishing in the Territorial waters of Afognak Island was terminated, and the two salmon canneries in operation on Litnik Bay were closed and finally removed from the island. During the next 20 years unauthorized commercial fishing was carried on by resident whites and natives, who sold their catches to merchants at Afognak and Kodiak. Every locality about the island which produced an appreciable run of salmon was fished. The catch was used chiefly in the preparation of pickled bellies and dried and smoked backs.

Early in 1912 information was laid before the Department to the effect that the natives of Afognak were largely dependent upon the salmon fisheries of the island for a livelihood. To properly conserve the fisheries and to assist the natives, an order was issued by the Department whereby the natives and white men married to native women were permitted to fish in the reservation for commercial purposes after first obtaining a license. Accordingly, in the spring of 1912, more than 100 licenses were issued to these people, and in each season since then the same privilege has been granted. Necessary restrictions have been imposed in order that the salmon runs may be protected from close fishing, which might otherwise ensue. These restrictions applied to the kind and amount of gear which could be used and to the seasons when operations might be carried on. Each locality was given special consideration by the establishment of close seasons during the summer, for which the general law made no provision, the object being to insure some escapement of salmon to the spawning grounds.

The conduct of the work thus begun in 1912 has been continued without much change to the present writing. The runs of salmon have varied somewhat in the eight seasons which have passed, yet there appears to be no striking difference in the situation to-day from that in 1911. The fisheries have survived the disaster of 1912, when the eruption of Mount Katmai filled all streams of the island with volcanic ash, and salmon are now about as plentiful as before that catastrophe. Taking the streams separately, it is observed that those on the west side of the island are not producing as many red salmon as they did before the eruption, but the island as a whole shows a rather uniform production if some allowance is made for the lean

years immediately following 1912. The present condition is neither particularly encouraging nor discouraging.

The streams on the east side of the island show a general improvement in the runs of salmon as compared with several years ago, and it seems probable that they will continue to improve under the increased liberation of fry from the hatchery on Litnik Lake. It is of special interest to record in this connection that red salmon appeared in greater numbers in 1919 than ever before in Litnik Bay, and that the collection of red salmon eggs at the hatchery was the largest ever made. In round numbers 78,000,000 eggs were taken, and it was estimated that there remained on hand a supply of unspawned salmon sufficient to have refilled the hatchery with eggs had opportunity been available.

The commercial catch of salmon in Afognak waters is shown in the following table:

CATCH OF SALMON BY APPARATUS AND SPECIES, AFOGNAK RESERVATION, 1919.

Locality.	By seines.					By gill nets.	Total.
	Coho.	Chum.	Hump-back.	King.	Red.	Red.	
Little Afognak.....	5,179	119	2,112	.....	19,830	3,505	30,745
Litnik Bay.....	5,203	.....	.....	.....	.....	.....	5,203
Paramanof Bay.....	35	235	12,344	.....	14,854	3,714	31,182
Malina.....	.....	218	1,098	22	18,430	4,607	24,405
Danger Bay.....	.....	.....	5,871	.....	27	.....	5,898
Seal Bay.....	.....	.....	1,573	27	11,634	.....	13,234
Izhut Bay.....	.....	.....	.....	.....	754	1,219	1,973
Pauls Bay.....	.....	.....	.....	.....	523	.....	523
Total.....	10,417	602	22,998	49	66,052	13,045	113,163

The customary patrol of the fishing grounds in the Afognak Reservation was again followed in 1919, William E. Baumann, of Afognak, being employed temporarily to carry on the work, which, as heretofore, included general supervision of all commercial fishing in the reserved waters.

Litnik Bay was not open to commercial fishing except for silver salmon; this accounts for the fact that but the one species was taken there. All the red salmon were wanted for purposes of propagation, while the run of humpbacks was inconsequential.

In comparison with the catch of 1918, it appears that cohos increased 102 per cent; humpbacks decreased from 70,791 to 22,998, a decline of 67½ per cent; and reds increased from 50,662 to 79,097, an advance of 56 per cent. Chums and kings were taken in negligible quantities. The entire catch was sold to the Kodiak Fisheries Co., at Kodiak.

Approximately 90 per cent of the catch was made by means of beach seines, the remainder being taken with gill nets. The streams are small and clear, hence gill-net fishing is not practicable off their mouths. Traps are not permitted, and purse seines are not used for the reason that the natives are not prepared to operate them.

**ANNETTE ISLAND FISHERY RESERVE.**

The Annette Island Fishery Reserve, in southeastern Alaska, was created by a Presidential proclamation dated April 28, 1916, for the benefit of the Metlakatla Indians and any other natives of Alaska who might care to take up their abode on Annette Island. The reserve includes Annette Island and a number of smaller adjacent islands, together with the surrounding waters, and is administered by the Bureau of Education, Department of the Interior, in the interests of the resident natives.

The season of 1919 was the second in which fishery operations within the reserve were carried on in accordance with the five-year contract entered into with the Annette Island Packing Co. By the terms of this contract the contracting company pays a fee of \$100 a year for each fish trap operated and a royalty of 1 cent for each fish taken from these traps. In addition the company pays the natives for fish taken in seines. The natives also receive payments for other services and materials furnished by them. In 1919 the fees from the seven fish traps operated amounted to \$700; 794,625 fish were taken from the traps, providing a royalty of \$7,946.25; and the amount paid the natives for fish taken by purse seines amounted to \$25,231.85. The total income to the natives, including the Metlakatla Commercial Co., from the Annette Island Packing Co. for the season of 1919 was \$90,032.88.

**COPPER RIVER FISHERY.**

At the close of the fishing season of 1918, it was found that the regulations of December 29, 1917, affecting fishing for salmon in the Copper River had failed to accomplish the purposes sought by their promulgation, namely, an escapement of salmon sufficient to provide for the ample seeding of the spawning beds and to supply the needs of the natives and other inhabitants of the region. Furthermore, it was repeatedly alleged that the regulations were discriminative in effect for the reason that operations in the delta district were materially restricted while those at Abercrombie Canyon and Miles Lake were almost unaffected. It was expedient, therefore, that appropriate action be taken looking toward a revision of the regulations in order that the original objects in view should be attained.

On September 16, 1918, announcement was made of a hearing to be held at Seattle, Wash., November 22, 1918, to consider the matter of changing the existing Copper River regulations. As a result new regulations were promulgated on December 20, 1918, effective January 1, 1919. The important changes in the new order were the extension of the weekly close season by 10 days in all parts of the river, the omission of the weekly close period of 36 hours, the prohibition of all stake nets, a reduction of 1,200 feet in the lateral distance interval and of 200 feet in the length of all nets the use of which was authorized in the waters of the delta over which the Secretary of Commerce has jurisdiction, an extension of 200 feet in the length of all nets whose use is permitted in Miles Lake, the closing of the west and north shores of Miles Lake and the east side of the river through Abercrombie Canyon, and a redefining of the delta

by the exclusion of all areas not strictly in the river or its outlets or within 500 yards outside the mouth of each.

Under the new definition of the Copper River delta, fishing on the tide flats between the grass banks and the sand islands 3 or 4 miles offshore was unaffected, except as the prohibitions of the general law were applicable. By reason of that fact, the packing companies having canneries at Cordova and near the delta put their fishing gear in operation in this open field as soon as salmon began to run, and they made a very considerable catch before fishing could be commenced in the protected waters. Even after the close season had elapsed and all waters of the delta were open to commercial fishing, the flats were the preferred grounds and the bulk of the catch was made there. When the season was at its height there were approximately 65,000 fathoms of gill nets in operation on the delta. The greater part of this gear was used in the form of stake nets, though a small quantity was used as set nets in the sloughs, leaving the remainder for drift fishing in the channels crossing the tide flats.

Fishing in the delta district began about the middle of May and was diligently prosecuted until early in July, about which time all of the companies except the two nearest the field withdrew their men for the humpback fishing in Prince William Sound. The excepted companies did not stop fishing on the delta until late in August. The total catch of salmon in the waters of the delta was 1,129,934. Of this number 1,096,090 were red salmon; 8,972, kings; and 24,872, cohos.

In Miles Lake, all fishing was by means of gill nets, a total of 3,250 fathoms being used. Fishing in the canyon was carried on by the use of dip nets, there being from 20 to 50 men employed as dip-net fishermen, the number varying with the fluctuations in the run of salmon. Fishing began both in lake and canyon on June 15 and continued until September 16. The following catch of salmon was made: Reds, 157,597; kings, 4,092; and cohos, 15,778; or a total of all species of 177,467. This entire catch was canned by F. H. Madden at the Abercrombie cannery, formerly operated by the Abercrombie Packing Co. The following number of cases of salmon was packed: Reds, 13,933 cases of 1-pound talls and 1,248 cases of  $\frac{1}{2}$ -pound flats; kings, 1,383 cases; and cohos, 1,461 cases.

The total catch of salmon in Copper River waters was 1,307,401, of which number 1,253,687 were reds, 13,064, kings, and 40,650 cohos.

Early in the season Assistant Agent E. M. Ball of the Bureau's staff and Special Agent Joseph A. Bourke, whose services had been temporarily secured by detail through courtesy of Gov. Riggs, erected a number of notices on the Copper River delta, indicating the extent of the waters affected by departmental regulations. Soon thereafter Mr. Ball returned to Cordova and devoted his attention to fishery matters in the Prince William Sound region and to the westward. Mr. Bourke continued to act for the Bureau during the fishing season on the Copper River. Newt Casperson was employed in special capacity and stationed for a number of weeks in the vicinity of Miles Lake and Abercrombie Canyon.

The great importance of the Copper River fishery and the several unusual problems involved in connection therewith, especially in regard to the extent of the spawning areas, seemed to demand a special inquiry into conditions in order that as complete information

as possible might be available for future guidance. Accordingly arrangements were made for an investigation under the leadership of Dr. Henry B. Ward, of the University of Illinois. Associated with Dr. Ward were Prof. W. A. Oldfather, also of the University of Illinois, and J. R. Russell, superintendent of the Bureau's fish-cultural stations in Washington. The party arrived at Cordova on July 17, 1919, and proceeded up the Copper River & Northwestern Railway, thence taking a local guide and suitable camping equipment. The investigation covered several hundred miles of territory and included visits to a number of the more important spawning grounds on the tributary streams and lakes of the Copper River system. The party returned to Cordova September 6, 1919. A complete report submitted by Dr. Ward is given on page 119.

#### YUKON RIVER FISHERY.

In 1919 the Yukon River salmon fisheries assumed a position of large interest due to the successful operation of a cannery on Kwiguk Pass or Slough near the upper end of Kwikluak Pass, the most southerly outlet of the Yukon. The commercial utilization of salmon dates back to 1918 only, as prior to that year all salmon taken from the Yukon were used locally. The canning of Yukon salmon was begun in 1918 by the Carlisle Packing Co., rather as development or experimental work. The company was entering virgin territory, where business prudence required that it make a practical test of the feasibility of commercial operations in a region whose fishery wealth was almost unknown. Operations were conceded to be of experimental nature to determine whether the size of the runs of salmon would warrant the permanent establishment of a cannery on the river. Until that time little was known regarding the number of salmon ascending the Yukon River and its tributaries, though it was generally understood that a considerable catch was made annually by the natives for domestic use. The number thus taken probably did not exceed a few hundred thousand salmon each season, or a comparatively small number for a river of such size. The canning company made a total catch in 1918 of 115,531 salmon, more than half of which were chums.

In 1918 strong objections were made in certain quarters to cannery operations on the Yukon. Toward the end of the season, these objections took form and culminated in protests by some of the natives and white settlers along the river against the continued operation of this cannery, or the establishment of any more, the basic contention being that the supply of salmon was not more than adequate for local requirements. In contradiction of these representations, the packing company insisted that the runs were of enormous proportions and that fishing as conducted in the lower reaches of the river had made no appreciable impression on the supply of salmon and that in all probability it never could.

In November, 1918, a public hearing was held at Seattle, Wash., to determine the need, if any, of limits upon commercial fishing in the Yukon River as a means of safeguarding the fishery, and to ascertain the facts in regard to conflicting opinions and expressions bearing upon the entire matter. The information presented at the hearing showed the existence of a situation which might become serious if

reasonable protective regulations were not made effective. Bishop P. T. Rowe, in charge of Episcopal Church affairs in Alaska, expressed the opinion that it was not so much that one cannery might result disastrously, but that it might be the thin entering wedge of extensive commercial exploitation. At the same time W. T. Lopp, chief of the Alaska division of the Bureau of Education, entertained a similar view. He felt that some regulation was necessary, but that reasonable cannery operations could be permitted with safety.

The outcome of the hearing was the promulgation of regulations which included prohibiting the taking of salmon for export purposes from the Yukon and its tributaries above the junction of Clear River and the Yukon, and limiting the case pack and the number of barrels and tierces which might be pickled or mild cured. The pack of canned salmon was limited to 30,000 cases; pickled salmon, to 1,000 barrels; and mild-cured salmon, to 200 tierces.

In 1919 the total number of salmon taken from Yukon River waters for export was 469,949, divided as follows: Cohos, 37,070; chums, 327,898; kings, 104,822; and redds, 159. The pack was as follows: Cases, 57,085; barrels, 214; tierces, 47. Of the total number of salmon caught, it was reported that 29,256 cohos, 194,452 chums, 65,433 kings, and 159 redds, an aggregate of 289,300 were taken in waters outside the scope of the regulations referred to above. The catch within the river was 180,649 salmon. Thus it appears that approximately 62 per cent of the commercial catch of salmon in Yukon River waters was taken in areas beyond the jurisdiction of the Department of Commerce, while only 38 per cent were caught within such areas.

In addition to the cannery of the Carlisle Packing Co., there were four salteries operated on the lower Yukon River in 1919. The Delta Fish Co. was located about 2 miles above the entrance to Kwiguk Slough; J. J. Stokes, about 4 miles below Aproka Pass; William O'Connor, 4 miles above the entrance to Akularak Slough; and the Fuller Fish Co., at the mouth of Andreafski River. Operations of all these concerns were upon a small scale, the total pack being only 239 barrels of pickled salmon. The Delta Fish Co. was the only one that salted in tanks and afterwards transferred their pack to barrels for shipment. The pack of J. J. Stokes was disposed of locally, as was also the pack of William O'Connor. The Fuller Fish Co. intends to operate on a larger scale next year. Part of their pack this season was sent to the States and the balance sold locally. John Lamont has an outfit of barrels, salt, and fishing gear ready to begin operations another season.

During the fall and winter of 1919 concerted action of ecclesiastical inception was undertaken to end commercial fishing for salmon in Yukon River waters, it being alleged that a continuance of such activities meant the destruction of the salmon runs, without which the natives would be unable to survive as a self-supporting people. Undoubtedly the salmon of the Yukon are indispensable to the ordinary development of the country and economical maintenance of human life therein. Various industries of interior Alaska, such as mining and trapping, are more or less directly or indirectly dependent upon salmon. Fishing is not carried on by the resident whites to an extent that would constitute an industry. The natives, however, spend part of their summers in catching salmon and drying them for winter food for themselves and their dogs. Some of them prepare annually quan-



FIG. 1.—NATIVE SALMON FISHERY, YUKON RIVER.

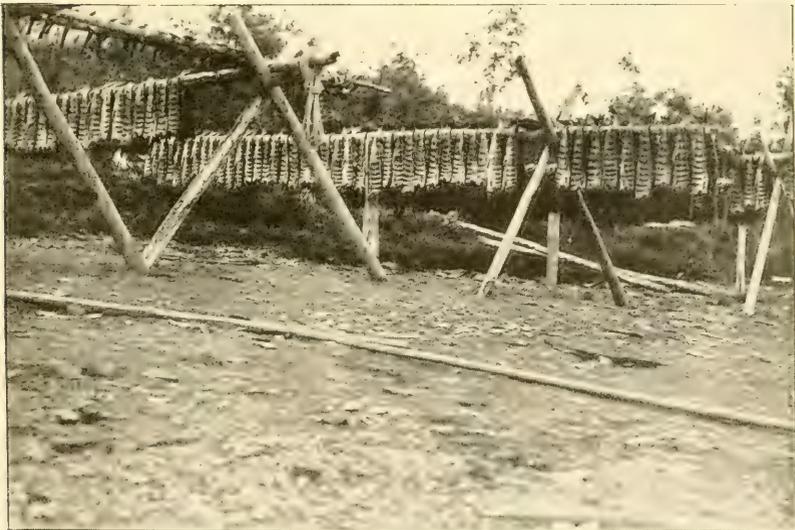


FIG. 2.—NATIVE METHOD OF CURING SALMON, YUKON RIVER.



tities of fish over and above their own needs and sell them to trappers, prospectors, military telegraph stations, and commercial companies at various places along the river.

In the propaganda circulated by Archdeacon Hudson Stuck late in 1919 it was asserted that the cannery near the mouth of the Yukon was operated under permission granted by the Bureau of Fisheries. No such permission was granted, nor was any asked; in fact the Department of Commerce has authority only to limit fishing operations but not to prohibit the establishment of canneries. Allegations were made at the same time as to the great privation caused to the natives and other residents of the Yukon and tributary waters because of the shortage of the salmon in 1919. Undoubtedly there was a light run of salmon in 1919 in the Yukon, as there was in practically all other waters of Alaska; it was an unfavorable season for salmon throughout Alaska. The light run in the Yukon has had its counterpart heretofore, as it is a matter of record that in earlier years the runs of salmon have been very light. There is authentic record of limited runs of salmon as far back as 1879, in which year the natives of the Yukon were forced to go to Norton Sound and elsewhere for salmon.

It seems appropriate to point out that in 1919 there was much high water in the Yukon, which interfered with the operation of native fishing gear; heavy quantities of driftwood also lessened the take of salmon by the natives. Over and above all, consideration must undoubtedly be given to the psychological effect of the establishment of the cannery on the natives; they heard that the cannery was in operation, hence at once assumed that there would be no salmon passing to upper waters. They, therefore, in many instances did not make proper effort to take salmon.

An extensive investigation of the Yukon was made by Inspector Townsend, of the Alaska service, who covered more than 4,000 miles of Yukon waters on the Bureau's vessel *Swan*. He interviewed many traders and other residents of the Yukon in order to ascertain the actual condition of the natives. In some instances it was found that the natives not only had enough fish for themselves, but were able to make sales of the surplus; elsewhere shortages were recorded. But as the season progressed there was no information from official sources received by the Bureau or by the governor of Alaska, which indicated that there had been undue privation suffered during the year by the natives because of any shortage of salmon.

In 1918 it was reported that 6,638 whites, 4,269 natives, and 6,183 dogs were dependent largely upon the salmon of the Yukon. It is computed that about 1,100,000 salmon would suffice amply for all such food requirements. Present requirements are materially smaller, as influenza has since taken heavy toll of the Yukon natives. It must not be overlooked that there are various other species of fish in the Yukon, such as whitefish, grayling, and trout, available for food purposes. The whitefish is a close relative of the famous whitefish of the Great Lakes. The natives also have an abundant supply of game to augment their larder.

It is not the province of the Department of Commerce in its legal relation to the fisheries of Alaska to consider as paramount the interests of any particular packing company or of any branch of the fishery industry, or any class of people, but under the law it is charged primarily with the protection of the salmon fisheries. Congress has

given the Secretary of Commerce authority to do certain things when in his judgment the protection and preservation of the fisheries demand such action. The Department will therefore give unbiased consideration to all the information which comes before it touching upon the questions involved, but it is not required to accept as correct anything less than a fair, unprejudiced presentation of the facts.

The two main contradictory views involving the Yukon situation are, first, that of the commercial interests which contend that there are large runs of salmon in the Yukon and that the number taken for their purposes is but a small fraction of the total; and second, that of certain of the natives and others who maintain that the runs are small and that no salmon can be exported without a resulting local state of privation. The question of large interest, however, to the Department is not whether commercial fishing shall cease in order that noncommercial fishing may continue, but whether the runs of salmon in the Yukon are being or will be depleted under the present scale of operations. It is proper that cognizance be taken of any condition that threatens to destroy the fisheries, whether it be the result of operations by a packing company or by a resident population, or by both.

There is much to be learned regarding the salmon runs in the Yukon before the Department considers further limitations upon fishing in those waters. Competent investigators will, therefore, be sent to the Yukon in 1920 to study the salmon runs and to ascertain the actual conditions of the natives in their relation to the salmon fisheries. Further regulations of the Yukon salmon fisheries will depend very largely upon the results of their observations. It remains true that a just regard for the rights of humanity must inevitably weigh heavily in considering the final regulation of these fisheries, but it seems now that the Yukon can support at least a reasonable commercial fishery for salmon and at the same time insure an ample supply for local food purposes in perpetuity.

#### CENTRAL AND WESTERN ALASKA FISHERY.

In order that the Bureau might be in possession of accurate and trustworthy information regarding certain phases of the salmon fisheries of central and western Alaska, arrangements were made for a joint investigation by Dr. C. H. Gilbert, of Stanford University, engaged as special assistant, and Henry O'Malley, field assistant. Dr. Gilbert and Mr. O'Malley left Seattle on May 12 and returned early in September, 1919. While en route to western Alaska, a stop was made at Cordova, from which place local trips were made in connection with Copper River fishery conditions. Thereafter the journey to the Bristol Bay region was continued, the overland route from Iliamna being followed. A number of weeks were spent on Bristol Bay waters and tributaries, following which inquiries were made in the Port Moller and Ikatan regions. The conclusion of major field work was in the vicinity of Karluk. Much valuable information was secured as a result of the investigation. The report of Dr. Gilbert and Mr. O'Malley is given on page 143.

## WOOD RIVER CENSUS.

A count of the salmon entering Lake Aleknagik, on Wood River, in western Alaska, was made in 1919 in accordance with the custom of past seasons. Warden Shirley A. Baker had general supervision of the work. The actual count was intrusted to Russell Noyes, fish-culturist at Afognak station, who was assigned to this special duty. He was assisted in the counting by three men in the employ of the Alaska Packers Association.

The rack, consisting of heavy cotton web attached to piling driven across the lower end of the lake just above the outlet, was made ready by June 24. It was installed by the Alaska Packers Association, some assistance in towing equipment to the lake and returning it to the cannery at Nushagak at the completion of the count being rendered by the Alaska-Portland Packers Association.

Salmon made their appearance at about the usual time and continued to run through July, as is ordinarily the case. Counting began June 25 and stopped July 31. Weather conditions in 1919 were normal, and no circumstances arose to differentiate the season from preceding ones except the heavy decline in the run of salmon. The largest counts were made on July 10 and 11, when 31,035 and 41,519 salmon entered the lake on those respective dates. Records of the enumeration are surprising in that only 3 days out of 37 show a count in excess of 10,000 salmon. As compared with 943,202 red salmon counted in 1918, the census gives a total of 145,114 red salmon as having entered Lake Aleknagik in 1919. Details of the count appear in the following table:

WOOD RIVER SALMON CENSUS IN 1919.

Date.	Num-ber.	Date.	Num-ber.	Date.	Num-ber.
June 25.....	62	July 8.....	177	July 21.....	513
26.....	91	9.....	3,480	22.....	437
27.....	5	10.....	31,035	23.....	827
28.....	208	11.....	41,519	24.....	513
29.....	203	12.....	7,610	25.....	327
30.....	219	13.....	2,116	26.....	172
July 1.....	379	14.....	1,530	27.....	252
2.....	799	15.....	6,734	28.....	59
3.....	830	16.....	4,795	29.....	128
4.....	5,111	17.....	1,988	30.....	179
5.....	23,108	18.....	925	31.....	156
6.....	6,831	19.....	336		
7.....	1,055	20.....	405	Total.....	145,114

Upon the recommendation of Dr. C. H. Gilbert, of Stanford University, who, with Field Assistant Henry O'Malley of the Bureau, made extensive investigations for the Government in Alaska in 1919, it has been decided to discontinue the Wood River census. As soon as funds are available it is planned, as recommended by Dr. Gilbert, to undertake similar work at Chignik Lake and probably also at Karluk.

In view of the discontinuance of the Wood River census, it seems advisable to present herewith the following tabulation pertaining to the work from the time of its inception in 1908 through 1919:

WOOD RIVER CENSUS AND RED SALMON RUN IN NUSHAGAK BAY AND TRIBUTARIES, 1908-1919.

Year.	Nushagak Bay catch.	Wood River tally.	Total.	Per cent of escape.
1908.....	6,140,031	2,603,655	8,740,686	30.0
1909.....	4,687,635	893,244	5,580,879	16.0
1910.....	4,384,755	670,104	5,054,859	13.2
1911.....	2,813,637	354,299	3,167,936	11.1
1912.....	3,866,950	325,264	4,192,214	7.7
1913.....	5,236,008	753,109	5,989,117	12.5
1914.....	6,174,097	(a)	-----	-----
1915.....	5,676,457	259,341	5,935,798	4.3
1916.....	3,592,574	551,959	4,144,533	13.3
1917.....	5,679,818	1,081,508	6,761,326	15.9
1918.....	6,078,965	943,202	7,022,167	13.4
1919.....	1,452,931	145,114	1,598,045	9.0

<sup>a</sup> Count not made.

### SALMON HATCHERIES.

#### EXTENT OF OPERATIONS.

Four salmon hatcheries were operated in Alaska in 1919, two by the Government and two by packing companies, and in addition some fish-cultural work was carried on by the Territory. The four hatcheries referred to have a combined hatching capacity of 280,000,000 red-salmon eggs. The Territorial work was somewhat experimental in nature.

The total collection of red-salmon eggs in Alaska in 1918 was 142,001,000, from which there were hatched and liberated in the waters of Alaska 95,969,700 fry, or 5,579,500 more than in 1917-18. In 1919 the take of red-salmon eggs was 119,060,000, or 22,941,000 less than in 1918. This decrease was due to smaller runs of salmon at all the hatcheries except that of Afognak.

#### OPERATIONS OF ALASKA HATCHERIES IN 1919.

Station.	Red or sock-eye salmon eggs taken in 1918.	Red or sock-eye salmon liberated in 1918-19.	Red or sock-eye salmon eggs taken in 1919.
McDonald Lake.....	447,300,000	35,329,700	9,752,000
Afognak.....	554,681,000	25,583,000	79,178,000
Fortmann.....	19,620,000	15,205,000	18,420,000
Quadra.....	20,400,000	19,852,000	11,710,000
Total.....	142,001,000	95,969,700	119,060,000

<sup>a</sup> 3,440,100 eyed eggs transferred to the State hatchery at Bonneville, Oreg., and 1,059,900 to Federal hatcheries in Oregon.

<sup>b</sup> 20,700,000 eyed eggs transferred to British Columbia, and 5,000,000 to Quinault, Wash.

#### HATCHERY REBATES.

The act of June 26, 1906, provides, among other things, that the catch and pack of salmon by the owners of private hatcheries in Alaska shall be exempt from all license fees and taxation of every

nature at the rate of 10 cases of canned salmon for every 1,000 red or king-salmon fry liberated upon certain conditions, which are (1) the approval of the character of their hatchery operations by the Secretary of Commerce, notice thereof to be filed in the office of the clerk or deputy clerk of the United States district court of the division of Alaska wherein such hatchery is located and the owners accordingly so notified; and (2) the filing of proof by the hatchery operators with the clerk of the court of the number of salmon fry liberated during the fiscal year for which report is made. Duplicates of such statements must also be filed with the Secretary of Commerce. The clerk of the court then issues to the owner whose hatchery operations have been approved nontransferable certificates in such denominations as he desires covering in the aggregate the number of fry so liberated. These certificates are accepted by the Government in lieu of money in payment of all license fees or taxes against the pack of canned salmon as above stated. The following table gives the rebates due to private operators for the fiscal year ending June 30, 1919.

REBATES CREDITED TO PRIVATE SALMON HATCHERIES DURING FISCAL YEAR  
ENDED JUNE 30, 1919.

Owner.	Location.	Red-salmon fry liberated.	Rebate due.
Alaska Packers Association.....	Naha Stream.....	15,205,000	\$6,082.00
Northwestern Fisheries Co.....	Hugh Smith (Quadra) Lake.	19,852,000	7,940.80
Total.....	.....	35,057,000	14,022.80

HATCHERY OPERATIONS.

MCDONALD LAKE.

Out of the collection of 47,300,000 red-salmon eggs taken at the McDonald Lake hatchery in 1918, a shipment of 3,440,100 eyed eggs was made to the State hatchery at Bonneville, Oreg.; one of 1,059,900 eyed eggs, to Bureau stations in Oregon; and 35,329,700 fry were liberated in waters tributary to Yes Bay, Alaska. The loss of eggs and fry aggregated 7,470,300, or approximately 16 per cent.

The collection of red-salmon eggs at the McDonald Lake station in the fall of 1919 was the smallest that has ever been made, only 9,752,000 being obtained. Operations were interrupted in the midst of the season by high water which damaged the retaining racks and permitted the escape of a large number of spawners. No humpback-salmon eggs were collected.

AFOGNAK.

The Afognak station experienced the most successful season in the history of its operations, the total take in 1919 being 79,178,000 red-salmon eggs. It was also reported that there were many salmon available for spawning still in the lake when the capacity of the hatchery had been reached. No effort was made to obtain humpback-salmon eggs.

From the collection of 54,681,000 red-salmon eggs taken in 1918, a consignment of 20,700,000 was shipped to the Fisheries Department of British Columbia for the restocking of the Fraser River, and a ship-

ment of 5,000,000 was made to the Bureau's station at Quinault, Wash. Plants of fry and fingerlings in Litnik Lake aggregated 25,583,000. The loss of eggs and fry was 3,398,000, or 6.2 per cent.

## FORTMANN.

The Fortmann salmon hatchery of the Alaska Packers Association is located at Heckman Lake on Revillagigedo Island, southeast Alaska.

In 1918, a collection of 19,620,000 red-salmon eggs was made, from which were hatched and liberated through nursery ponds into the Naha Stream system 15,205,000 fry. The loss of eggs and fry was 4,415,000, or 22½ per cent. Between September 8 and November 22, 1919, a total of 18,420,000 red-salmon eggs was taken.

The collection of humpback-salmon eggs in 1918 was 3,660,000, from which there were produced and planted 3,235,000 fry, the loss of eggs and fry being 425,000, or 11.6 per cent. The number of humpback-salmon eggs taken in 1919 was 600,000, a decrease of 83.6 per cent from the previous year.

## QUADRA.

The Northwestern Fisheries Co. continued the operation of its Quadra hatchery, located on Hugh Smith Lake, previously known as Quadra Lake. Spawn taking in 1918 began August 8 and was discontinued September 24. It resulted in a collection of 20,400,000 red-salmon eggs from which there were hatched and planted 19,852,000 fry. The loss of eggs and fry was 548,000, or approximately 2.7 per cent.

In 1919, the collection of red-salmon eggs at Quadra began August 12 and ended November 14; the total take was 11,710,000.

## GENERAL STATISTICS OF THE FISHERIES IN 1919.

The total investment in the Alaska fisheries in 1919 was \$74,181,560, an increase of \$430,771 over 1918. Of this amount approximately 92 per cent was invested in the salmon industry. The fishery industry gave employment to 28,534 persons, a decrease of 2,679 from the number employed in 1918. The total value of the products in 1919 was \$50,282,067, a decrease of \$8,872,792 from 1918, or approximately 15 per cent. This lessened production was due almost wholly to the heavy falling off in the pack of salmon.

## SUMMARY OF INVESTMENTS, PERSONS ENGAGED, AND PRODUCTS OF ALASKA FISHERIES IN 1919.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
<b>INVESTMENTS.</b>								
Salmon canning.....		\$33,741,891		\$12,897,947		\$19,855,333		\$66,495,171
Salmon mild-curing.....		741,635						741,635
Salmon pickling.....				236,261		354,161		590,422
Salmon, fresh.....		104,336						104,336
Salmon dry-salting.....						103,862		103,862
Hallbut fishery.....		1,979,457						1,979,457
Herring fishery.....		418,571		431,338		50,663		900,572
Cod fishery.....				938,699		347,376		1,286,075
Whale fishery.....		545,256				1,245,611		1,790,867

SUMMARY OF INVESTMENTS, PERSONS ENGAGED, AND PRODUCTS OF ALASKA FISHERIES  
IN 1919—Continued.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Num-ber.	Value.	Num-ber.	Value.	Num-ber.	Value.	Number.	Value.
<b>INVESTMENTS—contd.</b>								
Clam fishery.....				\$147,167				\$147,167
Crab fishery.....		\$200						200
Shrimp fishery.....		41,796						41,796
Total.....		37,573,142		14,651,412		\$21,957,006		74,181,560
<b>PERSONS ENGAGED.</b>								
Whites.....	7,027		3,435		5,864		16,326	
Natives.....	2,584		843		448		3,875	
Chinese.....	1,366		536		868		2,770	
Japanese.....	982		266		259		1,507	
Filipinos.....	919		280		379		1,578	
Mexicans.....	232		250		1,409		1,891	
Miscellaneous.....	246		59		282		587	
Total.....	13,356		5,669		9,509		28,534	
<b>PRODUCTS.</b>								
<b>Salmon:</b>								
Canned.....							a 4,583,688	43,265,349
Mild-cure l.....							b 4,290,600	916,800
Pickled.....							b 1,622,000	195,447
Frozen.....							b 1,552,480	130,355
Fresh.....							b 5,208,327	356,688
Dry-salted.....							b 212,244	17,601
Dried and smoked.....							b 415,000	43,000
By-products, oil.....							c 966	966
By-products, fertilizer.....							b 724,000	18,680
<b>Halibut:</b>								
Fresh.....							b 7,783,179	880,433
Frozen.....							b 6,495,372	670,147
Canned.....							b 240	25
<b>Herring:</b>								
Canned (½-pound cans).....							a 6,357	40,395
Canned (1-pound cans).....							a 95,448	811,366
Dry-salted for food.....							b 510,000	20,150
Fresh, for bait.....							b 1,254,926	11,210
Frozen for bait.....							b 2,444,655	24,246
Pickled, for bait.....							b 40,000	800
Pickled, Scotch cure.....							b 7,718,985	451,240
Pickled, spiced.....							b 11,715	1,676
Pickled, Norwegian cure.....							b 2,216,120	147,634
Fertilizer.....							b 1,712,000	56,653
Oil.....							c 169,374	110,800
<b>Cod:</b>								
Dry-salted.....							b 9,829,343	773,297
Pickled.....							b 956,098	46,014
Frozen.....							b 86,971	4,209
Stockfish.....							b 2,900	700
Tongues.....							b 18,000	1,770
<b>Whales:</b>								
Oil.....							c 875,374	656,510
Sperm oil.....							c 377,032	276,344
Fertilizer, meat.....							b 2,060,000	76,420
Fertilizer, bone.....							b 538,000	13,472
Bone.....							b 13,647	2,729
Ivory.....							b 746	225
Meat, frozen.....							b 50,000	1,500
Clams.....							a 33,765	184,363
<b>Trout:</b>								
Fresh.....							b 80,977	9,086
Frozen.....							b 2,780	408
Pickled.....							b 2,200	165
Canned.....							a 371	3,496
<b>Sable fish, fresh and frozen.....</b>								
Red rockfish.....							b 509,369	35,485
Crabs.....							b 69,048	1,414
Shrimps.....							d 80	160
Miscellaneous fresh fish.....							b 60,000	21,000
Total.....							b 52,123	1,639
Total.....								50,282,067

a Cases.

b Pounds.

c Gallons.

d Dozens.

## SALMON INDUSTRY.

The situation in southeast Alaska is serious. It is certain that under present conditions, a repetition of the astounding production of 1918 could not reasonably be expected, nor could it be assumed that there would be a progressive increase in pack with the passing seasons. Fluctuations in runs, which in themselves should not be regarded as absolute indicators of conditions, will occur, but a lessened catch is not to be dismissed as an unimportant development in the situation. A diminished catch, together with an inadequate escapement of salmon to the spawning grounds, presents what may be a serious condition of the fisheries, one which should receive the careful and thoughtful attention of both the Government and the packers. It is a recognized fact that in the southeast district salmon fishery operations are becoming more intensified each season, seines and traps alike being employed in greater numbers than before, and other movable appliances being operated more assiduously as the years go by. In view of these things, it is a logical conclusion that the industry can not hold its present position, much less grow, unless some provision is made for the replenishment of the fisheries.

Central Alaska, which is of much greater extent than either of the other districts, embraces some localities that showed a greatly reduced production of salmon in 1919, while other regions yielded approximately as many fish as in 1918, but for the district as a whole there was a heavy falling off sufficient to attract more than passing notice. A comparison of the packs in 1918 and 1919 shows that the shrinkage was largely in the catch of humpback and chum salmon and that the localities most seriously affected were Prince William Sound, Cook Inlet, and Kodiak Island waters. Though the decline was felt in all sections of the district, there is less cause for concern over the situation here than elsewhere in Alaska.

The season of 1919 was markedly a failure in western Alaska. The shrinkage in production was approximately 67 per cent, and it affected both canning and pickling operations. The pack of canned salmon was the smallest that has been made since 1900 and was 62 per cent less than in 1918. On the basis that the salmon of 1919 were four-year fish, a comparison with the pack in 1915 shows a drop of 48 per cent; if they were five-year fish, a comparison with the pack in 1914 shows a decline of 58 per cent. These percentages would have been higher were it not that the pack in 1919 included 57,085 cases of Yukon River salmon, whereas the packs of 1914 and 1915 did not include any Yukon salmon.

The cause of this sudden and serious falling off in the salmon runs of western Alaska, and especially Bristol Bay, is not known, but in the absence of a better reason it may be attributed to overfishing in recent years. Apparently it was not a question of delayed runs, but seems to have been due to a real scarcity of salmon. Some persons have held that the exhaustion of the salmon fisheries is practically impossible, but to those taking a broad view of the situation this breakdown of the run of red salmon is acceptable evidence of the fallacy of any theory that the runs are impregnable.

The records of the Bristol Bay district for the last 20 years afford a basis for serious study. At first glance they show that the drain on the red-salmon run has been steadily increasing, larger numbers

of salmon being taken, with few exceptions, in the successive seasons. The pack increased from 600,000 cases in 1900 to 1,666,000 in 1918. It then dropped to 589,464 cases in 1919, a decrease of about 65 per cent. Attention has been directed in the past to these constantly increasing catches and the encroachments they meant upon the number of salmon necessary for the maintenance of the runs and the corresponding reduction of the safety quota. It may be that the packers, who seemed to be devoting all their energies to increasing production, viewed the situation too optimistically during the plenteous years and that facts of vital importance were overlooked until the sudden break in 1919 from superficially satisfactory conditions. While there may be many speculations as to the cause of the let-down in 1919, the best explanation is that it was due to overfishing. This was in substance concurred in by various salmon packers, who agreed to the necessity of further limitation by departmental regulations upon fishing at a hearing on the matter held at Seattle in November, 1919.

Operations on the Yukon River were greater than in 1918, as a pack of approximately 57,000 cases of king and chum salmon was made by the one company there established. In addition a few hundred barrels of salmon were pickled. Approximately 500,000 salmon were used in the preparation of these products. All commercial fishing was carried on below the junction of the Clear River and the Yukon, and according to the reports of operators about two-thirds of the catch of salmon was made in Bering Sea off the mouth of the Yukon.

#### SALMON CATCH AND FORMS OF GEAR.

The greater part of the salmon catch of Alaska is made by three kinds of apparatus, namely, seines, gill nets, and pound nets. Statistics show that a total of 800 seines were operated in 1919, aggregating in length 137,284 fathoms. This is a decrease of 38 seines from the number used in 1918, but an increase of 6,157 fathoms in the amount of seine web. There was an increase of 28 in the number of seines in southeast Alaska, and a decrease of 39 and 27 in central and western Alaska, respectively. The total number of gill nets used in the salmon industry in 1919 was 4,120, the combined length of which was 459,937 fathoms, a decrease of 19,175 fathoms in the amount of gill-net web operated in Alaska as a whole. Each district shows a decline in the use of this form of gear. In southeast Alaska there were 3,172 fathoms less than in 1918; in central Alaska, 4,552 fathoms less; and in western Alaska, 11,451 fathoms less. These decreases were due in large part to the collapse of the pickling industry.

There were operated in connection with the salmon industry 630 pound nets, of which 484 were driven and 146 were floating, or an increase of 78 over the number used in 1918. Southeast Alaska is credited with 301 driven and 143 floating traps, gains of 11 and 64, respectively; central Alaska had 172 driven traps, an increase of 6 over 1918, and 3 floating traps, the first to be used in the district; western Alaska had 11 driven traps, as against 17 in 1918, a decrease of 6.

Taking Alaska as a whole, there was an increase in the number of fathoms of seines of  $4\frac{1}{2}$  per cent over 1918; there was a decrease in

the number of fathoms of gill nets of 4 per cent, and an increase of 14 per cent in the number of pound nets. In 1919 seines took 36 per cent of the total catch of salmon in Alaska; pound nets 42 per cent; gill nets 19 per cent; and lines, wheels, and dip nets the remaining 3 per cent. The catch, by apparatus, in 1918 was as follows: Seines, 30 per cent; pound nets, 41 per cent; gill nets, 28 per cent; and other appliances, 1 per cent. There was an increase in the 1919 catch by seines of 6 per cent, by pound nets of 1 per cent, and a falling off in the catch by gill nets of 9 per cent. The following table shows the proportionate catch by districts according to the principal kinds of apparatus:

PERCENTAGE OF SALMON CAUGHT IN EACH ALASKA DISTRICT BY PRINCIPAL FORMS OF APPARATUS.

Apparatus.	Southeast Alaska.		Central Alaska.		Western Alaska.	
	1918	1919	1918	1919	1918	1919
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Seines.....	38	46	39	31	4	3
Pound nets.....	58	49	48	50	4	4
Gill nets.....	2	2	11	18	90	92

Alaska produced 58,172,665 salmon of all species in 1919 as compared with 101,454,688 in 1918, a falling off of 42½ per cent. The decrease in southeast Alaska was 12,095,965, or approximately 23½ per cent; in central Alaska, 12,681,153, or 56 per cent; and in western Alaska, 18,504,905, or 67 per cent. This is the largest shrinkage from a previous season in the yield of salmon ever reported for Alaska. In 1919, the decrease by species was 481,835 cohos, 1,981,098 chums, 22,421,386 humpbacks, and 18,637,334 redds. Kings increased 240,230.

SALMON TAKEN IN 1919, BY APPARATUS AND SPECIES, FOR EACH GEOGRAPHIC SECTION OF ALASKA.

Apparatus and species.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
<b>Seines:</b>				
Coho, or silver.....	414,341	91,317	800	506,458
Chum, or keta.....	6,061,747	696,139	98,499	6,856,385
Humpback, or pink.....	10,459,348	736,662	13,343	11,209,353
King, or spring.....	9,516	2,076	4,826	16,418
Red, or sockeye.....	1,087,611	1,491,915	130,793	2,710,319
Total.....	18,032,563	3,018,109	248,261	21,298,933
<b>Gill nets:</b>				
Coho, or silver.....	335,739	61,869	103,419	501,027
Chum, or keta.....	249,133	87,432	586,190	922,755
Humpback, or pink.....	93,692	58,049	29,611	181,352
King, or spring.....	19,053	17,646	234,782	271,481
Red, or sockeye.....	401,561	1,580,602	7,232,274	9,214,437
Total.....	1,099,178	1,805,598	8,186,276	11,091,052
<b>Pound nets:</b>				
Coho, or silver.....	794,053	338,929	325	1,133,307
Chum, or keta.....	3,083,663	1,180,484	49,962	4,314,109
Humpback, or pink.....	13,760,123	645,287	2,681	14,408,091
King, or spring.....	43,963	34,863	26,944	105,770
Red, or sockeye.....	1,725,587	2,604,659	349,074	4,679,320
Total.....	19,407,389	4,804,222	428,986	24,640,597

## SALMON TAKEN IN 1919, BY APPARATUS AND SPECIES, FOR EACH GEOGRAPHIC SECTION OF ALASKA—Continued.

Apparatus and species.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
<b>Lines:</b>				
Coho, or silver.....	278,692			278,692
Chum, or keta.....	63,372			63,372
Humpback, or pink.....	96,180			96,180
King, or spring.....	564,606			564,606
Red, or sockeye.....	880			880
Total.....	1,003,730			1,003,730
<b>Dip nets:</b>				
Coho, or silver.....		10,362		10,362
King, or spring.....		3,554		3,554
Red, or sockeye.....		95,775		95,775
Total.....		109,691		109,691
<b>Wheels:</b>				
Chum, or keta.....			22,499	22,499
King, or spring.....			6,163	6,163
Total.....			28,662	28,662
<b>Total:</b>				
Coho, or silver.....	1,822,825	502,477	104,544	2,429,846
Chum, or keta.....	9,457,915	1,964,055	757,150	12,179,120
Humpback, or pink.....	24,409,343	1,439,998	45,635	25,894,976
King, or spring.....	637,138	58,139	272,715	967,992
Red, or sockeye.....	3,215,639	5,772,951	7,712,141	16,700,731
Grand total.....	39,542,860	9,737,620	8,892,185	58,172,665

## SALMON CANNING.

## CHANGES IN CANNERIES.

Several changes in the ownership of canneries were reported in 1919. In southeast Alaska, the Mountain Point Packing Co. acquired the plant of the Alaska Clam Canning Co., which ceased to operate in Alaska; the Southern Alaska Canning Co. took over the cannery of the Alaska Pacific Herring Co., at Big Port Walter, which latter concern was dissolved; the Doyhof Fish Products Co. sold its plant at Scow Bay to the G. W. Hume Co. and withdrew from Alaska. In central Alaska, the plant of the Lighthouse Canning Co., at Cordova, was sold to the Hillery-Scott Co.; the Eyak River Packing Co., operating a plant on Eyak River, was formerly the Clark-Graham Co.; and the Abercrombie Packing Co. was superseded by F. H. Madden. No change in the ownership of the latter cannery is understood to have taken place. In western Alaska, the interests of the Everett Packing Co., Phoenix Packing Co., and the Fidalgo Island Packing Co., all at Herendeen Bay, were consolidated. Their canning operations were carried on at the plant of the Fidalgo Island Packing Co. The Yukon cannery of the Carlisle Packing Co. was moved from Andraefski down to Kwiguk Slough, about 12 miles from the mouth.

NEW CANNERIES.<sup>a</sup>

There were 13 new salmon canneries in Alaska in 1919, 9 of which were opened and operated in southeast Alaska.

<sup>a</sup>New canneries are indicated by asterisks (\*) in the table on page 42.

In the central district two canneries, which before 1919 were engaged in canning other sea food, began the canning of salmon, and one new plant was opened.

In western Alaska one new cannery was put in operation. The Alaska Packers Association built a cannery on the Ugashik River, but owing to the small run of salmon it was not opened, and therefore is not included in the list in 1919.

## CANNERIES NOT OPERATED.

Fourteen canneries in Alaska were not operated in 1919, 9 of which were in southeast, 2 in central, and 3 in western Alaska. They were owned and located as follows:

Alaska Fisheries Co.....	Washington Bay.
Lane & Williams.....	Moira Sound.
T. E. P. Keegan.....	Douglas.
H. Van Vlack & Co.....	Thomas Bay.
Columbia Salmon Co.....	Craig.
Anacortes Fisheries Co.....	Shakan.
	{ Santa Ana.
	{ Hunter Bay.
Northwestern Fisheries Co.....	{ Roe Point.
	{ Orca.
	{ Seldovia.
Everett Packing Co.....	Herendeen Bay.
Phoenix Packing Co.....	Do.
Midnight Sun Packing Co.....	Kotzebue Sound.

The first 4 named above were permanently closed; the other 10 are reported as being idle rather than permanently closed.

## TOTAL CANNERIES OPERATED.

In all, there were 134 salmon canneries operated in Alaska in 1919, of which number southeast Alaska had 76, central Alaska 30, and western Alaska 28. There was no change in the number credited to the southeast district; the central district gained 1; and the western district lost 2.

## COMPANIES CANNING SALMON IN ALASKA, NUMBER AND LOCATION OF CANNERIES OPERATED, AND NUMBER OF POUND NETS OWNED BY EACH, 1919.

[New canneries indicated by \*.]

Company.	Canneries.		Pound nets.	
	Number.	Location.		
Southeast Alaska:				
Alaska Fish Co.....	1	Waterfall.....		
Alaska Herring & Sardine Co.....	1	Port Walter.....	a 20	
		{ Chilkoot.....	b 11	
		{ Chomly.....	c 8	
		{ Yes Bay.....	d 13	
Alaska Pacific Fisheries.....	3	{ Loring.....	e 11	
		{ Wrangell.....	e 6	
Alaska Packers Association.....	2	{ Wrangell.....		
Alaska Packing & Navigation Co.....	1	Pavlof Harbor.....		
Alaska Salmon & Herring Packers (Inc.).....	1	Tyce*.....		
Alaska Sanitary Packing Co.....	2	{ Cape Fanshaw*.....	5	
		{ Wrangell.....		
American Packing Co.....	1	Juneau.....	b 2	
Anacortes Fisheries Co.....	1	Kasaan.....	8	
Annette Island Packing Co.....	1	Metlakatla.....	7	
a 17 floating.	b 1 floating.	c 4 floating.	d 9 floating.	e 5 floating.

## COMPANIES CANNING SALMON IN ALASKA, NUMBER AND LOCATION OF CANNERIES OPERATED, AND NUMBER OF POUND NETS OWNED BY EACH, 1919—Continued.

Company.	Canneries.		Pound nets.
	Number.	Location.	
<b>Southeast Alaska—Continued.</b>			
Astoria & Puget Sound Canning Co. ....	1	Excursion Inlet .....	a 13
Auk Bay Salmon Canning Co. ....	1	Auk Bay .....	6
Baranof Packing Co. ....	1	Red Bluff Bay .....	2
Barnes, F. C., & Co. ....	1	Lake Bay .....	1
Beaulaie Packing Co. ....	1	Port Beaulaie* .....	a 5
Beagle Packing Co. ....	1	Ketchikan .....	b 5
Burnett Inlet Packing Co. ....	1	Burnett Inlet .....	1
Cape Fanshaw Fish & Packing Co. (Inc.) ..	1	Cape Fanshaw* .....	b 3
Carlson, John L., & Co. ....	1	Auk Harbor* .....	1
Cole, R. L., & Co. ....	1	Deweyville .....	1
Columbia Salmon Co. ....	1	Tenakee .....	1
Deep Sea Salmon Co. ....	2	{ Ford Arm .....	b 20
		{ Port Althorp .....	b 20
Douglas Island Packing Co. ....	1	{ Douglas Island* .....	7
		{ Ketchikan .....	c 9
Fidalgo Island Packing Co. ....	2	{ Pillar Bay .....	7
		{ George Inlet .....	2
George Inlet Packing Co. ....	1	George Inlet .....	2
Haines Packing Co. ....	1	Letinkof Cove .....	1
Harris, P. E., & Co. ....	1	Hawk Inlet .....	1
Hidden Inlet Canning Co. ....	2	{ Hidden Inlet .....	d 5
		{ Hood Bay .....	5
Hood Bay Packing Co. ....	1	{ Hood Bay* .....	1
Hoonah Packing Co. ....	2	{ Gambier Bay .....	a 13
		{ Hoonah .....	e 17
		{ Nakat Harbor .....	7
Humø, G. W., Co. ....	2	{ Scow Bay .....	4
		{ Karheen .....	5
Karheen Packing Co. ....	1	Karheen .....	5
Ketchikan Packing Co. ....	1	Ketchikan .....	16
Libby, McNeill & Libby .....	2	{ Taku Harbor .....	16
		{ Yakutat .....	1
Marathon Fishing & Packing Co. ....	1	Cape Fanshaw .....	b 3
Mountain Point Packing Co. ....	1	Wrangell Narrows .....	10
Myers, Geo. T., & Co. ....	1	Chatham .....	10
Northern Packing Co. (Inc.) ..	1	Juneau .....	1
North Pacific Trading & Packing Co. ....	1	Klawak .....	1
Northwestern Fisheries Co. ....	2	{ Dundas Bay .....	d 10
		{ Quadra .....	d 11
Noyes Island Packing Co. ....	1	Steamboat Bay .....	1
Olympic Fisheries Co. ....	1	(Floating)* .....	1
Pacific American Fisheries .....	1	Excursion Inlet .....	d 16
Petersburg Packing Corporation .....	2	{ Petersburg .....	a 10
		{ Washington Bay* .....	a 6
Point Ward Packing Co. ....	1	Point Ward .....	1
Pure Food Fish Co. ....	1	Ketchikan .....	c 4
Pybus Bay Fish & Packing Co. ....	1	Pybus Bay .....	2
Pyramid Packing Co. ....	1	Sitka .....	b 8
Sanborn-Cutting Co. ....	1	Kake .....	1
Sitka Packing Co. ....	1	Sitka .....	5
Smiley, J. L., & Co. ....	1	Ketchikan .....	b 5
		{ Big Port Walter .....	a 5
		{ Quadra Bay .....	4
		{ Rose Inlet .....	a 9
		{ Moira Sound .....	c 7
		{ Skowl Arm .....	f 21
		{ Ketchikan .....	c 6
		{ Heceta Island .....	4
		{ Tee Harbor .....	1
		{ Tenakee Inlet .....	1
		{ Fumter .....	c 6
		{ Peril Strait .....	1
		{ Union Bay .....	4
		{ Ward's Cove .....	1
		{ Alitak .....	5
		{ Chignik .....	4
		{ Kaslof .....	16
		{ Larsen Bay .....	1
		{ Cordova .....	c 2
		{ Lazy Bay .....	2
		{ Shepard Point .....	a 4
		{ Cordova .....	10
		{ Chignik .....	6
		{ Port Nellie Juan .....	5
		{ Eyak River .....	1
<b>Central Alaska:</b>			
Alaska Packers' Association .....	4	{ Alitak .....	5
		{ Chignik .....	4
		{ Kaslof .....	16
		{ Larsen Bay .....	1
Alaska Sea Food Co. ....	1	Cordova .....	c 2
Alitak Packing Co. ....	1	Lazy Bay .....	2
Canoe Pass Packing Co. ....	1	Shepard Point .....	a 4
Carlisle Packing Co. ....	1	Cordova .....	10
Columbia River Packers' Association ..	1	Chignik .....	6
Copper River Packing Co. ....	1	Port Nellie Juan .....	5
Eyak River Packing Co. ....	1	Eyak River .....	1

g 2 floating.  
b All floating.

c 1 floating.  
d 3 floating.

e 5 floating.  
f 4 floating.

## COMPANIES CANNING SALMON IN ALASKA, NUMBER AND LOCATION OF CANNERIES OPERATED, AND NUMBER OF POUND NETS OWNED BY EACH, 1919—Continued.

Company.	Canneries.		Pound nets.
	Number.	Location.	
Central Alaska—Continued.			
F. H. Madden .....	1	Abercrombie .....	4
Fidalgo Island Packing Co. ....	1	Port Graham .....	7
Franklin Packing Co. ....	1	Sawmill Bay * .....	2
Hillery-Scott Co. ....	1	Cordova .....	1
Hoonah Packing Co. ....	1	Katalla .....	1
Kadiak Fisheries Co. ....	1	Kodiak .....	3
Kenai Packing Co. ....	1	Drier Bay .....	18
Libby, McNeill & Libby .....	1	Kenai .....	2
Moore Packing Co. ....	1	Orea Inlet .....	4
		Chignik .....	16
Northwestern Fisheries Co. ....	3	Kenai .....	18
		Uyak .....	18
Pacific American Fisheries .....	2	Ikatan .....	18
		King Cove .....	4
Pioneer Packing Co. ....	1	Cordova * .....	2
San Juan Fishing & Packing Co. ....	1	Seward .....	4
Sockeye Salmon Co. ....	1	Morzhovoi Bay .....	1
Surf Packing Co. ....	1	Tuxedni Harbor * .....	4
Valdez Packing Co. ....	1	Valdez .....	4
Western Alaska:			
Alaska Packers' Association .....	8	Kvichak River (2) .....	4
		Naknek River (3) .....	
		Nushagak Bay (2) .....	
		Ugagak River .....	
Alaska-Portland Packers' Association .....	2	Naknek * .....	3
		Nushagak Bay .....	
Alaska Salmon Co. ....	1	Wood River .....	
Bristol Bay Packing Co. ....	1	Kvichak River .....	
Carlisle Packing Co. ....	1	Kwiguk Slough .....	1
Columbia River Packers' Association .....	1	Nushagak Bay .....	
Herendeen Bay Consolidated Canneries .....	1	Herendeen Bay .....	
		Ekuk .....	
		Kvichak Bay (Koggiung) .....	
		Libbyville .....	
Libby, McNeill & Libby .....	6	Lockanok .....	
		Nushagak .....	
		Ugagak River .....	
Naknek Packing Co. ....	1	Naknek River .....	
Nelson Lagoon Packing Co. ....	1	Nelson Lagoon .....	
Northwestern Fisheries Co. ....	2	Naknek River .....	
		Nushagak .....	
Pacific American Fisheries .....	1	Port Moller .....	
Red Salmon Canning Co. ....	2	Naknek River .....	
		Ugashik River .....	

## STATISTICS.

The number of salmon canneries in operation in Alaska in 1919 was 134, one less than in 1918. The investment in the salmon-canning industry was \$66,495,171, an increase of \$2,593,774. The southeast district shows an increase of \$4,770,765; the central district, an increase of \$937,266; and the western district, a decrease of \$3,114,257.

In 1919, the canning industry gave employment to 25,499 persons, or 1,003 less than the number employed in 1918. Whites increased 74, Chinese 36, Filipinos 239, and Mexicans 157. Natives decreased 1,124, Japanese 34, and miscellaneous 351.

A total of 4,583,688 cases of salmon, valued at \$43,265,349, was packed in Alaska in 1919, a decrease in pack of 2,022,147 cases and in value of \$7,776,600 from the production of 1918. This is a drop of 30½ per cent in output and 15 per cent in value from the high records of 1918. Perhaps for the first time in the history of salmon canning in Alaska each district shows a smaller pack than was

made in the preceding year. Comparing the 1918 pack with that of 1919, southeast Alaska dropped from 3,375,445 cases to 3,119,260, a decrease of 256,185 cases; central Alaska, from 1,391,951 to 771,907 a decrease of 620,044 cases; and western Alaska, from 1,838,439 to 692,521, a decrease of 1,145,918 cases. Comparing the pack by species for 1918 and 1919, it is found that cohos increased from 218,958 to 232,870 cases, a gain of 13,912 cases; chums increased from 1,364,960 to 1,365,563 cases, a gain of 603 cases; humpbacks dropped from 2,438,954 to 1,611,608 cases, a decrease of 827,346 cases; kings increased from 49,226 to 95,986 cases, an increase of 46,760 cases; and reds dropped from 2,533,737 to 1,277,661 cases, a decrease of 1,256,076 cases.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SALMON-CANNING INDUSTRY IN 1919.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
<b>INVESTMENT.</b>								
Canneries operated.....	No. 76	\$6,860,381	No. 30	\$2,606,786	No. 29	\$5,101,559	No. 135	\$14,568,726
Working capital.....		13,445,847		4,570,887		6,674,595		24,691,329
Wages paid.....		7,012,062		2,511,223		3,991,311		13,514,596
<b>Vessels:</b>								
Power vessels over 5 tons.....	358	2,374,186	100	1,009,051	77	1,145,325	535	4,528,562
Net tonnage.....	6,635		2,711		7,015		16,361	
Launches under 5 tons.....	147	157,114	149	152,458	43	201,847	339	511,419
Sailing.....	2	54,000	8	323,500	33	1,118,010	43	1,495,510
Net tonnage.....	2,954		12,389		45,982		61,325	
Barges.....	3	35,086					3	35,086
Net tonnage.....	3,295						3,295	
Rowboats and skiffs.....	1,242	104,093	821	124,413	1,458	629,438	3,521	857,944
Lighters, scows, and houseboats.....	392	332,193	246	257,133	185	369,176	823	958,502
Pile drivers.....	61	390,184	43	188,604	24	64,605	128	643,393
<b>Apparatus:</b>								
Haul seines.....	188	92,024	113	39,161			301	131,185
Fathoms.....	22,510		16,265				38,775	
Purse seines.....	396	331,368	72	32,991	22	39,200	490	403,559
Fathoms.....	75,140		17,069		5,700		97,909	
Gill nets.....	270	52,283	1,071	119,255	2,633	482,317	3,974	653,855
Fathoms.....	45,875		77,211		328,098		451,184	
Pound nets driven.....	292	2,161,187	172	953,348	11	37,000	475	3,151,535
Pound nets, floating.....	142	339,241	3	8,700			145	347,941
Dip nets.....			35	437			35	437
Fish wheels.....	1	642			6	950	7	1,592
<b>Total.....</b>		<b>33,741,891</b>		<b>12,897,947</b>		<b>19,855,333</b>		<b>66,495,171</b>
<b>PERSONS ENGAGED.</b>								
<b>Fishermen:</b>								
Whites.....	1,781		1,135		3,028		5,944	
Natives.....	1,376		282		61		1,719	
Filipinos.....	41						41	
Mexicans.....	28						28	
Miscellaneous <sup>a</sup> .....	56						56	
<b>Total.....</b>	<b>3,282</b>		<b>1,417</b>		<b>3,080</b>		<b>7,788</b>	
<b>Shoresmen:</b>								
Whites.....	3,258		1,151		2,064		6,473	
Natives.....	1,173		493		213		1,879	
Chinese.....	1,366		536		808		2,770	
Japanese.....	928		266		337		1,431	
Filipinos.....	878		279		379		1,536	
Mexicans.....	204		250		1,384		1,838	
Miscellaneous <sup>a</sup> .....	151		37		275		463	
<b>Total.....</b>	<b>7,958</b>		<b>3,012</b>		<b>5,420</b>		<b>16,330</b>	

<sup>a</sup> Koreans, Porto Ricans, Kanakas, Negroes, etc.

## INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SALMON CANNING INDUSTRY IN 1919—Continued.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
<b>PERSONS ENGAGED—</b>								
continued.								
<b>Transporters:</b>	No.		No.		No.		No.	
Whites.....	774		251		226		1,251	
Natives.....	14		19		3		36	
Miscellaneous <sup>a</sup> .....	23		6		5		34	
Total.....	811		276		234		1,321	
<b>Grand total:</b>								
Whites.....	5,813		2,537		5,318		13,668	
Natives.....	2,563		794		277		3,634	
Chinese.....	1,366		536		868		2,770	
Japanese.....	928		266		237		1,431	
Filipinos.....	919		279		379		1,577	
Mexicans.....	232		250		1,384		1,866	
Miscellaneous <sup>a</sup> .....	230		43		280		553	
Total.....	12,051		4,705		8,743		25,499	
<b>PRODUCTS.<sup>b</sup></b>								
<b>Coho, or silver:</b>	Cases.		Cases.		Cases.		Cases.	
$\frac{1}{2}$ -pound flat.....	8,597	\$130,524	910	\$10,926	212	\$3,400	9,719	\$144,850
1-pound flat.....	10,359	128,680			79	995	10,438	129,675
1-pound tall.....	150,558	1,661,074	54,831	601,210	7,324	88,017	212,713	2,350,301
Total.....	169,514	1,920,278	55,741	612,136	7,615	92,412	232,870	2,624,826
<b>Chum, or keta:</b>								
$\frac{1}{2}$ -pound flat.....	3,981	33,209					3,981	33,209
1-pound tall.....	1,141,744	7,706,656	160,222	1,084,132	59,616	496,459	1,361,582	9,287,247
Total.....	1,145,725	7,739,865	160,222	1,084,132	59,616	496,459	1,365,563	9,320,456
<b>Humpback, or pink:</b>								
$\frac{1}{2}$ -pound flat.....	27,990	286,607	195	1,835			28,185	288,442
1-pound flat.....	7,553	58,700					7,553	58,700
1-pound tall.....	1,488,979	12,420,147	86,449	698,213	442	3,544	1,575,870	13,121,904
Total.....	1,524,522	12,765,454	86,644	700,048	442	3,544	1,611,608	13,469,016
<b>King, or spring:</b>								
$\frac{1}{2}$ -pound flat.....	2,670	45,459	2,378	44,791	2,536	46,797	7,584	137,047
1-pound flat.....	2,002	27,981	640	8,052	8,890	132,803	11,532	168,836
1-pound tall.....	25,609	295,042	9,325	108,113	41,936	552,019	76,870	955,174
Total.....	30,281	368,482	12,343	160,956	53,362	731,619	95,986	1,261,057
<b>Red, or sockeye:</b>								
$\frac{1}{2}$ -pound flat.....	53,620	902,247	44,639	755,947	23,977	379,430	122,236	2,037,624
1-pound flat.....	43,960	589,979	43,487	511,117	23,044	294,405	110,491	1,395,501
1-pound tall.....	151,638	1,936,763	368,831	4,522,995	524,465	6,697,081	1,044,934	13,156,839
Total.....	249,218	3,428,989	456,957	5,790,059	571,486	7,370,916	1,277,661	16,589,964
<b>Grand total.....</b>	<b>3,119,260</b>	<b>26,223,068</b>	<b>771,907</b>	<b>8,347,331</b>	<b>692,521</b>	<b>8,694,950</b>	<b>4,583,688</b>	<b>43,265,349</b>

<sup>a</sup> Koreans, Porto Ricans, Kanakas, Negroes, etc.<sup>b</sup> Cases containing  $\frac{1}{2}$ -pound cans have been reduced one-half in number, and thus, for the purpose of affording fair comparison, all are put upon the basis of 48 1-pound cans per case.

OUTPUT OF CANNED SALMON IN ALASKA, 1913 TO 1919.<sup>a</sup>

Product.	1913	1914	1915	1916	1917	1918	1919	Total.
Coho, or silver:	<i>Cases.</i>							
½-pound flat.....	3,587	4,579	2,050	13,145	30,412	26,238	9,719	89,730
1-pound flat.....	266	285	2,338	8,191	362	12,786	10,438	31,666
1-pound tall.....	71,926	152,199	119,880	240,573	162,457	179,934	212,713	1,139,682
Total.....	75,779	157,063	124,268	261,909	193,231	218,958	232,870	1,264,078
Chum, or keta:								
½-pound flat.....	985	373	.....	1,423	26,760	3,559	3,981	37,081
1-pound flat.....	2,619	5,568	317	.....	2,530	2,996	.....	14,030
1-pound tall.....	287,314	657,918	479,629	722,692	877,457	1,358,405	1,361,582	5,744,997
Total.....	290,918	663,859	479,946	724,115	906,747	1,364,960	1,365,563	5,796,108
Humpback, or pink:								
½-pound flat.....	20,822	2,103	4,325	41,491	91,403	63,557	28,185	251,886
1-pound flat.....	3,258	9,286	3,508	14,796	6,014	20,215	7,553	64,630
1-pound tall.....	1,348,801	974,660	1,867,683	1,681,506	2,199,559	2,355,182	1,575,570	12,003,261
Total.....	1,372,881	986,049	1,875,516	1,737,793	2,296,976	2,438,954	1,611,608	12,329,777
King, or spring:								
½-pound flat.....	1,585	3,143	2,404	2,617	12,973	6,000	7,584	36,306
1-pound flat.....	.....	4,804	3,755	3,804	5,133	5,267	11,532	34,295
1-pound tall.....	32,785	40,092	82,092	59,452	43,845	37,959	76,870	373,095
Total.....	34,370	48,039	88,251	65,873	61,951	49,226	95,986	443,696
Red, or sockeye:								
½-pound flat.....	29,041	53,825	52,033	81,565	124,309	137,008	122,236	600,017
1-pound flat.....	11,735	64,671	112,847	86,395	89,612	151,864	110,491	627,615
1-pound tall.....	1,924,461	2,083,147	1,765,139	1,936,971	2,274,460	2,244,865	1,044,934	13,273,977
1½-pound nominals.....	.....	.....	2,293	.....	.....	.....	.....	2,293
2-pound nominals.....	.....	.....	.....	6,006	.....	.....	.....	6,006
Total.....	1,965,237	2,201,643	1,932,312	2,110,937	2,488,381	2,533,737	1,277,661	14,509,908
Grand total.....	3,739,185	4,056,653	4,500,293	4,900,627	5,947,286	6,605,835	4,583,688	34,333,567

<sup>a</sup> The number of cases shown has been put upon the common basis of 48 1-pound cans per case.

## AVERAGE ANNUAL PRICE PER CASE OF 48 1-POUND CANS OF SALMON, 1909 TO 1919.

Product.	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
Coho, or silver.....	\$4.07	\$4.89	\$5.67	\$4.44	\$3.45	\$4.39	\$4.31	\$5.34	\$8.76	\$9.15	\$11.27
Chum, or keta.....	2.28	3.04	3.72	2.37	2.21	3.37	2.59	3.34	6.14	6.27	6.82
Humpback, or pink...	2.40	3.15	3.94	2.55	2.58	3.50	2.78	3.64	6.44	6.58	8.35
King, or spring.....	4.32	5.34	6.48	5.37	4.04	5.01	4.63	5.36	10.40	9.85	13.13
Red, or sockeye.....	4.53	5.30	6.33	5.45	4.54	5.58	5.82	6.04	9.48	9.44	12.98

## LOSSES AND DISASTERS IN SALMON-CANNING INDUSTRY.

The heaviest losses of property in the salmon-canning industry occurred in southeast Alaska, the largest single item being the cannery of the Alaska Pacific Fisheries, at Chilkoot, which, with its contents, was destroyed by fire on June 8, 1919. The buildings were valued at \$20,502 and the contents, composed largely of gear and supplies for the season's operations, at \$33,445, thus making a total loss of \$53,947. Further losses in the same district were small buildings valued at \$6,822, boats and floating equipment at \$19,123, and gear at \$12,448. The total of all reported property losses in southeast Alaska was \$92,340.

In central Alaska a fire at the cannery of the Carlisle Packing Co., at Cordova, destroyed a web house and contents, the combined value of which was \$30,144. Additional losses in that district consisted of miscellaneous small buildings valued at \$2,000, scows and boats at \$5,657, and gear at \$7,550. In all, property valued at \$45,351 was lost in central Alaska.

Losses in western Alaska aggregated \$11,770, of which amount \$4,450 represented the value of floating property, including the schooner *Premier* (292 tons net), which belonged to the Alaska Packers' Association, and was wrecked off the southern coast of the Alaska Peninsula while making the voyage from San Francisco to Bristol Bay. Small buildings and wharfs valued at \$2,200 and gear valued at \$5,120 constitute the other losses of property in western Alaska.

The value of all property lost in Alaska in connection with salmon canning in 1919 was \$149,461.

Thirteen lives were lost in this industry. In southeast Alaska one fisherman was drowned and three shoresmen were killed; in central Alaska one fisherman and one shoresman were killed; and in western Alaska two fishermen were killed and three fishermen, one shoresman, and one transporter were drowned.

#### MILD CURING OF SALMON.

The mild-cure salmon industry shows a marked advance in 1919 over that reported in 1918. It was centered almost exclusively in southeast Alaska, the investment being credited wholly to that district. A total of 5,376 tierces of salmon was mild cured in Alaska in 1919, an increase of 1,428 tierces over the production in 1918. Of this number, 5,194 tierces were packed in southeast Alaska, 7 in central and 175 in the western district. There were more than 30 packers of mild-cured salmon, chief among which were the following concerns:

Goemaere Fish Co. (Inc.).....	Washington Bay.
	Tye.
	Port Conclusion.
	Port Alexander.
Pacific Mild Cure Co.....	Waterfall.
	Ketchikan.
	Cape Fanshaw.
	3 floating plants.
Columbia & Northern Fishing & Packing Co.....	Wrangell.
Vendsyssel Packing Co.....	Tye.
H. R. Thompson.....	Ketchikan.
Columbia Salmon Co.....	Tenakee.
M. B. Dahl & Co.....	Floating plant.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SALMON MILD CURING INDUSTRY IN 1919.

Item.	Tierces.	Number.	Value.	Item.	Tierces.	Number.	Value.
<b>INVESTMENT.<sup>a</sup></b>				<b>PERSONS ENGAGED—</b>			
Plants.....		11	\$89,388	continued			
Operating capital.....			547,006	Transporters:			
Vessels:				Whites.....		21	
Power vessels over 5				Grand total.....		133	
tons.....	23		86,888	<b>PRODUCTS.</b>			
Net tonnage.....	407			<b>Southeast Alaska:</b>			
Barges.....	1		3,000	Coho salmon.....	28	Pounds. 22,600	\$4,656
Net tonnage.....	176			Chum salmon.....	2	1,600	140
Launches under 5				King salmon.....	5,164	4,130,800	874,879
tons.....	9		5,124	Total.....	5,194	4,155,000	879,675
Rowboats and skiffs.....	10		347	<b>Central Alaska:</b>			
Lighters and scows.....	4		9,850	King salmon.....	7	5,600	950
Apparatus:				<b>Western Alaska:</b>			
Lines.....		4	32	King salmon.....	175	140,000	36,175
Total.....			741,635	Grand total.....	5,376	4,290,600	916,800
<b>PERSONS ENGAGED.<sup>a</sup></b>							
Fishermen:							
Whites.....		2					
Shoresmen:							
Whites.....		101					
Natives.....		8					
Japanese.....		1					
Total.....		110					

<sup>a</sup> Southeast Alaska only.

SALMON PICKLING.

The salmon-pickling industry of Alaska in 1919 shows a general shrinkage in all directions from the high figures of 1918 and in such proportions as to be little less than a collapse of the industry. In comparing the records of 1918 with those of 1919, some interesting facts are disclosed. Southeast Alaska had 7 plants in 1918 as against none in 1919, and an investment of \$278,306 in 1918, as against none in 1919; central Alaska had 2 salteries in 1919 as against 9 in 1918, and investments of \$236,261 in 1919 as compared with \$492,160 in 1918; western Alaska had 9 salteries in 1919 as against 11 in 1918, and investments of \$354,161, as compared with \$592,491 in 1918. There was a total decrease of 16 salteries and a smaller investment by \$772,535.

The reported pack of pickled salmon was 8,110 barrels, valued at \$195,447, as compared with 56,890 barrels in 1918, valued at \$1,079,881. All pickling operations in southeast Alaska in 1919 were incidental to more important undertakings, while a considerable part of the pack in central and western Alaska was prepared by concerns engaged chiefly in other fishery activities, particularly salmon canning. The most important packers in the respective districts were as follows: Southeast Alaska, Pacific Mildcure Co. and Columbia & Northern Fishing & Packing Co.; central Alaska, Shumagin Packing Co. and Universal By-Products Co.; western Alaska, Alaska Packers Association, Bering Sea Salmon Packing Co., Golden Gate Salmon Co., Libby McNeill & Libby, Peter M. Nelson, and Alaska Salmon Co.

One noteworthy change in the ownership of salteries occurred in western Alaska when the plant of Olson Bros., at Koggiung, was sold to the Bering Sea Salmon Packing Co., of San Francisco.

Losses in the salmon-pickling industry were small, consisting wholly of miscellaneous gear, valued at \$3,550.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SALMON-PICKLING INDUSTRY IN 1919.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
<b>INVESTMENT.</b>								
	No.		No.		No.		No.	
Salteries.....			2	\$36,955	9	\$102,750	11	\$139,705
Operating capital.....				129,736		131,346		261,082
<b>Vessels:</b>								
Power vessels over 5 tons.....			2	11,000	3	23,000	5	34,000
Net tonnage.....			16		57		73	
Sailing.....					3	49,725	3	49,725
Net tonnage.....					991		991	
Launches under 5 tons.....					9	16,800	9	16,800
Rowboats and skiffs.....			32	1,920	47	10,015	79	11,935
Lighters and scows.....					5	6,800	5	6,800
File driver.....					1	2,000	1	2,000
<b>Apparatus:</b>								
Haulseines.....					7	800	7	800
Fathoms.....					300		300	
Purse seines.....			1	2,800			1	2,800
Fathoms.....			200				200	
Gillnets.....			14	3,850	110	10,225	124	14,075
Fathoms.....			1,050		6,438		7,488	
Pound nets, driven.....			5	50,000			5	50,000
Wheels.....					2	700	2	700
<b>Total.....</b>				<b>238,261</b>		<b>354,161</b>		<b>590,422</b>
<b>PERSONS ENGAGED.</b>								
<b>Fishermen:</b>								
Whites.....			38		66		104	
Natives.....			1		22		23	
<b>Total.....</b>			<b>39</b>		<b>88</b>		<b>127</b>	
<b>Shoemen:</b>								
Whites.....			18		59		77	
Natives.....			6		1		7	
Mexicans.....					25		25	
<b>Total.....</b>			<b>24</b>		<b>85</b>		<b>109</b>	
<b>Transporters:</b>								
Whites.....			21		8		29	
Natives.....					2		2	
<b>Total.....</b>			<b>21</b>		<b>10</b>		<b>31</b>	
<b>Grand total.....</b>			<b>84</b>		<b>183</b>		<b>267</b>	
<b>PRODUCTS.<sup>a</sup></b>								
	Barrels.		Barrels.		Barrels.		Barrels.	
Coho, or silver.....	706	\$13,206	204	3,024	292	5,918	1,202	22,148
Chum, or keta.....	70	2,080	27	135	41	555	138	2,770
Humpback, or pink.....	26	260	50	700	45	548	121	1,508
King, or spring.....	241	4,542	8	232	618	16,267	867	21,041
Red, or sockeye.....	12	355	587	12,380	5,183	135,245	5,782	147,980
<b>Total.....</b>	<b>1,055</b>	<b>20,443</b>	<b>876</b>	<b>16,471</b>	<b>6,179</b>	<b>158,533</b>	<b>8,110</b>	<b>195,447</b>

<sup>a</sup> Each barrel holds 200 pounds of fish.

## SALMON FREEZING.

The output of frozen salmon from Alaska in 1919 was prepared by six companies in southeastern Alaska engaged primarily in the freezing of halibut and the canning of salmon. For that reason, no investment is credited to this business and no persons are shown as employed therein. The companies referred to were as follows: Booth Fisheries Co., Goemaere Fish Co. (Inc.), Juneau Cold Storage Co., Libby, McNeill & Libby, National Independent Fisheries Co., New England Fish Co.

There was produced in Alaska in 1919 a total of 1,552,480 pounds of frozen salmon, valued at \$130,355, a decrease from 1918 of 325,442 pounds in production and of \$40,509 in value.

## QUANTITY AND VALUE OF SALMON FROZEN IN ALASKA IN 1919, BY SPECIES.

Species.	Pounds.	Value.
Coho, or silver.....	254,784	\$27,022
Chum, or keta.....	437,878	28,651
Humpback, or pink.....	356,680	17,834
King, or spring.....	396,213	46,156
Red, or sockeye.....	106,925	10,692
Total.....	1,552,480	130,355

## FRESH-SALMON TRADE.

The fresh-salmon trade of Alaska in 1919 was confined wholly to the southeast district. Nearly all of this business was incidental to the canning and mild-curing industry, there being only three firms whose chief trade was dealing in fresh salmon. They were Knutsen Bros., at West Point, and H. Bergman and the Fresh Fish Co., both at Ketchikan. The quantity of salmon sold fresh in Alaska in 1919 was reported as 5,208,327 pounds, valued at \$356,688. This is an increase in production of 947,412 pounds, and in value of \$20,112.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA FRESH-SALMON TRADE IN 1919.<sup>a</sup>

Item.	Quantity.	Value.	Item.	Quantity.	Value.
<b>INVESTMENT.</b>			<b>PERSONS ENGAGED.</b>		
	<i>Number.</i>				
Operating capital.....		\$27,685	Fishermen: Whites.....	16	
Wages paid.....		27,581	Shoresmen: Whites.....	8	
Launches.....	2	2,800	Transporters: Whites.....	10	
Rowboats.....	11	470	Total.....	34	
Seines, haul (100 fathoms).....	1	150	<b>PRODUCTS.</b>		
Gillnets (105 fathoms).....	2	150		<i>Pounds.</i>	
Pound nets, driven.....	4	43,000	Coho, or silver.....	1,306,698	\$71,694
Pound nets, floating.....	1	2,500	Chum, or keta.....	420,722	15,334
Total.....		104,336	Humpback, or pink.....	450,429	9,703
			King, or spring.....	2,695,854	242,756
			Red, or sockeye.....	334,624	17,201
			Total.....	5,208,327	356,688

<sup>a</sup> Confined wholly to southeast Alaska in 1919.

## DRY SALTING OF SALMON.

The dry salting of salmon in Alaska in 1919 was represented by the activities of a single packer, the Kuskokwim Fishing & Transportation Co., at Apokak. The investment was increased from \$58,345 in 1918 to \$103,862 in 1919, the increase being accounted for entirely by the inclusion of the value of certain vessels not reported in 1918.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA DRY SALTING OF SALMON IN 1919.<sup>a</sup>

Item.	Quantity.	Value.	Item.	Quantity.	Value.
INVESTMENT.			PERSONS ENGAGED—cont.		
	<i>Number.</i>			<i>Number.</i>	
Plants.....	1	\$10,000	Shoresmen:		
Operating capital.....		29,162	Whites.....	3	
Power vessels over 5 tons.....	4	63,000	Natives.....	25	
Net tonnage.....	423		Transporters:		
Launches.....	1	200	Whites.....	1	
Seine and rowboats.....	16	900	Total.....	39	
Gillnets, 1,160 fathoms.....	20	600			
Total.....		103,862	PRODUCTS.		
PERSONS ENGAGED.				<i>Pounds.</i>	
Fishermen:			Coho, or silver.....	71,670	\$7,167
Whites.....	10		Chum, or keta.....	15,104	1,359
			King, or spring.....	110,820	7,757
			Red, or sockeye.....	14,650	1,318
			Total.....	212,244	17,601

<sup>a</sup> Confined wholly to western Alaska.

## DRYING AND SMOKING OF SALMON.

The drying and smoking of salmon in Alaska is not an essential branch of the salmon industry, though a considerable quantity of salmon is doubtless so prepared and used locally, chiefly by the Indians. Statistics of the number of salmon used in this way are unavailable, but a conservative estimate would place the quantity at 400,000 pounds, having a value of at least \$40,000. In addition to this, the Juneau Cold Storage Co. kippered 15,000 pounds of salmon, valued at \$3,000.

## SALMON BY-PRODUCTS.

The most notable change in the salmon by-products industry was the withdrawal from Alaska of the Fish Cannery By-Products Co., at Ward Cove. This company met with misfortune in 1918 by the loss in transit of new machinery intended for installation in its oil and fertilizer factory, and as a result it decided not to operate. The plant was then offered for sale and remained idle in 1919.

The Pacific American Fisheries was the only concern in Alaska in 1919 utilizing the offal and other fishery waste at its canneries in the production of by-products. It operated plants in connection with the canneries at Excursion Inlet in southeast Alaska, and at Ikatan in central Alaska. As these reduction plants were incidental to the canning of salmon, no investment in the by-products industry is shown for 1919. The products were 362 tons of fertilizer, valued at \$18,680, and 966 gallons of oil, valued at \$966.

## HALIBUT FISHERY.

The large halibut banks of the North Pacific Ocean are located largely in extraterritorial waters. They are fished by vessels from Seattle, Prince Rupert, and Alaskan ports, to which places fares are delivered. There are also large banks off the coast of British Columbia, Washington, and Oregon, which are visited by these same vessels. The impracticability of making the necessary segregation of catches, in order to show how much of the total production of halibut from the Pacific Ocean should be credited to the respective regions, is at once obvious. The statistics appearing herein include all catches delivered at ports in Alaska and at Seattle by American vessels fishing on Yakutat, Portlock, Albatross, and the banks adjacent to the coast of southeast Alaska. A total of 14,278,791 pounds is thus accounted for. American vessels also delivered at Prince Rupert and Vancouver a total of 11,761,750 pounds of halibut which in all probability came largely from the Alaskan banks.

## STATISTICAL SUMMARY.

The investment in the halibut industry in 1919 was \$1,979,457, as against \$2,594,292 in 1918, a falling off of \$614,835. The industry gave employment to 867 persons as compared with 1,186 in 1918, a decrease of 319. Production increased from 13,869,706 pounds in 1918 to 14,278,791 pounds in 1919, a total of 409,085 pounds. Values dropped from \$1,667,686 to \$1,550,605, a decline of \$117,081.

The principal handlers of halibut were Libby, McNeill & Libby, at Taku; New England Fish Co., at Ketchikan; Alaska Fish & Cold Storage Co., successor to the Glacier Fish Co., at Scow Bay; Booth Fisheries Co., at Sitka; Juneau Cold Storage Co., at Juneau; National Independent Fisheries Co., at Juneau; Ripley Fish Co., at Ketchikan, Wrangell, and Petersburg; and the San Juan Fishing & Packing Co., at Seward.

One fisherman was drowned while engaged in halibut fishing. Minor property losses aggregating in value \$10,000 were also reported.

## INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA HALIBUT FISHERY IN 1919.

Item.	Quantity.	Value.	Item.	Quantity.	Value.
<b>INVESTMENT.</b>			<b>PERSONS ENGAGED.</b>		
Fishing vessels:	<i>Number.</i>		Whites	<i>Number.</i> 863	
Steam and gas.....	94	\$1,140,900	Natives.....	3	
Net tonnage.....	1,957		Japanese.....	1	
Outfit.....		560,000	<b>Total.....</b>	<b>867</b>	
Launches.....	5	11,451			
Dories and scows.....	192	10,200	<b>PRODUCTS.</b>		
Fishing apparatus.....		51,550		<i>Pounds.</i>	
Shore property.....		205,356	Fresh (including local).....	7,783,179	\$880,433
<b>Total.....</b>		<b>1,979,457</b>	Frozen.....	6,495,372	670,147
			Canned.....	240	25
			<b>Total.....</b>	<b>14,278,791</b>	<b>1,550,605</b>

**HERRING FISHERY.**

The herring industry of Alaska suffered a decided setback in 1919, due to a weaker demand for Alaska pickled herring. Packers experienced great delay in marketing their products, the explanation being that the importation of European herring had closed the large eastern markets to the Scotch-cured herring from Alaska, and that the Norwegian-cured herring from Alaska were virtually unsalable. A further reason may be given for this unsatisfactory condition, namely, faulty packing and poor selection, both of which are matters wholly within the control of the packers. Any difficulty they encountered in the disposal of herring so packed may be easily understood. If the industry is to survive and expand, it is imperative that goods of high standard be produced regardless of method of cure.

A review of operations in 1919 would indicate that packers recognized the fact that Scotch-cured herring are preferred in American markets to those of any other cure. This is evidenced by the statistics for that year, which show that the bulk of the pack was prepared according to the Scotch formula, though the total production was considerably less than in 1918.

**STATISTICAL SUMMARY.**

The investment in the herring industry in 1919 was \$900,572, a decrease of more than 50 per cent from the amount reported in 1918. This was partly due to a change in classification of some operators, but a further cause was the failure of a number of packers to resume operations in 1919. The number of persons employed was 427, or approximately 50 per cent less than in 1918, when 884 were reported. The herring products in 1919 were valued at \$1,676,170, as compared with \$1,819,538 in 1918, a decrease of \$143,368. Canned herring was the leading product, representing in value more than 50 per cent of the total output. Scotch-cured herring took second place, although there was a decline in production of 20 per cent and a shrinkage in value of approximately 40 per cent from 1918. The production of Norwegian-cured herring dropped to 11,080 barrels, or a falling off in output of 73 per cent as compared with the pack in 1918.

Losses in the herring industry aggregated \$7,360, of which amount \$2,600 represented the value of apparatus and other equipment, and \$4,760 the value of 281 barrels of pickled herring.

## INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA HERRING FISHERY IN 1919.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
<b>INVESTMENT.</b>								
Plants operated.....	4	\$98,192	6	\$92,491	1	\$12,000	11	\$202,683
Operating capital.....		224,866		257,550		24,283		506,699
<b>Vessels:</b>								
Power vessels over 5 tons.....	8	41,500	8	37,300	1	6,500	17	85,300
Net tonnage.....	195		134		11		340	
Launches under 5 tons.....	2	6,592	5	7,500	1	1,000	8	15,092
Boats, row and seine.....	22	1,860	26	1,375	11	1,000	59	4,235
Lighters and scows.....	8	12,500	8	9,700	2	350	18	22,550
Pile driver.....	1	1,500					1	1,500
<b>Apparatus:</b>								
Haul seines.....	6	10,500	10	13,077	2	530	18	24,107
Fathoms.....	560		1,685		200		2,445	
Purse seines.....	10	21,061	3	8,000	6	3,500	19	32,561
Fathoms.....	1,230		490		600		2,320	
Gill nets.....			14	1,860	100	1,500	114	3,360
Fathoms.....			700		1,700		2,400	
Dip nets.....			2	10			2	10
Pound nets.....			6	2,475			6	2,475
<b>Total.....</b>		<b>418,571</b>		<b>431,338</b>		<b>50,663</b>		<b>900,572</b>
<b>PERSONS ENGAGED.</b>								
<b>Fishermen:</b>								
Whites.....	67		38		5		110	
Natives.....	3		9		16		28	
Others.....	5		16				21	
<b>Total.....</b>	<b>75</b>		<b>63</b>		<b>21</b>		<b>159</b>	
<b>Shoresmen:</b>								
Whites.....	58		86		6		150	
Natives.....	7		24		71		102	
Others.....	11						11	
<b>Total.....</b>	<b>76</b>		<b>110</b>		<b>77</b>		<b>263</b>	
Transporters: Whites.....			5				5	
<b>Grand total.....</b>	<b>151</b>		<b>178</b>		<b>98</b>		<b>427</b>	
<b>PRODUCTS.</b>								
Canned (3-pound cans).....							a 6,357	40,395
Canned (1-pound cans).....							a 95,448	811,366
Dry salted for food.....							b 510,000	20,150
Fresh for bait.....							b 1,254,926	11,210
Frozen for bait.....							b 2,444,655	24,246
Pickled for bait.....							b 40,000	800
Pickled for food, Scotch cure.....							b 7,718,985	451,240
Pickled for food, spiced.....							b 11,715	1,676
Pickled for food, Norwegian cure.....							b 2,216,120	147,634
Fertilizer.....							c 856	56,653
Oil.....							d 169,374	110,800
<b>Total.....</b>								<b>1,676,170</b>

a Cases.

b Pounds.

c Tons.

d Gallons.

**COD FISHERY.**

The outstanding facts in connection with the cod industry of Alaska in 1919 are a decrease in production of 23 per cent as compared with that of 1918 and a reduction in the number of operators from 32 to 19. The most conspicuous withdrawal from this field was that of the Northern Fisheries (Inc.), which in 1918 was likewise the most conspicuous accession to the list of operators. Other withdrawals were said to have been occasioned by the lack of transportation, a difficulty which could not be overcome successfully, since no regular

steamer service was maintained in western Alaska. Other operators claimed that their business was injured by the importation of cod from Japan with which they were unable to compete.

Bering Sea retains its supremacy as the chief field of production, though very considerable catches were made on the banks of the Pacific Ocean south of the Alaska Peninsula. Winter fishing in the vicinity of the Shumagin and Sannak Islands is carried on rather indifferently since the introduction of power dories, previous to the use of which it constituted a prosperous industry. The reason assigned for the decline of the winter fishing is that the fishermen are not able to handle the additional weight which the installation of power in the dories has meant when it becomes necessary to launch or haul out their boats. The common dory was easily handled on the beaches.

## VESSEL FISHERY.

Two important changes occur in the list of companies and individuals carrying on the vessel cod fishery of Alaska in 1919; one is the omission of the Northern Fisheries (Inc.), which did not resume operations after 1918, and the other the addition of Lars Mikkelson who purchased and sent north to engage in cod fishing in the vicinity of the Aleutian Islands the steamer *Dora*, which by reason of its years of faithful service to the people of western Alaska, is now the most noted vessel in Territorial waters. The small gas schooner *Alice*, used by the Northern Fisheries (Inc.), in connection with its shore station at Kodiak, is now shown under the name of the W. J. Erskine Co., while the schooners *Charles Brown* and *Azalea* and the gas schooner *Valdez* are dropped from the list. The *Allen A*, belonging to the Alaska Codfish Co., was reported a total loss by being blown ashore on Unga Island early in the year, but subsequently it was hauled off and towed to Seattle for repairs, and finally sold. The *Fanny Dutard*, owned by J. A. Matheson, was withdrawn from foreign trade in which it was engaged in 1918 and reentered the Bering Sea cod fleet in 1919. No other changes were noted in the vessels operated.

## ALASKA COD FLEET IN 1919.

Name.	Rig.	Net tonnage.	Operators.
City of Papeete.....	Schooner.....	370	Alaska Codfish Co., San Francisco, Calif.
Glendale.....	do.....	281	Do.
Mawema.....	do.....	392	Do.
Alasco.....	Power schooner.....	23	Do.
Alasco II.....	do.....	5	Do.
Alasco III.....	do.....	8	Do.
Trio.....	do.....	9	Alaska Ocean Food Co., Seattle, Wash.
Fanny Dutard.....	Schooner.....	252	J. A. Matheson, Anacortes, Wash.
Dora.....	Steamer.....	217	Lars Mikkelsen, Seattle, Wash.
John A.....	Schooner.....	235	Pacific Coast Codfish Co., Seattle, Wash.
Chas. R. Wilson.....	do.....	328	Do.
Maid of Orleans.....	do.....	171	Do.
Alice.....	do.....	220	Robinson Fisheries Co., Anacortes, Wash.
Wawona.....	do.....	413	Do.
Sequoia.....	do.....	324	Union Fish Co., San Francisco, Calif.
Galilee.....	do.....	328	Do.
Beulah.....	do.....	339	Do.
Louise.....	do.....	328	Do.
Martha.....	do.....	14	Do.
Golden State.....	Power schooner.....	223	Do.
Pirate.....	do.....	30	Do.
Union Flag.....	do.....	10	Do.
Alice.....	do.....	15	W. J. Erskine Co., Kodiak, Alaska.
Flossie.....	do.....	10	Do.
Edith.....	do.....	7	Do.

## SHORE STATIONS.

Only two concerns in southeast Alaska reported having handled any cod. They were Libby, McNeill & Libby and the New England Fish Co., both of which froze a few tons of cod incidentally in the freezing of halibut. The more important operators in central Alaska were the Alaska Ocean Food Co., at Port Chatham; W. J. Erskine Co. and O. Kraft & Son, at Kodiak; Shumagin Packing Co., at Squaw Harbor; Pacific American Fisheries, at Ikatan; and the Union Fish Co. and the Alaska Codfish Co., at several stations in the Shumagin and Sannak Islands.

## STATISTICAL SUMMARY.

The investment in the Alaska codfish industry in 1919 was \$1,286,075, which is an increase of \$14,957 over that of 1918. A total of 702 persons were employed as compared with 697 in 1918.

A total of 10,893,312 pounds of cod was produced, having a value of \$825,990. This is a decrease of 3,169,648 pounds in production, and \$131,194 in value.

## INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA COD FISHERY IN 1919.

Item.	Quantity.	Value.	Item.	Quantity.	Value.
<b>INVESTMENT.</b>			<b>PERSONS ENGAGED—contd.</b>		
	<i>Number.</i>			<i>Number.</i>	
Value of shore stations.....		\$139,070	Transporters:		
Cost of operations.....		196,590	White.....	173	
Wages paid.....		546,063	Grand total.....	702	
Vessels:			<b>PRODUCTS.</b>		
Power vessels over 5 tons	10	114,644	Vessel catch:	<i>Pounds.</i>	
Net tonnage.....	547		Dry salted cod.....	8,015,668	\$638,880
Launches under 5 tons..	50	26,915	Pickled cod.....	416,398	20,837
Sailing vessels.....	14	239,070	Frozen cod.....	86,971	4,209
Net tonnage.....	3,753		Tongues.....	17,400	1,740
Dories.....	292	14,590	Total.....	8,536,437	665,666
Pile drivers.....	2	250	Shore-station catch:		
Apparatus:			Dry-salted cod.....	1,813,675	134,417
Seines (75 fathoms).....	1	250	Pickled cod.....	539,700	25,177
Gill nets (75 fathoms)...	1	195	Stockfish.....	2,900	700
Hooks.....	3,024	53	Tongues.....	600	30
Lines.....	1,246	8,385	Total.....	2,356,875	160,324
Total.....		1,286,075	Total:		
<b>PERSONS ENGAGED.</b>			Dry-salted cod.....	9,829,343	773,297
Fishermen:			Pickled cod.....	956,098	46,014
Whites.....	494		Frozen cod.....	86,971	4,209
Natives.....	8		Stockfish.....	2,900	700
Negroes.....	2		Tongues.....	18,000	1,770
Total.....	504		Total.....	10,893,312	825,990
Shoresmen:					
White.....	25				

## WHALE FISHERY.

## SHORE STATIONS.

Three companies were reported as having engaged in whaling operations in Alaska in 1919. They were the United States Whaling Co., at Port Armstrong; North Pacific Sea Products Co., at Akutan; and the Pioneer Mining & Ditch Co., at Nome, the latter concern taking only the beluga or white whale.

The United States Whaling Co. operated three steamers in whale killing, *Star I* (133 tons), *Star II*, and *Star III* (97 tons each). The North Pacific Sea Products Co. employed a fleet of four steam whalers, the *Kodiak* and *Unimak* (99 tons each), the *Paterson* (77 tons), and the *Tanginak* (71 tons). The steamer *Elihu Thompson* (448 tons) and the barge *Fresno* (1,149 tons) were used as transporting and refrigerating vessels. No losses were reported in this industry. The results of the season were exceptionally gratifying, a large number of whales being captured.

## STATISTICAL SUMMARY.

The investment in the whaling industry in Alaska in 1919 was \$1,790,867, an increase of \$439,896 over 1918. Employment was given to 311 men, or 14 less than in 1918. The value of the whale products was \$1,027,200 as compared with \$834,127 in 1918. Whales to the number of 580 were taken, exceeding the number taken in 1918 by 132.

## INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SHORE WHALING OPERATIONS IN 1919.

Item.	Number.	Value.	Item.	Number.	Value.
INVESTMENT.			PRODUCTS.		
Vessels:			Whales:		
Steam and gas.....	8	\$415,000	Finback.....	242	
Net tonnage.....	1,121		Humpback.....	132	
Barge.....	1	30,000	Sulphur-bottom.....	68	
Net tonnage.....	1,149		Sperm.....	95	
Launches under 5 tons.....	2	1,400	Sei.....	2	
Rowboats.....	2	60	Beluga.....	41	
Scows.....	2	400	Total.....	580	
Pile driver.....	1	150			
Value of plants.....		427,339	Whale oil.....	<sup>a</sup> 875,374	\$656,510
Cash capital.....		633,139	Sperm oil.....	<sup>a</sup> 377,032	276,344
Wages paid.....		283,379	Fertilizer, meat.....	<sup>b</sup> 2,060,000	76,420
Total.....		1,790,867	Fertilizer, bone.....	<sup>b</sup> 538,000	13,472
PERSONS ENGAGED.			Whalebone.....	<sup>b</sup> 13,647	2,729
Whites.....	226		Ivory, sperm.....	<sup>b</sup> 746	225
Natives.....	26		Meat, frozen.....	<sup>b</sup> 50,000	1,500
Japanese.....	59		Total.....		1,027,200
Total.....	311				

<sup>a</sup> Gallons.<sup>b</sup> Pounds.

## CLAM CANNING.

The only reported clam canning in Alaska in 1919 was carried on by three companies in the central district. Two of these, the Pioneer Packing Co., at Cordova, and the Pinnacle Rock Packing Co., at Boswell Bay, Hinchinbrook Island, continued operations in accordance with the custom of preceding seasons, obtaining their raw product from the beds between Hinchinbrook Island and the mainland from Cordova to Katalla. The Surf Packing Co., a new concern, opened a cannery at Tuxedni Harbor, on the west shore of Cook Inlet, and made a small pack. It operated in virgin territory where clams were said to be fairly abundant, but on this point there is no trustworthy information at hand and nothing is known of the size of areas occupied by the clams. As that company was also engaged in the canning of salmon, it is shown in that category and not listed as a clam cannery. It is also indicated elsewhere in this report that the Pioneer Packing Co. entered the salmon-canning business for which reason its classification was changed from the clam to the salmon industry, and the investments entered accordingly. This leaves the Pinnacle Rock Packing Co. as the only concern engaged exclusively in the canning of clams. The Lighthouse Canning Co., the pioneer clam-packing concern of central Alaska, sold its cannery at Cordova and ceased to operate. The Hillery-Scott Co., its successor, did not pack clams. Aside from the changes in the character of operations as noted above, the smaller pack in 1919 in comparison with that of the two seasons immediately preceding would presage a diminution in the supply of clams.

The investment in this industry in 1919 was \$147,167. Employment was given to 237 persons, an increase of 55 over 1918. The total pack was 33,765 cases as against 43,575 in 1918. The products were valued at \$184,363, as compared with \$214,504 in 1918, a decrease of \$30,141.

## INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA CLAM-CANNING INDUSTRY IN 1919.

Item.	Number.	Value.	Item.	Number.	Value.
INVESTMENT.			PERSONS ENGAGED—contd.		
Canneries operated.....	1	\$22,000	Shoresmen:	42	.....
Working capital.....		49,990	Whites.....	3	.....
Wages paid.....		69,377	Natives.....	45	.....
Vessels:			Total.....	237	.....
Power dories.....	10	3,000	Grand total.....		
Rowboats and skiffs.....	36	1,800			
Scows.....	1	1,000			
Total.....		147,167	PRODUCTS.		
PERSONS ENGAGED.			½-pound cans <i>a</i> .....	<i>b</i> 13,874	\$55,496
Diggers:			No. 1 eastern oyster cans <i>a</i> ..	<i>b</i> 19,891	128,867
Whites.....	185	.....	Total.....	33,765	184,363
Natives.....	6	.....			
Filipinos.....	1	.....			
Total.....	192	.....			

*a* 48 per case.*b* Cases.

## MINOR FISHERIES.

## TROUT.

The most notable change in respect to the trout fisheries of Alaska in 1919 was the failure to operate of the Midnight Sun Packing Co., at Kotzebue, where 2,587 cases of Dolly Vardens were canned in 1918—the largest single product of the trout fisheries. The canning and pickling of trout almost ceased in 1919; only 371 cases, valued at \$3,496, were packed, largely by four salmon-canning companies in central Alaska, and 11 barrels were salted in western Alaska. There was an increase in the quantity of fresh trout handled in southeast Alaska, the entire production being credited to the Ripley Fish Co. The gross value of all trout products in 1919 was \$13,155, a decrease of \$20,529 as compared with the output in 1919.

## PRODUCTS OF ALASKA TROUT FISHERY IN 1919.

Section and species.	Fresh.		Frozen.		Pickled.		Canned.	
	Pounds.	Value.	Pounds.	Value.	Barrels.	Value.	Cases.	Value.
Southeast Alaska:								
Dolly Varden.....	68,584	\$8,282					3	\$27
Steelhead.....	12,383	804	2,780	\$408				
Total.....	80,967	9,086	2,780	408			3	27
Central Alaska:								
Dolly Varden.....							265	2,761
Steelhead.....							12	108
Total.....							277	2,869
Western Alaska:								
Dolly Varden.....					11	\$165	91	600
Grand total.....	80,967	9,086	2,780	408	11	165	371	3,496

## SABLEFISH.

None of the minor fisheries of Alaska shows a greater shrinkage in production than the sablefish. Whether it be due to a smaller catch or to the failure to save the entire catch can not be stated. As sablefish are taken in fishing for halibut and yield but a small return to the fishermen, it seems probable that a considerable quantity may have been wasted rather than that there was an actual shortage in the supply. The catch is made chiefly on the halibut banks off the coast of Alaska. The total production of sablefish was 509,369 pounds, valued at \$35,485, a decrease of 826,670 pounds in quantity and \$31,866 in value; 289,158 pounds, valued at \$22,682, were shipped fresh, and 220,211 pounds, valued at \$12,803, were shipped frozen.

## RED ROCKFISH.

The red rockfish, like the sablefish and other deep-water fishes, are taken largely on the halibut banks in connection with that fishery. The demand for rockfish is somewhat limited, a fact which doubtless curtails deliveries to buyers. The total reported production in 1919 was 69,048 pounds, valued at \$1,414, as compared with 338,669 pounds in 1918, valued at \$67,351.

## CRABS.

John Murphy, at Tenakee, was the only operator in Alaska reporting a catch of crabs in 1919. He marketed 80 dozen, valued at \$160. His investment in the crab fishery was \$200.

Inquiries made in 1919 regarding the methods of canning crabs indicate a desire on the part of some salmon packers to engage in the canning of crabs if the process is not too difficult and costly. This is a matter which merits investigation, as under proper encouragement a new industry may be developed in Alaska.

## SHRIMPS.

Shrimp fishing in Alaska in 1919 was carried on by one operator, the Alaskan Glacier Sea Food Co., at Petersburg. Employment was given to 2 white fishermen and 15 Japanese shoresmen. The investment in plant, boat, gear, and wages paid was \$41,796. The total production was 60,000 pounds of shrimp, valued at \$21,000. Market conditions were unsatisfactory to the company operating in Alaska, as the competition originating in southern waters could not be met without serious loss.

## MISCELLANEOUS FISHERY PRODUCTS.

Under this head are classed all flatfish, smelt, "lingcod", etc., which are taken in small quantities in connection with more important fishery operations. The total output was 52,123 pounds, valued at \$1,639.

## MINOR FUR-BEARING ANIMAL WORK.

### GENERAL WORK.

The major functions of the Bureau in Alaska have been devoted primarily to affairs pertaining to the fur seals of the Pribilof Islands and the general fisheries operations in the coastal regions. To the extent that facilities and funds have permitted, attention has been devoted to the minor fur-bearing animals. In his annual report for the fiscal year ended June 30, 1919, the Commissioner of Fisheries again recommended that the Bureau be relieved of the incongruous duty of administering the minor fur-bearing animals of the Territory. Favorable action by Congress is anticipated in the near future, it being probable that jurisdiction will be transferred to the Bureau of Biological Survey of the Department of Agriculture.<sup>a</sup>

The arrangement made in 1918 with the governor of Alaska whereby employees of the Bureau have been named as ex officio game wardens and the Territorial game wardens and special employees for the suppression of the liquor traffic among the Indians have been designated as special wardens in the Bureau's Alaska service, without additional compensation, was continued in effect during the year 1919. Some changes in the force of wardens have occurred. The employees under direction of the governor's office identified with this work in 1919 were as follows:

Game wardens: Patrick Hamilton, Ketchikan; J. C. Lund, Juneau; P. S. Ericksen, McCarthy; J. A. Baughman, Seward; Stephen Foster, Nenana; R. E. Steel, Eagle; and M. O. Colberg, Nome.

Special employees: J. F. McDonald, Juneau; J. A. Bourke, Valdez; Thomas P. Killeen, Nome; and John A. Moe, Ruby.

P. S. Ericksen, of McCarthy, was succeeded by E. A. Young at Chitina.

In January, 1920, the services of Stephen Foster were discontinued.

The Bureau has continued the employment of Game Warden F. A. Martin at Anchorage as special fur warden at a nominal salary. The cooperative arrangement with the governor's office has been of value in that a number of violations of the fur-bearing animal law and regulations, which otherwise would probably have gone unnoticed, have received attention.

Reports have been received that more than the usual number of blue foxes have been taken along the Bering Sea coast between Cape Avinof and the Yukon delta. The death of so many natives in the Bristol Bay region as a result of the influenza epidemic has greatly reduced the number of persons trapping and will probably mean increased takes by the white trappers, though possibly not so large an output from the district as a whole.

<sup>a</sup> The act of Congress approved May 31, 1920, transferred jurisdiction over the minor fur-bearing animals of Alaska to the Bureau of Biological Survey, Department of Agriculture.

## REGULATIONS.

There was no change in the minor fur-bearing animal regulations in 1919, but under date of January 9, 1920, the following regulation was issued by the Secretary of Commerce, extending the prohibition on the killing of sea otters in Alaska:

By virtue of the authority vested in me by section 4 of "An Act to protect the seal fisheries of Alaska, and for other purposes," approved April 21, 1910, it is hereby ordered that the killing of any sea otter within the limits of Alaska Territory or in the waters thereof is prohibited until November 1, 1925.

Years ago sea-otter hunting was a lucrative industry in North Pacific waters, and, as not infrequently happens, it was conducted so assiduously that the practical extinction of sea otters resulted. Protective legislation has undoubtedly had a beneficial effect, but the reestablishment of sea otters upon a commercial basis can not be expected for years to come. It is urgently necessary that every precaution be taken to protect fully this highly valuable marine fur-bearing animal. By the terms of the North Pacific Sealing Convention of July 7, 1911, the taking of sea otters in waters covered by it outside the 3-mile limit is prohibited. In administering the fur-bearing animal laws and regulations within the Territorial waters of Alaska, it is the policy of the Bureau to support and parallel the provisions of the international treaty in respect to sea otters.

The Bureau has from time to time received advices of a desire in certain parts of Alaska for the removal of the prohibitions upon the killing of beaver and marten. The Bureau feels, however, that the time is not yet ripe for making an open season for these valuable fur-bearing animals, as there is no authentic evidence available to show that their numbers have been replenished to an extent justifying such action. Undoubtedly both beavers and martens are more numerous in some sections of Alaska than a few years ago, but this is the best evidence that the regulations were needed and have been producing beneficial results. A continuance of the same policy for some time to come is considered advisable.

## VIOLATIONS OF REGULATIONS AND SEIZURES OF SKINS.

On January 22, 1919, Assistant Agent Christoffers cooperated with the collector of customs at Seattle in the seizure from an express company of 10 trunks containing skins consigned from Seward, Alaska, to San Francisco. The trunks were the property of J. H. Smith, of Anchorage, and contained 717 beaver skins, 20 swan skins, and one can of beaver castors. No claim was made for possession of the furs, and the shipper was not apprehended for prosecution.

On February 1, 1919, Special Warden Martin seized 44 marten skins from John E. Carlson at Anchorage. Carlson was fined \$100 and costs, amounting in all to \$118.15.

Game Warden Stephen Foster seized two marten skins, one on February 17, 1919, from Charles P. Christiansen and one on March 4, 1919, from Tom Cook, both in the Kantishna River region.

United States Commissioner Charles J. Koen, of St. Michael, forwarded to the Seattle office three beaver skins which were seized from two natives, one of whom pleaded guilty and was sentenced to 20 days in jail, while the other stood trial, was convicted, and sentenced to 60 days in jail. Commissioner Koen also reported that in April

and May he sentenced five other natives to terms in jail ranging from 10 to 30 days for the killing of beaver. The skins were not secured. All of these cases originated on the Galsovia River.

In May, 1919, Game Warden Lucy seized a beaver skin from a native named Jim Johnny Mie in the vicinity of Petersburg. Mie was prosecuted for having the skin in his possession, pleaded guilty, and served five days in jail at Ketchikan.

In June, 1919, Warden Larson seized a beaver skin from an Indian near Ketchumstock.

One June 22, 1919, Frank O'Farrell shipped 13 marten skins from Tanana, which were seized by Deputy Collector of Customs Hillard at Eagle and turned over to Game Warden R. E. Steel. Twelve more marten skins were seized by Warden O'Connor at Skagway on July 7 when a parcel-post package addressed from Tanana to O'Farrell at Seattle was examined under search warrant. All the skins were forwarded to the Seattle office of the Bureau. O'Farrell afterward presented a certificate, dated June 26, 1919, that 25 marten skins were of Canadian origin. The Bureau, upon the recommendation of the deputy collector of customs at Eagle, refused to accept it as covering the seized skins, and they were confiscated.

Examination of mail shipments were made at Skagway under search warrants by Warden Philip R. Hough on July 16 and 17 and resulted in the seizure of 20 marten shipped by R. L. Smith from Ruby, 25 beaver shipped by D. R. Stern from Nulato, and 1 beaver by John B. Steppe from the Kantishna region. The skins were retained by the marshal at Skagway until released to the Bureau by a court order in March, 1920, and were then forwarded to Seattle.

In July, 1919, certain seizures of illegally taken furs were made in Alaska by the United States marshal, these furs having been placed in the mail by Peter Vachon of Tolovana. The shipments were located by means of search warrants executed with the permission of the Post Office Department at the post office at Tolovana and on board a vessel near Eagle. The seizures comprised 714 marten skins and 699 beaver skins, which at the end of the year were still in the possession of the United States marshal at Fairbanks for use in the prosecution of the shipper.

On August 9 customs officials at Seattle seized seven beaver skins from James P. Browner, chief engineer of the schooner *Ozmo*. Browner stated that the skins had been given to him by J. W. Felder in the Kuskokwim district, and that he did not know that their possession was unlawful. No prosecution was instituted; the skins were turned over to Assistant Agent Christoffers.

On September 5 the deputy collector of customs at St. Michael seized from a man named Miller 88 beaver skins turned over to him by Chris Betsch, a trader, to deliver to a bank at Nome. Other prosecutions were made as follows: Joe Knox, 7 beaver skins seized, sentenced to 30 days in jail; Sam Tajari, 24 beaver skins seized, fined \$200 and costs; Chris Betsch, 170 beaver skins seized, fined \$200 and costs. The case against Miller, in whose possession the 88 skins were found, was dismissed as it had been shown that the skins were turned over to him by Betsch for delivery to the Merchants and Miners Bank of Nome. The 289 skins were forwarded to the Bureau's Seattle office in June, 1920, by the United States marshal for sale for the account of the Government.

On October 17, 1919, Assistant Agent Christoffers, assisted by five deputy customs officers, searched the schooner *Ozmo*, arriving from the Kuskokwim River region, and seized 41 beaver and 4 swan skins.

On November 26, 1919, Warden O'Conner seized two marten skins from a native named Peter Brown. Prosecution was instituted in the United States commissioner's court at Haines against Brown for having illegally taken skins in his possession. He was tried on December 29 and was fined \$25 and costs.

On November 30, 1919, Warden O'Connor seized 69 muskrat skins at Haines from Harry Lindberg, a fur buyer. Lindberg was arraigned before the United States commissioner for having unprime skins in his possession, but the case against him was dismissed with the understanding that he would testify in behalf of the Government against Tom Lahey from whom he had purchased the skins. Lahey was charged with trapping muskrats in the close season, but at the trial in the United States commissioner's court at Juneau on December 13, 1919, the jury returned a verdict of not guilty. The court returned the skins.

On December 21, 1919, N. A. T. Joe was convicted before the United States commissioner at St. Michael of killing a mink on October 4, 1919. He was sentenced to 60 days in jail.

During the year two fur-seal skins, which had not been properly authenticated, were received by Funsten Bros. & Co. Both had apparently been taken by fishermen, one being sent in by John Michelson of Sointula, British Columbia, and the other by Charles Landberg of Neah Bay, Wash. They were accordingly confiscated by the Government and will be sold by the company at public auction.

#### SALES OF SEIZED SKINS.

During the calendar year 1919, the following seized skins were sold at public auction: In St. Louis, 8 fur-seal skins; and in Seattle, 753 beaver, 92 marten, 54 mink, 7 weasel, 3 lynx, 32 muskrat, 1 cross-fox, 20 swan skins, and 42 pounds of beaver castors. The gross amount received was \$16,236.27. Commission and other expenses amounted to \$866.75, leaving a balance of \$15,369.52 turned into the United States Treasury. A few seized skins remained unsold at the end of the year.

#### FUR FARMING.

Fur farming in Alaska is largely concerned with the propagation of foxes, though occasionally attempts are made to raise in captivity minks and martens, but without success. Foxes lend themselves more easily to domestication, especially the blue variety, and are exceptionally prolific under favorable conditions. Their skins have a comparatively high value at this time, which fact, coupled with that of easy breeding, constitutes sufficient inducement to the venture-some to engage in the industry, notwithstanding that the business is attended with risks and discouraging vicissitudes.

As in other undertakings, some failures were caused by careless and indifferent attention to business; others were due to the selection of

islands much too small for the purposes intended or too near other land, and to improper or inadequate feeding or none at all.

Fox farming follows two methods, impounding or corral breeding, and free-range or island breeding. Under the corral method, propagation has proved decidedly unsuccessful in most cases, not so much in actual breeding but in the rearing of young and the preservation of parent stock. Confinement in pens, necessarily of very limited dimensions, has two noticeable effects on foxes. Being accustomed to freedom in their movements, its denial either makes them vicious or morose. In the one case, they become fighters, destroying their young, their mates, and companions of the same sex; in the other, their time, night and day, is spent in a continual search for a way of escape, which if not found increases their misery and is often not ended until death supervenes.

Island breeding has been very successful when seriously undertaken. A prime requisite is area great enough to afford considerable range to the foxes and sufficiently distant from other land to prevent their escape. An ample supply of food is also necessary, for underfed foxes become cannibalistic, or puny and weak, if not diseased. If the natural food to be found on the island is not sufficiently abundant to properly sustain the animals, the deficiency must be supplied by the efforts of the fur farmer. His energy in this direction will probably determine the degree of success or failure which will attend his labors. Foxes at liberty on suitable islands will take care of themselves just as long as food is ample and they are not crowded. In the end intelligent management is indispensable to successful results.

From time to time the Bureau receives information from the fox farmers in Alaska regarding their experiences and success or failure, much of which may be of general interest and benefit to all fur farmers. Among those who operated in 1919 and filed reports are the following:

Sholin Bros. & Co., of Homer, report encouraging results in the rearing of silver-black foxes in corrals. At the beginning of 1919 they had 12 pairs of breeders, 9 of which produced young, the litters varying from 2 to 5 pups each. The total increase was 28, all of which were successfully raised. Fifteen pairs are being held for breeders in 1920. The foxes are fed fish, birds, porcupines, hair seals, and cereals, but chiefly fish which is mixed with a cereal and boiled to a porridge and fed at evening. The morning meal consists of bread made of shorts and a little seal oil. Occasionally meat is fed. These operators have found that the foxes do better in pens built 6 feet apart than in those connecting or immediately adjoining each other.

F. Berry, 12 miles northeast of Homer, is also breeding foxes in corrals. He started business in 1918 in partnership with Dr. E. F. German, of Anchorage, with one pair of silver-black foxes. A litter of pups was produced in 1919, but nothing was saved from it, as the parent male fox destroyed the young. Mr. Berry gives directions for the prevention of worms and internal parasites in foxes, as follows:

Burn all your old bones, pound them—not too fine—and add equal quantities of clean charcoal (burnt in the kitchen stove) of some hardwood; now chop fresh meat—something they like very well—and roll it and rub it into the charcoal and pulverized bone until it loses all semblance to meat in the mixture, then feed. They will not mind the dirt, just so they get the meat. One feed a week like this and your animals will never know worms.

In the fall of 1918, Abraham Ericksson, at Kenai, purchased two pairs of silver foxes at a cost of \$1,700 and placed them in pens. During the year both males killed their mates. In October he traded one male for a female, thus giving him a pair for breeding in 1920.

Joseph Falardeau, operating a fox farm at the head of Kachemak Bay, reports encouraging results in 1919. At the beginning of the year he had on hand five male and seven female silver foxes. Three pairs of these produced a total of nine pups, five being males and four females. This enabled him to increase his breeding stock to nine pairs. Mr. Falardeau regards it as important that each farmer endeavor to raise farm produce, also other products which may be required for fox food, to supplement the natural food resources of the region, such as fish, rabbits, and birds. Milk and eggs are especially desirable as food for young foxes.

Andrew Siewertson, who is using Perry Island as a fox farm, reports that out of a breeding stock of 12 blue foxes he lost 4 families by theft or desertion, raised 36 young, killed 2 for their skins, and sold 12 pairs.

J. D. Jefferson has stocked Bald Head Chris Island with blue foxes and the Dutch Group with cross foxes, having entered upon both in the spring of 1917. The increase of blues is not definitely known by Mr. Jefferson, but he estimates that there are now from 20 to 25 foxes on the island. One male and two female cross foxes, placed on the Dutch Group in 1917, have done nothing. They were taken off this year. The islands will be stocked with blue foxes under the ownership and management of C. L. Hoyt, who is fox farming on Axel Lind Island, a few miles from the Dutch Group.

Lee E. Dickinson operates a fox farm on Flemming Island in the western part of Prince William Sound, having stocked it in 1919 with dark-blue foxes. He reports that the foxes are fed fresh fish, chiefly cod and halibut, and that they thrive on that diet. This is in striking contrast with the statement of Mr. Jefferson, who reported that his foxes did not like cod and would not eat it ordinarily unless cooked and mixed with other things.

Passage Island, situated in the entrance of Port Graham, is used as a blue-fox farm by J. A. Herbert, of Seldovia. This farm was established several years ago and has been fairly successful. At the beginning of 1919 the stock consisted of 25 pairs. These produced about 100 pups, but heavy losses occurred, as approximately 80 per cent of the young were killed and carried away by eagles. Only 23 pups reached maturity. Twenty-seven foxes were sold for breeding purposes, 25 were killed for their pelts, and 10 pairs were held as stock for 1920. Salted fish heads were used as food for the animals. These are easily obtained at the cannery of the Fidalgo Island Packing Co. at Port Graham.

Hesketh and Yukon Islands, in Kachemak Bay, are used for fox-breeding purposes by U. S. Ritchie, who began this work more than 20 years ago. His foxes run at large, and can pass from one island to the other at low water. A few were killed for their skins, while 10 pairs were obtained elsewhere with which to restock, as the old stock was degenerating from inbreeding.

D. F. Dunagan, H. H. Waller, and J. L. Waller took over the fox corrals of N. P. Shular at Anchor Point and will continue operations under the name of the Anchor Point Silver Fox Farm. When owned

by Mr. Shular, this farm was reputed to be the most successful one in Alaska handling black and silver foxes.

O. Kraft & Son discontinued their fox-raising business on two small islands in Kalsin Bay, Kodiak Island, and removed all animals therefrom in the winter of 1918-19. The islands were much too small and were surrounded by reefs, to which the foxes would go at low water and not return before the flood tide cut them off from the island. When forced to swim, some of them left for the mainland of Kodiak and thus escaped.

Alex Friedolin continued operations on Hog Island, which he had stocked with blue foxes. No young animals were seen in 1919, and Mr. Friedolin thinks that the introduction of two strange males disturbed the other foxes and possibly caused the young to be killed. But one pelt was taken. Three pairs of breeders have been retained.

In May, 1919, Lars Hansen placed four pairs of blue foxes on Chank-liut Island, near the entrance to Chignik, where he had the year before planted mice to supply food for the foxes. One litter of young was born in 1919, but as the foxes run at large he does not know how many there were.

A. F. Piper, of Seldovia, reports that he has started a skunk farm with eight animals which were shipped from the States.

Peter Petrovsky continued operations on Amook Island. Part of his foxes are kept in corrals and others run at large on the island. No young foxes were raised in the corrals in 1919. In all, 16 foxes were killed for their pelts.

Rufus D. Blakely, of Ketchikan, reported further on his fur-farming operations on Bold Island. Beavers have been established in the lake in addition to the muskrats and appear to find a plentiful supply of food. Plans for stocking the island with foxes and marten are in abeyance.

Harry D. Colp reported that he has established a fur farm on Kupreanof Island near Petersburg. He has five pairs of silver foxes in corrals, one of which raised three pups in the spring of 1919. A varied diet is given the foxes, consisting of fish, several kinds of meats, rice, dog biscuits, and green stuff. Mr. Colp states that he does not expect to market any furs for some time as he wishes to increase his stock. He considers the possibilities of the business good.

C. E. Zimmerman is using the Brothers Islands in southeast Alaska for the propagation of raccoons and skunks. These islands were similarly used about six years ago, and it is Mr. Zimmerman's belief that some of the original stock still remains. He placed additional animals on the islands in the fall of 1919.

A. C. Smith, of Haines, reports that he has five silver-gray and one cross fox. No pups were born in 1919. One pair of silvers died as the result of fighting.

Aug. Wenzel continued operations on a ranch 32 miles below Fairbanks on the Tanana River. He reports having seven pairs of silvers and three pairs of crosses. But one pup was produced and raised this year. A total of three silver, four red, and four cross pelts were sold in the spring of 1919. Mr. Wenzel says that his foxes are tame and healthy. The food given is principally fish, cooked in summer and dried in winter. The rabbits are said to be coming back, and will thus furnish needed fresh meat.

W. H. Newton, of Healy River, reported that there was no increase in 1919 from his stock of four pairs of foxes; this possibly

was due to disturbance incident to clearing off timber near their quarters. Four of the animals were killed to cover expenses and two pairs were retained for stock. He feeds fish and vegetables with the addition of fat scraps.

L. G. Michael reports excellent results at his ranch near Franklin. At the beginning of 1919 he had 7 pairs of breeders, 2 silver and 5 cross males, and 4 red and 3 cross females; 17 pups were born, of which all but 1 were raised. He is retaining a stock of nine pairs of breeders. Mr. Michael writes that he feeds the young foxes plenty of canned milk, diluted 1 part milk and 2 parts water, with a little sugar added, about a tablespoonful to a quart. The adult foxes are fed fresh meat almost entirely. Although the foxes are all large animals they are confined in corrals. Mr. Michael says that the future for fox farming has never looked better.

A number of fur farmers mention the great number of gulls and other sea birds, and object to the prohibition against killing such birds for food for their animals.

#### LEASING OF ISLANDS.

The Department of Commerce has jurisdiction over 12 islands in central Alaska which are leasable, or have been leased to the highest bidder. These islands and their locations are as follows:

Chirikof.....	Southwest of Kodiak Island.
Long.....	Near Kodiak Island.
Marmot.....	East of Afognak Island.
Little Koniuji.....	Shumagin Group.
Simeonof.....	Do.
Little Naked.....	One of Naked Islands, Prince William Sound.
Carlson (Crafton).....	Prince William Sound.
Middleton.....	Gulf of Alaska.
Pearl.....	One of Chugach Islands.
Elizabeth.....	Do.
Aghiyuk.....	One of Semidi Islands.
Chowiet.....	Do.

Pearl Island was leased to I. D. Nordyke in 1917, but the annual rental has not been paid since that year. The lease has therefore been forfeited and the island is again available for lease to the highest bidder.

The islands named below were under lease on December 31, 1919:

Island.	Lessee.	Annual rental.
Chirikof.....	Karl Armstrong Kodiak, Alaska.....	\$200
Long.....	Kodiak Fox farm, Kodiak, Alaska.....	200
Marmot.....	C. W. Pajoman and N. I. Greive, Afognak, Alaska.....	200
Little Koniuji.....	Andrew Grosvold, Sand Point, Alaska.....	205
Middleton.....	Joseph Ibach, Cordova, Alaska.....	200

*Chirikof Island, southwest of Kodiak Island.*—This island was leased on July 1, 1919, to Karl Armstrong, of Kodiak. It had previously been used by the Semidi Propagating Co., but was abandoned a few years ago. Mr. Armstrong reported that on taking possession of the island there were found signs of a number of foxes and for that reason he will put no new stock on the island until after the present trapping season, when he will be able to judge what is needed for the future.

*Long Island, near Kodiak.*—On July 1, 1919, a lease for this island was issued to the Kodiak Fox Farm. This concern had been using the island for several years under a misapprehension that it had a valid right thereto through purchase from a former occupant, who was found upon investigation to have had no title to the island and could, therefore, convey none. This farm is probably the most completely equipped of any in Alaska. Extensive extracts from a previous report were published in "Alaska Fisheries and Fur Industries in 1915," and it is thought that the following from the recent report of the company will be of interest:

As previously reported, we had a number of blue foxes in captivity. Subsequently these were all liberated, for after two seasons of effort not a single blue pup had been born in the pens. Although we tried many experiments, our efforts were unavailing and we gave up our attempt to raise blue foxes in captivity.

Since the blue foxes have been at large, however, the increase has been highly satisfactory and the quality of the fur has improved. We attribute this to the careful selection we have made during each trapping season and to the fact that our foxes have been bountifully fed.

We still continue to feed salmon heads, as this has proved the most satisfactory for blue foxes. During the salmon season only fresh heads are fed; but at the same time we pack about 400 barrels in salt (about 80,000 pounds) to be used for winter feeding. These are thoroughly freshened for about six days in running water before being given to the foxes.

The foxes have segregated themselves in colonies about the island, and in the vicinity of each colony a feeding box has been placed. Twenty-two of these are now used where food is distributed every other day.

Breeding records, as originally planned, can not, of course, be kept for the blue foxes at large on the island, but by careful selection during the trapping season of only the desirable animals to be left as stock the quality of the fur can no doubt be greatly improved. We trap only in box traps; the foxes are carefully examined, and if desirable for breeding stock they are marked by "bobbing" the tail and again liberated. It is our aim to liberate three females to two males of the best animals trapped.

During the trapping season of 1919, 33 blue-fox skins were taken, and it was estimated that 150 animals were left.

Our efforts in raising silver-gray foxes in captivity have not been successful. While we have raised a number of these, and have several now in the pens of the third and fourth generation, the percentage of increase has been so small that we have decided it would not pay us to continue, so we will kill off the remaining stock and devote our efforts to the blues. Furthermore, the wire netting of our pens is commencing to rust after five years, and unless this is renewed in a short time there will be danger of the silver grays getting loose on the island and killing off the blues. At present prices the cost of renewing this wire would be about \$6,000 and we do not feel that our experience justifies such an expenditure.

During the winter of 1918-19 we killed 9 silver-gray foxes, leaving 21 silvers and 1 cross for breeding purposes. Shortly after this 11 of the silvers died, evidently from some epidemic among them, although we have been unable to determine the cause. Consequently, this season, we have not had a single pup from the silvers.

Two years previous we had a similar experience, having lost 10 of our breeders after the killing season from apparently the same disease. But this loss was more than replaced by 17 pups born and all successfully raised to maturity.

The 10 silvers and 1 cross will be killed this coming winter. We intend, also, to take about 50 blues, leaving about 100 on the island for stock.

*Marmot Island, east of Afognak.*—On July 1, 1919, a lease for this island was issued to Charles W. Pajoman and N. I. Greive, of Afognak. In October they placed thereon four cross and nine silver foxes. At the time of the lease the island was supposed to be barren.

*Little Koniuji, Shumagin Group.*—Andrew Grosvold continues as the lessee of this island. In November, 1919, the stock was increased by the addition of 19 pairs of blue foxes. In the year ending November 15, 1919, Mr. Grosvold took 30 skins. A year later he estimated that there were 30 pairs on the island.

*Middleton Island, Gulf of Alaska.*—This island is under lease to Joseph Ibach, of Cordova. The number of skins taken in 1919 has not been reported, but it is understood that results were satisfactory.

## FOREST SERVICE PERMITS.

Every island in Prince William Sound at all suitable for a fox farm is now being used for that purpose. All of them, except Little Naked Island and Crafton (Carlson) Island, are under the control of the Forest Service by reason of their location within the bounds of a national forest. A number of islands in southeast Alaska within the Tongass National Forest are also occupied as fox farms. An annual rental is charged and each operator is required to make a report to the Forest Service as to the character and volume of business carried on during the year. Records in the offices of the Forest Service at Cordova and Ketchikan show information in respect to the use of the several islands as follows:

## ISLANDS OCCUPIED FOR FUR FARMS UNDER FOREST SERVICE PERMITS.

Date of permit.	Island.	Occupant.
Aug. 1, 1913	Lone.....	F. A. Shumaker, Latouche, Alaska.
Jan. 1, 1919	Eleanor.....	Do.
Jan. 10, 1913	Perry.....	Andrew Siewertsen, Latouche, Alaska.
Aug. 5, 1915	Axel Lind.....	John Stainer, Ellamar, Alaska.
Applied for...	Glacier.....	Otto Hermsdorf, Latouche, Alaska.
Aug. 3, 1919	Bettles.....	H. D. Bush, Granite, Alaska.
Aug. 11, 1919	Observation.....	Robert E. Towsley, Seattle, Wash.
June 16, 1919	Seal.....	John Agamalian, Latouche, Alaska.
Jan. 1, 1918	Fairmount.....	Beyer & Davis, Cordova, Alaska.
Jan. 1, 1919	Bligh and Busby.....	Cloudman estate, Tom Cloudman, Valdez, Alaska.
Mar. 20, 1916	Smith.....	G. W. Fleming, Latouche, Alaska.
Mar. 13, 1919	Flemming.....	Gordon & Harris, Cordova, Alaska.
Jan. 1, 1914	Green.....	T. A. Haxby, Latouche, Alaska. <sup>a</sup>
June 14, 1919	Kanak.....	Joseph L. Hill, Katalla, Alaska.
July 20, 1916	Bald Head Chris.....	J. D. Jefferson, Valdez, Alaska.
Dec. 26, 1916	Dutch Group.....	Do.
May 24, 1919	Erlington.....	Kulper & Baker, Latouche, Alaska.
Apr. 21, 1917	Goose.....	Arthur Laviosa, Ellamar, Alaska.
Jan. 1, 1912	Naked and Peak.....	J. A. McPherson, Ellamar, Alaska.
Oct. 9, 1917	Olson and 3 unnamed.....	Ross & Hoyt, Valdez, Alaska.
Oct. 23, 1919	Entrance.....	R. M. Allen, Petersburg, Alaska.
Oct. 14, 1919	Walter.....	Andy Anderson, Petersburg, Alaska.
July 1, 1919	Hound.....	Blue Bell Ranch.
May 31, 1916	Bold.....	Bold Island Fur Farm Co., Ketchikan, Alaska.
Nov. 21, 1917	Strait.....	Cleary Bros., Petersburg, Alaska.
Dec. 15, 1919	Benjamin.....	H. S. Graves.
Jan. 25, 1917	Sukol.....	Hercules Fox Co., Petersburg, Alaska.
Sept. 9, 1919	Hoonah.....	Hoonah Fox Co., Hoonah, Alaska.
Aug. 28, 1919	Hill.....	L. B. McCoy, Chichagof, Alaska.
Dec. 11, 1919	Keku.....	V. A. Paine, Juneau, Alaska.
Nov. 26, 1917	Onslow.....	L. A. Stockley, 527 39th Ave., San Francisco, Calif.
Nov. 17, 1919	Liesnoi.....	Eric Todal, Petersburg, Alaska.
June 1, 1919	Sokolof.....	Wikan Bros. & Co.
June 29, 1914	Sumdum.....	James York, c/o E. Valentine, Juneau, Alaska.
Sept. 13, 1918	Brothers.....	C. E. Zimmerman, Petersburg, Alaska.

<sup>a</sup> Four Japanese have subleased this island from Dr. Haxby.

At the present time a number of fur farmers are occupying islands which are outside of the forest reserves, and serious complaint is made in regard to the difficulty of securing any valid claim on the land which they are using for their operations. Apparently the only way to secure protection through the General Land Office from trespassers is to homestead the land. Some provision for leasing these islands, or granting certain rights to bona fide occupants who are doing valuable development work, would seem to be desirable to assure the future of the business. Many islands along the coast of Alaska are suitable for fox farms. Those outside of forest reserves are open to occupancy in like manner as any other public land.

## SHIPMENTS OF FURS FROM ALASKA.

As in previous seasons, shipments of furs from Alaska were reported on special blanks prepared by the Bureau. Supplies of blanks were furnished to all postmasters in Alaska and to commercial companies, express companies, and all persons known to be shippers of furs. Postmasters indorsed the reports of mail shipments after they were properly filled out and forwarded them to the Bureau.

Reported shipments in 1919 confirm the general belief that the fur-bearing animals in Alaska are decreasing in numbers. In spite of the continued high prices of furs, there was an increased catch of only a few species, the chief of which were ermine, mink, and muskrat. The most notable declines were in the catch of foxes and lynx. As in previous reports, the fur year is reckoned from November 16 of one year to November 15 of the following year.

The following table shows the detailed statistics as compiled from information furnished the Bureau in regard to furs shipped from Alaska in 1917, 1918, and 1919:

FURS SHIPPED FROM ALASKA IN 1917, 1918, AND 1919.

Species.	Year ended Nov. 15, 1917.			Year ended Nov. 15, 1918.			Year ended Nov. 15, 1919.		
	Number of pelts.	Average value.	Total value.	Number of pelts.	Average value.	Total value.	Number of pelts.	Average value.	Total value.
Bear:									
Black.....	1,061	\$14.00	\$14,854.00	1,164	\$15.00	\$17,460.00	1,388	\$16.00	\$22,208.00
Brown.....	62	12.00	744.00	35	12.00	420.00	44	12.00	528.00
Glacier.....	8	20.00	160.00	35	30.00	1,050.00	20	30.00	600.00
Grizzly.....	13	17.00	221.00	42	20.00	840.00	76	20.00	1,520.00
Polar.....	<sup>a</sup> 144	40.00	5,760.00						
Beaver.....	<sup>b</sup> 118	10.00	1,180.00	<sup>c</sup> 109	21.00	2,289.00	<sup>c</sup> 796	17.76	14,139.96
Ermine.....	4,639	.90	4,175.10	9,133	1.50	13,699.50	18,617	1.90	35,372.30
Fox:									
Black.....	10	160.00	1,600.00	6	150.00	900.00	13	150.00	1,950.00
Blue.....	887	58.00	51,446.00	740	85.00	62,900.00	566	130.00	73,580.00
Blue, Pribilof Is-lands.....	567	61.11	34,653.50	692	82.51	57,099.50	667	195.31	130,274.50
Cross.....	2,669	35.00	93,415.00	1,704	50.00	85,200.00	1,280	70.00	89,600.00
Red.....	10,485	24.00	251,640.00	12,232	28.00	342,496.00	7,723	35.00	270,305.00
Silver gray.....	443	120.00	53,160.00	440	140.00	61,600.00	315	170.00	53,550.00
White.....	3,682	28.00	103,096.00	4,531	40.00	181,240.00	4,575	46.00	210,450.00
White, Pribilof Is-lands.....	39	26.33	1,027.00	19	56.84	1,080.00	30	55.33	1,660.00
Hare, arctic.....	89	.40	35.60	38	.10	3.80	135	.20	27.00
Lynx.....	21,210	14.00	296,940.00	7,692	26.00	199,992.00	1,085	42.00	45,570.00
Marten.....	<sup>d</sup> 1,210	14.00	16,940.00	<sup>d</sup> 1,023	19.00	19,437.00	<sup>e</sup> 1,107	32.00	35,424.00
Mink.....	18,832	4.00	75,328.00	24,572	6.50	159,718.00	28,040	9.00	252,360.00
Muskrat.....	72,264	.45	32,518.80	86,624	1.20	103,948.80	113,652	1.90	215,938.80
Otter:									
Land.....	1,308	15.00	19,620.00	1,647	22.00	36,234.00	1,709	25.00	42,725.00
Sea.....	<sup>f</sup> 2	344.85	689.70	<sup>g</sup> 1	150.00	150.00	<sup>g</sup> 1	300.00	300.00
Seal, fur, Pribilof Is-lands <sup>h</sup> .....	9,140	30.00	274,200.00	30,819	30.00	924,570.00	30,198	50.00	1,509,900.00
Seal, fur.....	<sup>i</sup> 5	30.00	150.00	<sup>j</sup> 9	30.00	270.00			
Squirrel.....	117	.05	5.85	153	.02	3.06	2,120	.03	63.60
Wolf.....	195	8.00	1,560.00	207	18.00	3,726.00	284	19.00	5,396.00
Wolverine.....	435	8.00	3,480.00	846	14.00	11,844.00	516	15.00	7,740.00
Total.....			1,338,599.55			2,288,170.66			3,021,182.16

<sup>a</sup> The killing of polar bears in Alaska is unlawful.

<sup>b</sup> A considerable number were seized skins. It is unlawful to kill beavers in Alaska.

<sup>c</sup> Seized skins. It is unlawful to kill beavers in Alaska.

<sup>d</sup> Checked against affidavits permitting shipments. It is unlawful to kill martens in Alaska.

<sup>e</sup> Includes 93 seized skins. It is unlawful to kill martens in Alaska.

<sup>f</sup> Unlawfully killed by natives.

<sup>g</sup> Found dead.

<sup>h</sup> Figures are for shipments during calendar year rather than killings.

<sup>i</sup> Taken by natives.

<sup>j</sup> Seized skins.

## FUR-SEAL INDUSTRY.

### PRIBILOF ISLANDS.

#### GENERAL ADMINISTRATIVE WORK.

Commercial sealing operations were continued in 1919 on a scale commensurate with the size of the seal herd and the facilities available. The policy, inaugurated this year, of improving the seal herd and at the same time adding to the Government's revenue by killing considerable numbers of the surplus large males taxed the working force to the utmost. Careful attention was given to the herds of blue foxes, and the value of the pelts secured is ample evidence that appropriate methods are being pursued. The welfare of the natives was given conscientious attention, and it is felt that they are now living under much better conditions as a whole than ever before. The by-products plant was operated for a limited period with results which warrant operations on a larger scale in 1920.

Aside from the major features of the Bureau's work on the Pribilofs, numerous other matters in connection therewith received attention. Among these may be mentioned the annual seal census, maintenance and upkeep of Government property, and a special investigation devoted to improving sealing methods, particularly the curing of pelts. Details are set forth in the following pages.

#### PERSONNEL.

A list of the Bureau's statutory employees for the Pribilofs is given in the introduction to this report. Details in regard to their activities are, for purposes of record, stated below. The work of a number of temporary employees is also recorded.

Agent and Caretaker H. C. Fassett tendered his resignation early in the year and left St. Paul Island on the *Saturn* May 21. Agent and Caretaker A. H. Proctor proceeded from St. George Island to St. Paul Island on the *Saturn* May 6 to assume charge of the Bureau's work at St. Paul. Storekeeper H. D. Aller was on St. George Island until July 11, when he went aboard the Coast Guard cutter *Unalga* for St. Paul Island. He arrived there July 12, and left for Seattle on the Coast Guard cutter *Bear* October 20. From May 6 until July 10 he was in charge of the Bureau's work on St. George. School-teacher C. E. Crompton then assumed charge and was appointed agent and caretaker, effective August 16.

Storekeeper Dr. G. Dallas Hanna arrived at the Pribilofs on the *Saturn* May 5 and left on the *Nanshan* October 13. While on the islands he had charge of the seal census work. Dr. Charles E. Johnson was in charge of the medical work on St. George Island until relieved by his successor, Dr. W. M. Murphy, who arrived on the *Nanshan* in September. Later Dr. Johnson proceeded to St. Paul Island on the *Nanshan*, for temporary duty, where he remained until after the arrival of Dr. J. J. Richstein. Dr. Johnson left St. Paul Island for

Unalaska on the *Eider* November 25. Subsequently he proceeded to Seattle on a commercial steamer. Dr. J. J. Richstein left Seattle October 26 on the *Eider* and arrived at St. Paul Island November 23. Dr. H. H. Stromberger was on St. Paul until October 13, when, having tendered his resignation, he took passage on the *Nanshan* for Seattle. Mrs. Agnes K. Stromberger, who had been employed as a nurse at St. Paul, left at the same time. Dr. Frank H. Gunn arrived at St. Paul Island on the *Nanshan* in September and left the following month on the *Nanshan*. Mrs. Cora Giles Haley, school-teacher, tendered her resignation and left St. Paul Island on the *Nanshan* in October. Mrs. Lois Lippet Proctor was employed as teacher in the junior school on St. George Island for a number of months in the first part of the year and, effective October 1, was appointed school-teacher for St. Paul Island in place of Mrs. Haley. Edward C. Johnston, who had held a number of positions in the Bureau, including that of naturalist on the *Albatross*, prior to military service, was appointed school-teacher, effective August 16, and arrived at St. George Island on the *Nanshan* September 6 to take up his work. Mrs. Ella J. Johnston was appointed special school-teacher for St. George Island, effective September 15.

Mr. Wm. P. Zschorna, employed temporarily for certain technical investigations, arrived at the Pribilofs on the *Saturn* in May and left on the *Nanshan* in October. Mr. A. Christoffersen, by-products expert, also arrived at the Pribilofs on the *Saturn* in May and left on the *Nanshan* in October.

#### PURCHASE AND TRANSPORTATION OF SUPPLIES.

The regular supplies for the support of the natives and for the general operation of the Bureau's business at the Pribilofs were purchased through competitive bids, chiefly at Seattle, Wash. Following the practice of previous years, schedules covering the greater part of these supplies were printed and distributed in the spring to prospective bidders.

About 100 tons of salt and 15 tons of general supplies were forwarded from San Francisco April 16 on the U. S. S. *Saturn*, Naval radio vessel, which arrived at the Pribilofs (St. George Island) May 5. The bulk of the season's shipment was subsequently assembled at Seattle and forwarded on the U. S. S. *Nanshan*, a supply vessel made available by courtesy of the Navy Department. The *Nanshan* sailed from Seattle August 22 and arrived at the Pribilofs (St. George Island) September 6, 1920. The supplies forwarded consisted of approximately 1,300 tons of general freight and 45,000 feet of lumber for St. Paul and about 400 tons of general cargo and 15,000 feet of lumber for St. George.

About 300 tons of supplies and 26,000 feet of lumber, which could not be taken by the *Nanshan* from Seattle, were forwarded August 28, to Unalaska on the Pacific American Fisheries steamer *Catherine D*. The supplies delivered by the *Catherine D* were then transported to the Pribilofs by the *Nanshan*, which made a trip from the islands to Unalaska for the purpose. The *Nanshan* was unable to make delivery of about 155 tons of the coal aboard for St. Paul Island, and it was accordingly left at Unalaska for subsequent delivery by the Bureau's vessel *Eider*.



FIG. 1.—FISHERIES VESSEL "EIDER," TENDER FOR PRIBILOF ISLANDS.



FIG. 2.—TRACTOR HAULING SEALSKINS FROM KILLING FIELD TO SALT HOUSE, ST. PAUL ISLAND.



Emergency supplies of coal and salt were purchased at Unalaska and delivered at the Pribilofs by the Coast Guard cutter *Unalga* in July.

The *Eider* made a trip from Unalaska to the Pribilofs in November. Cargo consisted of about 28 tons of the coal left by the *Nanshan* and approximately 20 tons of general supplies, part of which had been purchased by natives and some by employees at the St. Paul radio station.

#### USE OF TRACTORS.

For use in hauling seal carcasses to the by-products plant and sealskins to the salt houses, as well as for uses in connection with the upkeep and improvement of the St. Paul Island station, four Gray tractors were sent to the island on the *Nanshan*, arriving in September. These tractors will supplement the use of mules and autotrucks. Eight trailers were purchased and shipped with the tractors.

The tractors were secured from the War Department from unused stock originally intended for military use overseas. After the transportation problem at St. Paul Island, especially in respect to the lack of roads and sandy character of the surface had been given due consideration, the War Department recommended the Gray tractor as the most suitable. This is a wide-drive drum type. Instead of the customary two wide rear driving wheels, there is a single drum or wheel the full width of the road. Some use of the tractors in the fall indicates that they will prove a helpful addition to the equipment at St. Paul Island. Operations on St. George Island are much more concentrated near the village, hence there is less use for tractors than on St. Paul.

#### STEAMER "ROOSEVELT."

The steamer *Roosevelt*, which had been used in 1917 and 1918 for transporting the major portion of the supplies required by the Bureau at the Pribilofs and for bringing back sealskins and other products, was found to be in need of extensive repairs. The vessel was placed in dry dock at the Puget Sound Navy Yard April 21, 1919, where it was estimated that the cost of repairs and improvements would be approximately \$186,000. A decision was reached that the vessel did not warrant such a large expenditure, and steps were taken to dispose of it through sale. The *Roosevelt* was accordingly advertised for sale, and on July 15 was disposed of at public auction to Capt. M. E. Tallakson for \$28,000. Final payment was made and the sale approved July 30.

#### SCHOONER "EIDER."

As stated in the corresponding report for 1918 plans were under way for acquiring by construction or through purchase a suitable vessel of convenient size for local use at the Pribilofs. Early in 1919 it was realized that the appropriation of \$20,000 available was not adequate, and that it would be necessary to secure a supplemental appropriation from Congress. An additional appropriation of \$7,500 was obtained in a deficiency act approved July 11, 1919. Thus a total of \$27,500 became available.

Failing to secure satisfactory bids for the construction of a vessel, the Bureau finally purchased the power schooner *Idaho* from Lee & Brinton, of Seattle, for \$26,500. The vessel was renamed *Eider*. Its

registered dimensions are: Length over all, 88 feet; beam, 19.4 feet; depth, 9.2 feet; draft loaded, 9 feet. The registered tonnage is 76 gross and 52 net. The vessel is equipped with a 3-cylinder 110-horsepower Frisco Standard engine, together with appropriate auxiliary machinery. The *Eider* was built in 1913, and had been employed in the offshore halibut fishery. Certain alterations were made to the vessel, which provided two additional staterooms and a room for wireless equipment. The cost of these alterations were included in the purchase price. The vessel was equipped through the Navy Department with a one-half kilowatt wireless outfit and a 1-pound gun.

The *Eider* sailed from Seattle October 26 for Unalaska, arriving there November 17. Stops were made en route at Kodiak and King Cove. At Unalaska there were taken aboard about 28 tons of coal for St. Paul Island and about 20 tons of supplies for the radio station and natives at St. Paul. The vessel arrived at St. Paul November 23, and after discharging cargo left the 25th. It was necessary to keep aboard about 10 tons of coal for ballast. A stop was made at St. George, landing mail at Zapadni, and leaving for Unalaska November 26. Unalaska was reached the following day. Dr. Charles E. Johnson was a passenger from St. Paul to Unalaska.

#### SHIPMENT AND SALE OF OLD BONES.

One shipment of old bone was made from the Pribilofs in 1919. The material was transported from the islands by the U. S. S. *Saturn*, and was landed at San Francisco in June. The gross weight of the shipment, including sacks, was 106,131 pounds. In determining net weight a deduction of 5 pounds per sack for each of the 1,766 involved was made, and from the resulting remainder a deduction of 25 per cent was made for moisture. The net weight was 72,973 pounds, and on this basis the material was sold to the Pacific Bone, Coal & Fertilizer Co. at \$31 per ton. From the proceeds, \$1,131.08, there were deducted \$25.71 for expenses connected with the sale and \$527.55 for making payments to the natives for collecting the bone. The balance, \$577.82, was turned into the United States Treasury.

The shipment, by gross weight, originated as follows: St. Paul Island, 9,052 pounds unground bone; St. George Island, 56,584 pounds unground, 40,495 pounds ground.

The following statements present in tabular form the results of bone-collecting operations on the Pribilofs in the calendar years 1916 to 1918, inclusive. In addition to that shipped, there were perhaps 50 tons of bone practically ready for shipment at the Pribilofs at the end of 1919.

#### EXPENDITURES AND RECEIPTS ACCOUNT COLLECTION AND SALE OF OLD BONES, PRIBILOF ISLANDS, CALENDAR YEARS 1916 TO 1919, INCLUSIVE.

Approximate date of arrival at Seattle.	Net weight in pounds.	Expense of sale.	Receipts, less expense of sale.	Payments to natives.	Amount covered into United States Treasury.
August, 1917.....	32,170	.....	\$321.70	\$179.68	\$142.02
January, 1918.....	161,400	\$333.18	2,087.82	807.00	1,280.82
July, 1918.....	80,092	70.75	1,090.58	492.21	598.37
September, 1918.....	97,408	59.10	1,353.31	487.04	866.27
January, 1919.....	28,111	65.83	341.77	140.50	201.27
June, 1919.....	72,973	25.71	1,105.37	527.55	577.82
Total.....	472,154	554.57	6,300.55	2,633.98	3,666.57

## BY-PRODUCTS PLANT.

It was planned to operate the by-products plant, erected on St. Paul Island in 1918 for the reduction of seal carcasses into fertilizer and oil, to its full capacity in the season of 1919. Owing to a number of unforeseen difficulties, however, principally an unavoidable shortage of coal, it was possible to carry on operations for brief periods only. The output, including small quantities prepared in an experimental way in 1918, was transported to Seattle on the U. S. S. *Nanshan* in the fall. It consisted of 3,000 gallons of oil and 20,568 pounds of fertilizer, known to the trade as "meal." The oil and fertilizer were sold separately, to the highest bidder in each case. Four hundred and fifty gallons No. 1A clear and 450 gallons No. 2A clear were sold at \$1.50 per gallon, 850 gallons No. 2B crude and 250 gallons No. 3 crude at \$1.20, 700 gallons No. 1B crude at \$1, and 300 gallons foats at 90 cents. The total amount received for the 3,000 gallons was \$3,640. The 20,568 pounds of fertilizer "meal," sold at \$75 per ton, the amount received being \$771.30.

A. Christoffersen, a by-products expert, was employed as special assistant for several months in connection with the work of the plant.

## STUDY OF SEALING METHODS.

In order that the quality of the sealskins placed on the market by the Government might be improved if possible, the Bureau carried on in 1919 a special investigation. William P. Zschorna was specially employed a number of months for the work. He first made a study of the methods of handling sealskins at St. Louis through the various processes involved in their dressing, dyeing, and machining. Skins which had developed defects in the various processes were also noted. The work at St. Louis was then supplemented by field work at the Pribilofs. Attention was given to the methods employed in driving and killing seals and in the curing of the skins. Quite elaborate experiments were carried on as to the matter of curing skins, and the particular skins involved were later carefully followed in the course of regular processing at St. Louis.

The investigation resulted in a number of recommendations, four of which were deemed of sufficient practicability to warrant further study and some actual modification of previous methods for the season of 1920. They were: First, to make drives whenever possible the evening before the killing; second, to expend a greater amount of work in handling seals immediately before killing in order to keep them cool; third, to cool and clean skins before salting by immersing them in salt water for a number of hours; and fourth, to employ more elaborate methods in the salting and curing of skins. The work will be continued in 1920. The proposed plan of washing and cooling skins before salting will be tried out in an exhaustive way.

The investigation in 1919 also gave attention to the question of how much blubber should be left on sealskins of various sizes. As a result of the experiments of last season, it seems that skins do not cure as thoroughly in places where the blubber is unusually thick. The logical remedy appears to lie in removing part or much of the blubber. It is possible that it may not be feasible to fully remove the blubber on account of the danger of flaying or cutting the skins,

especially in the case of the smaller ones. There is naturally less danger from this source in removing blubber from the heavy large pelts as the hide is much thicker. Instructions will be issued that 1,000 skins be blubbered at the islands in 1920 in order to work out the best practice along this line. After results have been observed at the dressing and dyeing plant, it will be possible to determine the most advantageous course of action.

#### NATIVES OF PRIBILOF ISLANDS.

##### HEALTH CONDITIONS.

The health of the natives on both St. Paul and St. George Islands throughout the year 1919 was generally fair. The native community on St. George Island numbers about 120 people. For the full census year from April 1, 1919, to March 31, 1920, not one death occurred. When the circumstances and conditions are taken into consideration this is a noteworthy fact.

Undoubtedly more suitable supplies of food and clothing are telling in their effect upon the general health of the natives of the Pribilofs. Much remains, however, to be done. A great deal depends upon the attitude and interest taken in the natives by the employees of the Bureau stationed on the islands, but present efforts are hampered and the best results will never be attained until better housing conditions are provided on both islands, as well as facilities for obtaining suitable supplies of water for domestic purposes. To rebuild the natives' houses and install a water-supply system will require an expenditure of funds which can not be allotted from the current appropriations for the Alaska service, and specific action, therefore, is necessary by Congress in the matter. Such action can not be taken too soon, for every year the work is postponed means so much added loss. The efficiency with which the Department's work at the islands is performed depends to a degree, which is not likely to be overestimated, upon the maintenance of a community of strong, healthy laborers.

The people on the Pribilof Islands were exceptionally fortunate in 1919 in that they were not subjected to the ravages of the influenza which worked such havoc among other native communities in the Bering Sea region. At Unalaska, the port through which practically all travel between the Pribilof Islands and the rest of the world passes, there were upwards of 40 deaths due to influenza, most if not all the victims being natives. When the conditions at Unalaska became known at the Pribilofs, steps were immediately taken by the physician at St. Paul, through the agent in charge, to prevent the arrival of any vessel at the Pribilofs coming from Unalaska. The necessary action was taken, and while it resulted in depriving the Bureau of some assistance in sealing operations, the islands were in all probability spared from a very serious epidemic. The results secured by the Bureau's physicians during the year were very satisfactory in all matters requiring their attention.

A not unexpected epidemic of colds and allied disorders occurred shortly after the arrival of the first vessel at the islands in the spring of 1919. This was repeated again, on St. Paul Island at least, upon the arrival of the *Nanshan* later in the season.

## SCHOOLS.

Statutory provision is made for three school teachers for the Bureau's work at the Pribilof Islands. Since the native population is considerably larger on St. Paul Island than on St. George Island, it has been the custom for the Bureau to detail two of the teachers to the former island and one to the latter. To do justice to educational matters on St. George Island, two teachers are necessary, and to help out until other provision is made a temporary assistant is employed from time to time at a nominal salary to teach a number of the smaller children and to give instruction in household duties to some of the larger ones. An additional teacher to give full time to the work is urgently needed on St. George.

The Bureau is fortunate in being able to have the services of persons who are genuinely interested in their work, and in the last few years the results secured have been highly satisfactory. The Bureau has made special effort to provide suitable materials for carrying on the school work. The scope of this work includes not only instruction along the usual formal lines but in practical matters as well.

*St. Paul Island.*—For various reasons the school year 1918-19 was shorter than usual. The number of days in which formal instruction was given was 116, and the total number of pupils enrolled was 59. Percentage of punctuality was 97 and attendance 98.

Much attention was devoted to the teaching of English. The tenacity with which the natives of the Pribilofs cling to the use of the Aleut tongue is remarkable. The teachers on St. Paul, when taking up their work in the latter part of 1918, after having been absent on leave during the summer, noted how much the children had lost in their ability to use English in the preceding vacation. Since Aleut is not written on St. Paul Island, anything which tends to encourage composition upon the part of the children tends to stimulate the use of English.

The teachers state that the school library was well patronized by the pupils and that several of the young women of the village are regular applicants for books.

By way of indicating some other lines of instruction afforded by the St. Paul school, the following extracts are taken from the report for the year 1918-19 by Mr. and Mrs. Haley:

Sewing has been kept up all the year. The sewing classes are always popular. This year there have been three classes: The senior girls, the junior girls, and a class of boys. The materials furnished directly by the Bureau have been greatly enjoyed. Each of the senior girls has made by hand a pair of bloomers and a hemstitched towel. The class of boys (the oldest boys of the junior school) has learned to use thimbles, to sew "over and over," and to hem. This class was started at the request of the boys themselves. The junior girls did all their work with one kind of stitch. The sewing lessons have alternated with darning lessons, but darning does not appeal to the girls as sewing does. The knitting class did not begin until after Russian Christmas. It was taught this year, as last year, by a native woman.

The young women of the island were given an opportunity to come to the junior school building once a week after school hours for a reading class. They chose American history stories for the class work. The severity of the weather during the winter made this gathering rather irregular.

*St. George Island.*—The 1918-19 school year on St. George Island began October 7, 1918, and ended April 1, 1919. The initial enrollment consisted of 32 pupils—17 girls and 15 boys. Due to the departure of one boy from the island and the death of another, the enroll-

ment was subsequently reduced to 30. The number of days in which the school was in session was 92½. On this island also the school year 1918-19 was unavoidably shorter than is desirable. The percentage of punctuality was 99.96; attendance, 97.6.

No important changes were made in the method of instruction followed the preceding year. Special methods devised by the teacher on St. George were instrumental in securing and holding the interest of the children. Special emphasis was given to encouraging the use of English.

The importance of cleanliness, fresh air, and exercise was made a matter of instruction. The book, Gulick's Good Health, was taken up in the reading work of the most advanced class. A very good brief history of the Pribilof Islands, going back to the early discoveries of the Russians in Alaska, was prepared by Mr. Crompton and was taken up as a regular subject in the school.

Books in the school library were in good demand, an average of 10 volumes being exchanged daily. The services of a native boy who returned from the Salem Indian Training School, Chemawa, Oreg., in 1917, were utilized to assist with the school work. While the help of a native is essential under the circumstances, such assistance can not possibly be considered as satisfying the requirement for an additional teacher for St. George.

A temporary assistant was employed to aid in school work on St. George. The services of this assistant were devoted to instructing a number of the smaller children who had not yet entered the regular school, and also to teaching sewing and giving instruction in other matters pertaining to domestic economy.

#### ATTENDANCE AT SALEM INDIAN TRAINING SCHOOL, CHEMAWA, OREG.

The Salem Indian Training School maintained by the Government at Chemawa, Oreg., affords an opportunity for the young people of the Pribilofs to receive training in addition to that which they obtain at the local schools maintained on the islands by the Bureau.

In 1919, one boy, Laurence Merculief, from St. George Island, entered the training school, and four St. Paul boys, John Emanoff, Alfey Melovidov, Daniel Shabalin, and Peter T. Kochergin, returned home. Agrifina Fratis and Martha Fratis, of St. Paul Island, left the school June 15, 1919, but did not return to St. Paul. In the spring of 1920 they were at Marshfield, Oreg.

#### PRIBILOF ISLANDS NATIVES AT SALEM INDIAN TRAINING SCHOOL, DEC. 31, 1919.

Fratis, Akalina <sup>a</sup> .....	Resident of St. Paul Island.
Fratis, Ouliana.....	Do.
Stepetin, Nicolai.....	Do.
Stepetin, Vasilii.....	Do.
Lekanof, George.....	Resident of St. George Island.
Merculief, Laurence.....	Do.

#### SAVINGS ACCOUNTS.

Certain of the Pribilof Islands natives have personal funds in the custody of the U. S. Commissioner of Fisheries as trustee. These

<sup>a</sup> Mother of Ouliana Fratis and employed at the school.

funds are still on deposit with the Washington Loan & Trust Co., Washington, D. C., and draw interest at 3 per cent per annum, calculated on monthly balances. During the year 1919 three new accounts were opened by natives of St. Paul Island.

On January 1, 1919, the balance was \$3,174.65. Interest credited July 1, 1919, amounted to \$47.61, and on December 31, 1919, \$46.54, making a total of \$94.15 for the entire year. Funds in the sum of \$38.70 were deposited during the year. Withdrawals amounted to \$213.93. The balance on December 31, 1919, of \$3,093.57 is in accordance with the itemized statement which follows:

PRIBILOF ISLANDS NATIVES' SAVINGS ACCOUNTS IN CUSTODY OF U. S. COMMISSIONER OF FISHERIES, AS TRUSTEE, DEC. 31, 1919.

ST. PAUL ISLAND.			
		Merculieff, Terenty <i>a</i> .....	\$37. 53
		Oustigoff, Peter.....	23. 72
Bourdukofsky, Apollon.....	\$87. 78	Pankoff, Agrippina.....	228. 78
Bourdukofsky, Peter.....	58. 91	Pankoff, Maria M.....	41. 87
Diakanof, Auxenia (Mrs. C. H. Hope).....	24. 98	Sedick, Feofania <i>c</i> .....	13. 09
Emanoff, Alexey <i>a</i> .....	286. 94	Sedick, Laventy <i>c</i> .....	13. 09
Fratis, Agrifina <i>b</i> .....	90. 17	Sedick, Leonty <i>c</i> .....	13. 09
Fratis, Akalina <i>b</i> .....	531. 68	Sedick, Marina.....	38
Fratis, Martha <i>b</i> .....	90. 17	Tetoff, Vilkenty M.....	41. 86
Fratis, Ouliana <i>b</i> .....	90. 17		
Gromoff, Iuliania.....	388. 24	ST. GEORGE ISLAND.	
Hanson, John.....	4. 78	Galanin, Mary.....	236. 68
Kozloff, Parascovia.....	85. 40	Lestenkof, Michael.....	114. 64
Krukoff, Iuleta.....	8. 64	Merculief, Agrifina.....	62. 65
Mandregan, Alexandra M.....	9. 93	Merculief, Joseph.....	23. 57
Melovidov, Alfey.....	41. 87	Merculief, Polyxenia.....	11. 92
Melovidov, Anton.....	3. 60	Philemonof, Mary <i>a</i> .....	115.14
Melovidov, Iosef.....	41. 87	Philemonof, Zoya <i>d</i> .....	113. 91
Merculieff, Dosofey.....	37. 53	Shane, Michael.....	28. 78
Merculieff, Makary.....	37. 53	Zacharof, Emanuel.....	45
Merculieff, Mariamna.....	37. 53		
Merculieff, Paul.....	14. 70	Total.....	3,093.57

LIBERTY BONDS.

The 43 Liberty bonds of the fourth issue, amounting to \$2,150, were forwarded on July 22, 1919, to the St. George natives who subscribed to them, with the exception of one \$50 bond which was disposed of by the owner at par value.

The 44 Liberty bonds of the third issue, amounting to \$2,200, were forwarded, on July 22, 1919, and March 30, 1920, to the respective natives of St. George and St. Paul Islands, who subscribed to them, with the exception of one \$50 bond which was disposed of by the owner at par value.

From time of purchase the Commissioner of Fisheries had held these bonds in a safe-deposit box at the Washington Loan & Trust Co., Washington, D. C. In view of the fact that all bonds have been forwarded to their owners, the box is no longer retained by the Bureau.

*a* Deceased, estate undivided.  
*b* Not living on islands in 1919.

*c* New accounts opened in 1919.  
*d* Married to Michael Borenien in 1918. Now deceased.

## PAYMENTS FOR TAKING SEALSKINS.

In 1919 the general plan followed the previous year for making payments for the taking of sealskins at the Pribilofs was continued. By the terms of the contract with Funsten Bros. & Co., that firm provides funds for paying persons engaged in killing and skinning seals and salting and handling sealskins, or otherwise employed in connection therewith, and secures reimbursement from the proceeds of sales of skins. Payments in 1919 covered the salary of one general assistant, wages of two cooks and of a number of Aleutian Islands natives temporarily at the Pribilofs, and payments to Pribilof natives in accordance with numbers and sizes of seals killed. It was arranged that A. H. Proctor, the Bureau's agent at St. Paul Island, should make the necessary disbursements for both St. Paul and St. George Islands. He was bonded in the amount of \$15,000 by the United States Fidelity & Guaranty Co.

In July, 1919, the sum of \$21,000 was deposited by Funsten Bros. & Co. in the Seaboard National Bank, Seattle, Wash., to Mr. Proctor's credit. An additional deposit of \$2,850 was made by Funsten Bros. & Co., on January 22, 1920, to provide for payment of liabilities until the beginning of active work in 1920, a total deposit of \$23,850. Through December 31, 1919, expenses incurred amounted to \$22,318, leaving a balance of \$1,532 to apply on 1920 operations.

The items of expenditure for the calendar year 1919 paid from funds advanced by Funsten Bros. & Co. were as follows:

Salary of general assistant, April to December.....	\$1,350.00
Wages of 2 cooks.....	750.00
Wages of Aleutian Islands natives at St. Paul.....	4,055.00
Amount earned by St. Paul Island natives.....	14,093.00
Amount earned by St. George Island natives.....	2,070.00
Total.....	22,318.00

The natives of the Pribilofs were paid 50 cents each for skins taken from seals up to and including those of the 6-year-old class and \$1 per skin for those taken from seals of the 7-year-old class and upward, except that after August 10 payment for skins of the 6-year-old class was increased to \$1 per skin. No payments were made for skins of seals under the 6-year-old class killed for food purposes after August 10.

In determining the respective amounts due individually for sealing operations, the Pribilof natives were divided into classes according to their ability. Inasmuch as the taking of skins is necessarily cooperative work, each person can not individually take a definite number of skins.

*St. Paul Island.*—In the calendar year 1919 there were taken on St. Paul Island 24,053 skins. For these, after deducting skins from seals killed for food, payments were made on the basis of 50 cents each for 18,342 skins and \$1 each for 4,822 skins. The division was as follows:

DISBURSEMENTS TO ST. PAUL NATIVES FOR SEALING OPERATIONS, CALENDAR YEAR 1919.

CLASSIFICATION.	Number of men.	Share of each.	Total.	CLASSIFICATION.	Number of men.	Share of each.	Total.
First class.....	24	\$367.50	\$8,820.00	Second boys' class.....	4	\$5.00	\$20.00
Second class.....	11	294.00	3,234.00	Undivided credit <sup>a</sup> .....			645.00
Third class.....	3	239.00	717.00	Additional compensation <sup>b</sup> .....			100.00
Fourth class.....	2	183.50	367.00				
Fifth class.....	2	50.00	100.00	Total.....	55		14,093.00
Boys' class.....	9	10.00	90.00				

<sup>a</sup> For 645 seals 6 years and over taken Nov. 8 to Dec. 31. Fund later divided as follows: 22 first-class men, \$18 each; 11 second class, \$16 each; 3 third class, \$13 each; 1 fourth class, \$10; and 4 fifth class, \$6 each.

<sup>b</sup> Allowed 2 native foremen.

*St. George Island.*—The number of skins taken on St. George Island in the calendar year 1919 was 3,768. No skins were taken on this island after August 10 except from seals killed for food purposes, and no payments were made for taking such skins. Of the 3,768 skins taken, payment for 2,768 was on the basis of 50 cents each and for 586 on the basis of \$1 each. The natives participating in the operations were divided into six classes according to their ability and the amount of work performed. The division was made as follows:

DISBURSEMENTS TO ST. GEORGE NATIVES FOR SEALING OPERATIONS, CALENDAR YEAR 1919.

CLASSIFICATION.	Number of men.	Share of each.	Total.	CLASSIFICATION.	Number of men.	Share of each.	Total.
First class.....	15	\$78.50	\$1,177.50	Boys' class.....	1	\$29.50	\$29.50
Second class.....	6	63.00	378.00	Additional compensation <sup>a</sup> .....			100.00
Third class.....	2	52.00	104.00				
Fourth class.....	5	44.00	220.00	Total.....	31		2,070.00
Fifth class.....	2	30.50	61.00				

<sup>a</sup> Allowed 2 native foremen.

PAYMENTS FOR TAKING FOX SKINS.

As in previous seasons, the natives of the Pribilofs were paid \$5 for each fox skin taken in the season of 1918-19. The 144 skins taken on St. Paul Island yielded the natives of that island an aggregate of \$720, which was divided among 38 persons in amounts varying in accordance with their respective earnings. The aggregate of \$2,765 due the St. George natives for the 553 skins taken was divided among 29 persons in accordance with their respective earnings. The payments were made from the proceeds of the sale of the skins

CENSUS.

As in previous years, formal record was made as of March 31 of certain important facts regarding the native inhabitants of the Pribilofs. On March 31, 1919, the number of native inhabitants on St. Paul Island was 188 and on St. George Island 122, a total of 310. The corresponding figures for March 31, 1918, were: St. Paul Island, 199; St. George Island, 123, a total of 322. These figures show a total decrease of 12 in the year ended March 31, 1919. When the natives away from the islands, prospectively only temporarily, were taken into consideration, the total number on March 31, 1918, was

335 and on March 31, 1919, 329. On the basis of these last figures there was a decrease of 6 in the year ended March 31, 1919.

RECAPITULATION OF CENSUS OF NATIVES, MAR. 31, 1919.

St. Paul Island:	
Resident population Mar. 31, 1918.....	199
Births in year ended Mar. 31, 1919.....	11
	<hr/>
	210
Arrival in year (from Atka Island).....	1
	<hr/>
	211
Deaths in year.....	10
	<hr/>
	201
	<hr/>
Departures in year, permanent—	
To St. George Island.....	3
To Unalaska.....	3
	<hr/>
	6
	<hr/>
	195
Departures in year, temporary—To Unalaska.....	7
	<hr/>
Total native resident population, Mar. 31, 1919.....	188
Natives at Salem Indian Training School, Chemawa, Oreg.....	10
Others temporarily residing elsewhere.....	8
	<hr/>
Total natives accredited.....	206
	<hr/>
St. George Island:	
Resident population Mar. 31, 1918.....	123
Births in year ended Mar. 31, 1919.....	4
	<hr/>
	127
Arrivals in year (from St. Paul Island).....	3
	<hr/>
	130
Deaths in year.....	6
	<hr/>
	124
Departures.....	2
	<hr/>
Total native resident population Mar. 31, 1919.....	122
Native at Salem Indian Training School, Chemawa, Oreg.....	1
	<hr/>
Total natives accredited.....	123

FUR-SEAL HERD.

QUOTA FOR KILLING.

On April 8, 1919, the Secretary of Commerce approved the Bureau's recommendation that the quota of seals to be killed at the Pribilof Islands in the calendar year 1919 be as follows:

QUOTA OF SEALS FOR KILLING IN 1919.

Age class.	St. Paul.	St. George.	Total.
3-year olds.....	13,000	2,000	15,000
4-year olds.....	1,700	300	2,000
5-year olds.....	800	200	1,000
6-year olds and over.....	14,500	2,500	17,000
Total.....	30,000	5,000	35,000

It will be noted that the quota provided for the killing of a large number of seals 6 years of age and upwards. The five years of restricted killing of seals, from August 25, 1912, to August 24, 1917, provided for by the act approved August 24, 1912, giving effect to the North Pacific Sealing Convention of July 7, 1911, had resulted in the accumulation of a large number of males far in excess of the number required to maintain the breeding strength of the herd at a maximum. Furthermore, it was felt that this surplus accumulation of males meant not only a loss of revenue to the Government through failure to market as many of the pelts as possible, but through damage to the herd itself on account of the increased fighting on the part of the male seals. It had always been believed that the pelts of older males taken after the development of the so-called wig were practically useless to furriers. Fortunately, experiments conducted at the new dressing and dyeing plant at St. Louis on a limited number of large skins taken at the Pribilofs had demonstrated that a skin from a large seal could be dressed and dyed in such a manner that it commanded almost as great a market value as skins from 3 and 4 year old seals. Under these conditions it was deemed highly desirable to include a considerable number of large seals in the quota for 1919.

In establishing the quota it was realized that the inclusion of 17,000 seals 6 years old or older would involve work possibly beyond the facilities of the Bureau to accomplish. The killing and skinning of a small seal and the curing of its skin is an easy task compared with similar operations in respect to a full-grown bull seal. It was also known that a further difficulty would be encountered by reason of the fact that surplus large males would be found on the hauling grounds in greatest abundance only in the early part of the season, being less and less in evidence there as the season proceeded. It was thought best, however, to fix the quota at the figures which the interests of the service demanded and to accomplish as much as possible under the circumstances.

Through the year 1919 there were killed 7,731 seals 6 years old and over. While the number taken was very much below the number planned, it is believed that much good has been accomplished in the way of reducing the number of surplus males and in affording the means for increasing largely the Government's revenue from the Pribilofs.

#### KILLINGS OF SEALS.

*St. Paul Island.*—During the calendar year 1919 there were killed on St. Paul Island 24,053 seals. Aside from a few seals killed for food and for scientific experimental purposes, they were obtained in 70 drives, the first on April 5 and the last on December 18.

*St. George Island.*—During the calendar year 1919 there were killed on St. George Island 3,768 seals. With the exception of a few, these were secured in 38 drives, the first on June 3 and the last on November 7.

The total number of seals killed on both islands in the calendar year 1919 was 27,821. The tables following show details in regard to the killings in 1919.

## SEAL KILLINGS ON PRIBILOF ISLANDS IN 1919.

## ST. PAUL ISLAND.

Date.	Serial No. of drive.	Hauling ground.	Skins secured.	Date.	Serial No. of drive.	Hauling ground.	Skins secured.
Apr. 5.....	1	Sivutch (Sea Lion Rock).	49	July 23.....	35	Vostochni.....	512
May 10.....	2	do.....	64	July 30.....	36	Gorbatch.....	736
May.....		Northeast Point.....	a 1	July 31.....	37	Reef.....	468
May 28.....	3	Sivutch (Sea Lion Rock).	115	Aug. 1.....	38	Tolstoi.....	182
June 11.....	4	Tolstoi.....	84	Do.....	39	Lukanin and Kitovi.....	72
June 15.....	5	Vostochni.....	556	Aug. 2.....	40	Zapadni and Little Zapadni.....	232
June 16.....	6	Reef.....	113	Aug. 5.....	41	Morjovi.....	469
June 17.....	7	Zapadni and Little Zapadni.....	462	Aug. 6.....	42	Vostochni.....	198
June 19.....	8	Morjovi and Vostochni.....	1,288	Aug. 7.....	43	Gorbatch.....	531
June 20.....	9	Polovina.....	323	Do.....	44	Reef.....	182
June 21.....	10	Tolstoi.....	99	Aug. 8.....	45	Zapadni and Little Zapadni.....	189
June 23.....	11	Zapadni and Little Zapadni.....	347	Aug. 9.....	46	Gorbatch.....	171
June 24.....	12	Reef.....	597	Do.....	47	Reef.....	82
June 25.....	13	Morjovi.....	813	Do.....	48	Lukanin and Kitovi.....	39
June 27.....	14	Vostochni.....	613	Do.....	49	Tolstoi.....	50
June 28.....	15	Polovina.....	197	Aug. 10.....	50	Morjovi.....	153
June 30.....	16	Tolstoi, Lukanin, and Kitovi.....	286	Do.....	51	Vostochni.....	116
July 1.....	17	Zapadni and Little Zapadni.....	873	Aug. 22.....	52	Reef and Gorbatch.....	199
July 2.....	18	Gorbatch.....	1,042	Aug. 23.....	53	Tolstoi.....	48
July 3.....	19	Reef.....	369	Aug. 25.....	54	Zapadni and Little Zapadni.....	106
July 6.....	20	Morjovi.....	624	Aug. 27.....	55	Vostochni.....	176
July 7.....	21	Vostochni.....	1,241	Do.....	56	Morjovi.....	51
July 9.....	22	Gorbatch.....	1,029	Aug. 31.....	57	Tolstoi.....	41
July 10.....	23	Zapadni and Little Zapadni.....	894	Oct. 22.....	58	Reef and Gorbatch.....	175
July 11.....	24	Tolstoi, Lukanin, and Kitovi.....	412	Nov. 3.....	59	Gorbatch.....	122
Do.....	25	Gorbatch and Reef.....	719	Nov. 7.....	60	Reef.....	151
July 14.....	26	Morjovi.....	919	Do.....	61	Tolstoi.....	59
July 15.....	27	Vostochni.....	328	Nov. 10.....	62	Polovina.....	225
Do.....	28	Gorbatch and Reef.....	48	Nov. 14.....	63	Morjovi.....	247
July 16.....	29	Zapadni and Little Zapadni.....	1,259	Nov. 15.....	64	Vostochni.....	148
Do.....	30	Tolstoi.....	554	Nov. 26.....	65	Reef.....	47
July 22.....	31	do.....	168	Nov. 28.....	66	Gorbatch.....	49
Do.....	32	Lukanin and Kitovi.....	25	Nov. 29.....	67	Tolstoi.....	41
July 23.....	33	Gorbatch and Reef.....	332	Dec. 3.....	68	Zapadni.....	44
July 27.....	34	Morjovi.....	658	Dec. 5.....	68	Morjovi.....	60
				Dec. 12.....	69	Tolstoi.....	27
				Dec. 18.....	70	Morjovi.....	52
						Total.....	24,053

## ST. GEORGE ISLAND.

June 3.....	1	North and Staraya Artil.	16	July 19.....	24	East Reef.....	176
June 6.....	2	East Cliffs.....	96	July 21.....	25	North and Staraya Artil.	175
June 10.....	3	do.....	10	July 23.....	26	East Reef.....	122
June 12.....	4	North and Staraya Artil.	41	July 28.....	27	North.....	84
June 14.....	5	Zapadni.....	33	July 30.....	28	East Reef.....	65
June 15.....	6	East Cliffs.....	5	Aug. 2.....	29	North and Staraya Artil.	82
June 17.....	7	North and Staraya Artil.	65	Aug. 4.....	30	East Reef.....	39
June 19.....	8	East Reef and East Cliffs.	127	Aug. 5.....	31	Zapadni.....	43
June 21.....	9	North and Staraya Artil.	161	Aug. 7.....	32	North and Staraya Artil.	109
June 23.....	10	East Reef.....	36	Aug. 9.....	33	East Reef and North.....	60
June 25.....	11	North and Staraya Artil.	107	Aug. 20-21.....		Zapadni.....	a 2
June 26.....	12	Zapadni.....	58	Sept. 1-30.....			c 6
June 30.....	13	East Reef and East Cliffs.	219	Oct. 6.....			c 1
July 2.....	14	North and Staraya Artil.	242	Oct. 20.....	34	North.....	107
July 3.....	15	Zapadni.....	32	Do.....	35	East Cliffs.....	121
July 5.....	16	East Reef and East Cliffs.	146	Oct. 21.....	36	do.....	89
July 7.....	17	North and Staraya Artil.	144	Oct. 30.....	37	East Reef.....	65
July 9.....	18	East Reef and East Cliffs.	164	Nov. 4.....			a 8
July 10.....	19	Zapadni.....	25	Nov. 5.....			a 1
July 12.....	20	North and Staraya Artil.	287	Nov. 7.....	38	East Reef.....	11
July 14.....	21	East Reef and East Cliffs.	154				
July 16.....	22	North and Staraya Artil.	149			Total.....	3,768
July 17.....	23	Zapadni.....	82				

a Seals killed for natives' food.

b Seals killed for experimental work.

c Seals killed for fox food.

BRANDED SEALS.

Following the practice of previous years, there were killed on both St. Paul and St. George Islands in 1919 a number of the fur seals which had been branded when pups in 1912. The data obtained from year to year have been invaluable and are, of course, made more complete with the records of each succeeding year. The great value of the data lies in the fact that they are obtained from seals of known ages. The animals bearing the brand placed on pups in 1912 are the only ones which it has been possible to follow in a scientific way from year to year.

The animals were, of course, 7 years old in 1919. On St. Paul Island 11 were killed, on St. George Island 15. The following table gives certain information derived from them:

RECORDS OF BRANDED 7-YEAR-OLD MALE FUR SEALS KILLED ON PRIBILOF ISLANDS, CALENDAR YEAR 1919.

Serial No. of skins.	Date of killing.	Island.	Car-cass		Green-skin weight.		Trade classification.
			weight. <sup>a</sup>	length.	Pounds.	Ounces.	
AP 6600	June 16, 1919	St. Paul.....	278.0	67.75	34	8	Wig.
AP 6601	June 24, 1919	.....do.....	337.0	73.00	29	8	Do.
AP 6603	June 24, 1919	.....do.....	323.0	65.50	31	8	Do.
AP 6604	.....do.....	.....do.....	481.0	74.25	45	.....	Do.
AP 6605	.....do.....	.....do.....	370.0	72.75	34	.....	Do.
AP 6606	.....do.....	.....do.....	503.0	61.50	15	8	Extra extra large.
AP 6701	Aug. 22, 1919	.....do.....	314.0	73.25	42	.....	Wig.
AP 6702	.....do.....	.....do.....	330.5	73.25	37	8	Do.
AP 6703	.....do.....	.....do.....	274.0	74.50	36	.....	Do.
AP 6827	Oct. 22, 1919	.....do.....	370.0	76.50	44	8	.....
G 6083	June 3, 1919	St. George.....	192.0	64.50	20	.....	Wig.
G 6084	June 6, 1919	.....do.....	148.0	58.75	19	.....	Do.
G 6089	.....do.....	.....do.....	226.0	72.50	31	.....	.....
G 6092	June 11, 1919	.....do.....	413.0	72.00	40	.....	Wig.
G 6093	June 17, 1919	.....do.....	191.0	66.50	23	.....	Do.
G 6094	.....do.....	.....do.....	349.5	74.50	32	.....	Do.
G 6095	.....do.....	.....do.....	360.0	72.75	40	.....	Do.
G 6096	.....do.....	.....do.....	218.5	68.25	28	.....	Do.
G 6097	June 19, 1919	.....do.....	215.5	63.75	23	.....	Do.
G 6098	.....do.....	.....do.....	207.5	67.25	24	.....	Do.
G 6099	.....do.....	.....do.....	212.0	66.50	28	.....	Do.
G 6100	.....do.....	.....do.....	191.0	66.00	24	.....	Do.
G 6101	.....do.....	.....do.....	486.5	78.00	64	.....	Do.
G 6102	June 23, 1919	.....do.....	176.5	63.50	18	.....	Do.
G 6126	July 2, 1919	.....do.....	323.0	68.25	32	.....	Do.

<sup>a</sup> Seals were bled before being weighed.

Information in regard to the branded seals previous to 1919 may be obtained from preceding reports of the Alaska Fisheries and Fur Industries. It should be stated in this connection that an osteologic study of these branded seals is being made by Dr. G. Dallas Hanna.

AGE CLASSES OF SEALS.

Determination of the ages of seals killed is based on data derived from measurements of seals of known ages. The seals whose age was definitely known were those branded in 1912, of which a number have been killed from year to year. For practical purposes on the killing fields the length of the animal determines the age class into which it is placed, the length being the distance from the end of the

nose to the root of the tail. The following table shows the figures used for determining the ages of male seals:

AGE STANDARDS OF BODY LENGTHS OF SEALS.

Age.	Lengths of summer seals.	Lengths of fall seals.	Age.	Lengths of summer seals.	Lengths of fall seals.
	<i>Inches.</i>	<i>Inches.</i>		<i>Inches.</i>	<i>Inches.</i>
Yearlings.....	Up to 36.75	Up to 38.75	4-year olds.....	46 to 51.75	48 to 53.75
2-year olds.....	37 to 40.75	39 to 42.75	5-year olds.....	52 to 57.75	54 to 59.75
3-year olds.....	41 to 45.75	43 to 47.75	6-year olds.....	58 to 63.75	60 to 65.75

AGES OF SEALS KILLED ON PRIBILOF ISLANDS, CALENDAR YEAR 1919.

Age.	Summer (Jan. 1-Aug. 10), 1919.			Fall (Aug. 11-Dec. 31), 1919.			Grand total.
	St. Paul.	St. George.	Total.	St. Paul.	St. George.	Total.	
Yearlings.....	4	-----	4	7	-----	7	11
2-year olds.....	123	71	194	60	154	214	408
3-year olds.....	12,983	2,059	15,042	594	226	820	15,862
4-year olds.....	2,020	370	2,390	38	28	66	2,456
5-year olds.....	1,118	141	1,259	35	2	37	1,296
6-year olds.....	2,089	124	2,213	300	-----	300	2,513
7-year olds and over	3,652	586	4,238	980	-----	980	5,218
Cows <i>e.</i> .....	38	3	41	12	4	16	57
Total.....	22,027	3,354	25,381	2,026	414	2,440	27,821

<sup>a</sup> The few cows reported above, about one-fifth of 1 per cent of the total take, shown in the table, were accidentally and unavoidably killed. Every possible effort is made to avoid the killing of cows, but persons familiar with conditions at the islands will readily appreciate that once in a great while a cow is killed.

## CENSUS.

Following the practice of previous years a census of the fur-seal herd was taken in the summer of 1919. The increase in size of the herd from year to year renders it increasingly difficult to enumerate the animals and each year resort must be had to approximations and estimates to a greater extent than before. The difficulties can be eliminated to some degree by the erection of observation stations and perhaps the construction of walkways through the rookeries. The Bureau will take steps to bring about improvements of this character as soon as possible. Full information in regard to the census of 1919 is contained in the report, printed on pages 106 to 117, by Dr. G. Dallas Hanna, who was in immediate charge of the census work.

The following is a comparative statement of the numerical strength of the various elements of the herd in the years 1912 to 1919, inclusive:

GENERAL COMPARISON OF RECENT CENSUSES OF THE SEAL HERD.

Class of seals.	1912	1913	1914	1915	1916	1917	1918	1919
Harem bulls.....	1,358	1,403	1,559	2,151	3,500	4,850	5,344	5,158
Breeding cows.....	81,984	92,269	93,250	103,527	116,977	128,024	142,915	157,172
Surplus bulls.....	-----	-----	-----	-----	-----	8,977	17,110	9,619
Idle bulls.....	113	105	172	673	2,632	2,706	2,444	2,239
Young bulls (chiefly 5-year-olds).....	199	259	1,658	-----	-----	-----	-----	-----
6-year-old males.....	-----	-----	-----	11,167	15,397	13,755	-----	8,991
5-year-old males.....	-----	-----	-----	11,271	15,494	14,813	11,941	5,282
4-year-old males.....	100	2,000	9,939	15,848	15,427	16,631	7,114	5,747
3-year-old males.....	2,000	10,000	13,880	18,282	19,402	19,507	9,117	13,596
2-year-old males.....	11,000	15,000	17,422	23,990	24,169	26,815	30,159	33,081
Yearling males.....	13,000	20,000	23,068	30,307	33,645	38,013	41,595	46,444
2-year-old cows.....	11,000	15,000	17,422	23,990	24,245	26,917	30,415	33,287
Yearling cows.....	13,000	20,000	23,067	30,306	33,646	38,018	41,608	46,447
Pups.....	81,984	92,269	93,250	103,527	116,977	128,024	142,915	157,172
Total.....	215,738	268,305	294,687	363,872	417,281	468,692	496,432	524,235

## SPECIMENS FOR SCIENTIFIC PURPOSES.

In 1919 there were collected for the California Academy of Sciences, at San Francisco, a number of specimens of fur seals for its use in completing a fur-seal habitat group which is one of an elaborate series of groups installed at the academy's museum illustrative of natural history. The material included 3 adults from St. Paul Island and 3 adults and 13 pups from St. George Island. All the seals involved were animals found dead, with the exception of two accidentally killed on St. George Island. The appraised value of the collection was \$43, which amount was paid by the academy and transmitted to the disbursing clerk of the Department for deposit in the United States Treasury.

## FOXES.

The fox herds are a very important feature of the Bureau's operations on the Pribilof Islands. They produce considerable revenue for the Government each year, and the natives profit through payments made to them for taking the pelts. The revenue represents real production, for unless the herds were fostered by the Bureau's activities they would be reduced almost if not quite to the vanishing point. While the foxes would be able to subsist through the summer season on birds and other sources of food which they are able to secure unaided by man, few would survive the winter were seal meat not provided.

The fox herd is much larger on St. George Island than on St. Paul Island, at least the animals are apparent in larger numbers and the take of pelts each year is much greater. On St. George the feeding of foxes has been reduced to a system, on St. Paul it has not, but the matter is receiving very careful consideration. Natural and other factors on St. George have been much more favorable for controlling conditions than on St. Paul. In the matter of taking pelts, control of the food supply during the winter is almost as important as the supply itself. On St. George Island the beaches where foxes may resort for food are few and limited in extent. The seal-killing fields are limited to two, and both being small and close to the sea are easily cleaned of seal carcasses. The result is that the foxes are obliged to come to certain places for food put out for them. The food given them consists of seal carcasses saved from the killings of the preceding summer. The foxes accustomed to coming to certain places for food are easily induced to enter wire inclosures where the selection of those to be killed and of those to be released as breeders is a simple matter.

On St. Paul Island the open beaches are of considerable extent; the seal-killing fields are more numerous and some so situated that the removal of carcasses would be more difficult and has not been undertaken. It should be noted that foxes will feed in the winter season on seal carcasses left on the killing fields since the preceding summer. The absence of control of food supply in the winter on St. Paul makes it necessary there to capture them in steel traps. A fox once caught in a steel trap must be killed, and the selection of animals for the future breeding stock is an impossibility. From the standpoint of selecting breeders, the beneficial results of being able to observe the herd practically as a whole and to handle the individuals is strikingly shown in one way by the almost entire elimination of

white foxes from the St. George herd. On St. Paul Island the proportion of white foxes taken each year is very much larger. Furthermore, the releasing of animals as breeders insures that at least a minimum number has been reserved. When foxes are taken solely in traps, as on St. Paul, the maintenance of an adequate breeding stock must depend largely upon the judgment of the officer in charge. Whether it will be possible in time to follow profitably on St. Paul the methods employed on St. George is a problem for future solution.

#### TRAPPING SEASON OF 1919-20.

In the trapping season of 1919-20 there were taken on St. Paul Island 155 blue-fox pelts and 32 white-fox pelts, a total of 187; on St. George Island, 746 blue-fox pelts and 4 white-fox pelts, a total of 750 pelts. One additional white pelt was secured at St. Paul from a fox found dead in March, 1920. These figures show for both islands a take of 901 blue pelts and 37 white pelts, or a total of 938 pelts. The aggregate take was considerably larger than that for the preceding season, when 144 were taken on St. Paul and 553 on St. George, a total of 697. The take on St. George in the season of 1919-20 was the largest in many years.

On St. Paul trapping operations were carried on for about one week. Traps were set out December 2 and taken up the night of December 9.

The following extract is from a report submitted by Agent Proctor:

During the season of 1919-20 fox trapping was prosecuted under rather unusual weather conditions. The temperature was well above the freezing point, the ground was entirely free from snow, and light rains fell at intervals. This weather had been preceded by lower temperatures that had continued since well back into November, and it was therefore believed that the skins would be in prime condition.

In order that the fox runs would be well defined, the effort has heretofore been on this island to so time the trapping season as to get a period of clear weather, with the ground covered with a light layer of snow. Trips in the vicinity of the village made by the writer and reports from the more remote places by the natives showed that notwithstanding the absence of snow the fox runs were well defined in the soft ground and dead grass. Under the circumstances it was considered better to make a start under the conditions stated than to take a chance of encountering heavy winds with drifting snow at a later date.

Following the practice that has always obtained on this island, foxes were trapped in ordinary steel traps placed in the various runways and at other favorable points. The traps were secured to the ground by means of a chain and an iron stake driven into the soil. The traps and chains were then covered with grass and other suitable material to conceal them.

All the able-bodied workmen, with the exception of the native priest, were engaged in trapping, and each individual was supplied with as many traps as he was able to look after properly. In all, 42 men were engaged in trapping and an aggregate of 411 traps were employed by them.

In determining the length of the trapping period, the length of the immediately preceding seasons and the size of the catch were taken into consideration, it being thought that if the catch during the first few days of the present season had been noticeably large the season could be prolonged safely. A large catch would have been accepted as an indication that a greater number of young foxes had been brought to maturity this year than during the past years. The catch this season, however, during the first few days did not give this assurance, and the season was therefore confined to the seven actual trapping days originally determined upon. The traps were placed out in the late evening of December 2 and were taken up during the night of December 9, allowing seven full days for trapping operations.

The total number of skins secured during this period was 187 for a seven-day season, as against 144 skins secured in a five-day season in the preceding year. The average catch during the season of 1918 was 29 skins per day, with 39 men and 320 traps. The average number of skins taken daily during the present season by 42 men, with 411

traps, was 27 skins per day or 2 less per day than during the previous season. This would appear to indicate that the herd had made no such advances in numerical strength as to warrant a long period of trapping, with the attendant danger of overtrapping and an unwarranted reduction in fox life.

Under the conditions of fox life on this island it is difficult to see how any estimate of the actual number of foxes in existence can be secured. Unlike St. George Island, foxes here are rarely seen. During the summer and early fall the writer observed one family of two adults with three vigorous young in the cliffs near Zolotoi Sands, and several families were seen between Telegraph Hill and Halfway Point Lake and between Telegraph Hill and the vicinity of Little Zapadni rookery. A fox is rarely seen in the immediate vicinity of the village, though one did appear during the summer and loitered for a short time around our chicken house. Therefore, the only guide as to the number of foxes in existence is in the number taken from season to season. In earlier years this island supported a large fox herd, as indicated by the annual takes. The decrease in the herd, as indicated by the annual takes, appears to have followed the decrease in the number of seals taken and the gradual diminution in available food.

It would therefore appear that the problem of fox propagation here is, as on St. George Island, one of food. During the period from August, 1912, to August, 1917, the number of seals taken was limited to the number required for food for the native inhabitants. Little, if any, seal meat was available for the support of the foxes, and they had to subsist during that period almost entirely on the sea food of various kinds thrown up on the beaches. The increased takes of seals during the past two seasons have furnished abundant food, but the time has been too short to produce any marked effect upon the herd other than to show a satisfactory condition of nourishment, as indicated by the weights of the animals secured this season. The lightest fox taken this season was a blue female that weighed  $4\frac{1}{2}$  pounds, taken December 6, at Zapadni; the heaviest was a white male weighing  $17\frac{1}{2}$  pounds, taken at Tsamma on December 3. The average for the take was about 11 pounds. This may be accepted as a very satisfactory average weight for foxes of both sexes and all ages and indicates that the herd has found an abundance of food during the past year. Now that commercial sealing will proceed steadily there should be no shortage of food, and the physical condition of the herd should therefore show a steady improvement. With the animals in good physical condition and food abundant during all seasons of the year, we should expect larger litters to be brought to maturity and an early increase in the numerical strength of the herd. During the past sealing season killings were arranged, as far as practicable, with a view to leaving carcasses at various points on the island where foxes had been seen or where the ground formation was favorable for burrows, and this policy should be maintained.

As long as foxes are taken in steel traps nothing in the line of selective breeding can be considered, as every animal caught, regardless of its condition, must be killed. Neither can any effort be made to maintain approximately an equal number of animals of each sex. However, trapping by means of steel traps was not known to be detrimental to the herd in former years, when seals were killed in abundance and their carcasses permitted to lie on the ground in various places, and there is every reason to believe that with the continuation of commercial sealing the herd here can ultimately be brought to its former flourishing condition. How many years that will take can not at this time be foretold.

It has been suggested that the St. George method of fox trapping be tried on this island, but the writer is extremely doubtful as to the success of such an experiment. The St. George method of trapping foxes has been carried on only during the period of small seal killings and when the two killing fields used were kept free from carcasses during the winter season. The St. George killings are practically confined to the village killing field and to the killing field at Zapadni. During the period of the St. George method of trapping all of the seal carcasses on that island not required by the natives for food were placed in a silo and used for food at the village trap after the migration of the bird life. This method practically forced the foxes to resort to the village for food; that they come there solely for food during the winter season is shown by the promptness with which they abandon that feeding ground when the birds return to the island. To establish successfully the St. George method on St. Paul, traps would have to be built at several points and the killing fields would have to be kept free from food during the late fall and throughout the winter. This would place upon the working force an additional burden during sealing operations, and it is doubtful whether the results secured would warrant the necessary expenditure of money and labor at the present time.

The development of the by-products plant and extension of roads from the village to the various killing fields may materially change the conditions in the future, and

should that be the case a change in the trapping methods here might then be seriously considered.

All the skins secured here were dried as slowly as conditions at the various stations would permit, and it is believed that the objectionable "papery" condition of the skin is less noticeable than before. Special attention was given to this phase of the work. All the skins have been cased fur side in, in accordance with the instructions received from the Bureau.

On St. George Island fox trapping for the season of 1919-20 was carried on in the months of November and December, 1919, and January, 1920. Seven hundred forty-six blue-fox pelts, including 1 from an animal found dead, and 4 white-fox pelts, a total of 750, were taken. Two hundred twenty-nine male foxes and 225 females were released to insure the maintenance of a suitable breeding stock. It appears that the take of skins was the largest in 27 years. It should be noted that the number of animals released represents the least possible number of animals available at the time as a breeding stock. It is a moral certainty that not all the foxes on the island enter the traps during the season, and the reserved breeding stock is augmented by just the number which does not enter. Foxes released for breeders are marked so that if retaken the same season they will not be killed or charged a second time to the breeding stock if released.

In August, 1919, a small wire cage fox trap was constructed at Zapadni on St. George Island. It was used in the season of 1919-20 and was a complete success. It, of course, only supplements the fox-trapping house at the village. In 1919 arrangements were made for burying in the future the carcasses of foxes killed at the village. The plan adopted will remove all possibility of foxes having access to the carcasses and feeding on them with possible injurious results.

In the summer season of 1919 a supply of seal meat was preserved on St. George for use for fox food in the coming winter season.

In connection with the taking of fox pelts on St. George Island in the season of 1919-20 the following report has been submitted by Agent Crompton:

*Summary of season.*—Cold weather during the latter part of November made it advisable to open the season during that month as the foxes were visiting the feeding place in great numbers. Accordingly, trapping was begun the night of November 24, when 183 animals were handled in five hours, of which number 151 were killed. More foxes might have been taken on the opening night had proper facilities for handling the skins been available.

It was a fortunate thing that work was begun on November 24, as the following day brought warm winds and rain and for three weeks thereafter the thermometer did not register below 35° F. This very unfavorable situation forced the recommendation that the release of the breeding reserve be postponed until at least three-fourths of the expected catch of skins had been secured. Upon adopting this policy very few animals were released until after a total of 450 skins had been obtained.

Warm weather, with the consequent necessity for securing the skins before unprimeness developed, brought about the practice of all-night trapping. On these occasions the trap was opened about 7 o'clock in the evening and kept in operation until 6 or 7 o'clock the following morning. The foxes which had been caught before 12 midnight were disposed of at that hour; the remainder were attended to in the morning. After the first few nights of such work a system of operation was worked out by means of which it could be conducted without interfering with the regular duties of the following day.

All-night trapping was a decided success and the practice will be made a regular feature in future operations. Its advantages are (1) that more foxes may be handled during a given period, (2) that fewer nights of trapping are required, and (3) the animals are thus given more nights for undisturbed feeding. The work has the single danger of being too zealously conducted, in which case the foxes would be deprived of food for too long a period, if not permanently frightened off. During the season just past it was the practice to trap three or four, and on rare occasions five, nights

each week, no one being permitted to approach the fox house during the remaining nights. Except in emergencies it is felt that all-night trapping should be confined to not more than three nights in seven.

*Observations.*—The writer was present in the trapping room during several full nights and confirmed the well-known observation that low tides at night interfere with fox trapping. On one occasion, when the tide was extremely low during the midnight hours, 23 foxes were caught before 9.30 p. m., 3 foxes between that time and 3 a. m., and 38 were taken after 3 a. m. It was also repeatedly observed that the female fox is more nervous and timid than the male.

*Garden Cove and Zapadni.*—Trapping was conducted at two points other than the village, viz., Garden Cove and Zapadni. The work at Garden Cove, where a string trap was used, ended in a complete failure after 10 nights of trapping. It is not believed that a cage trap could be advantageously operated there.

The new cage trap at Zapadni was a great success. One hundred and thirty-four foxes were handled there during 20 nights, as against 38 animals in 18 nights of the preceding season. Of the foxes handled at Zapadni this season 77 were taken in four nights. The trapping work at Zapadni was placed in charge of only the most responsible of the native men and these were under definite orders as to the disposition to be made of the different classes of foxes caught. Telephone communication was continuous. Fox food has been periodically exposed at Zapadni since trapping ceased, and it is the intention to prepare a larger amount of food there next season.

*Close of season.*—Trapping was vigorously conducted along the lines indicated in the preceding paragraphs until, on January 30, the condition of the furs made it advisable to close the season. With a grand total of 1,204 foxes handled, this was the most successful season on this island since 1900-1901, when 1,335 animals were caught. With the single exception of the winter mentioned, it exceeds any season since 1890. In point of the number of pelts taken, it surpasses any season since 1892-93. These results speak high praise for the management of the foxes since the close of the last lease, when the herd was in an unsatisfactory condition.

*Condition of furs.*—Instructions were received to the effect that observations should be made to determine the relation of weather conditions to the primeness of the fox skins. Such observations as could be made on the pelts at this place showed that the relation is direct.

During a normal season the fur of the blue fox should certainly be prime between the dates December 1 and January 31, if not earlier and later than those dates. The skins taken on November 24, 1919, showed very dark on the flesh side, but the fur appeared to be in good condition. During the very warm and wet weather of early December the skins were fully furred but showed a tinge of reddish brown on the guard hairs. However, before the end of that month two unprime skins were noted on animals released for breeding, and it is not to be doubted that the unseasonable high temperatures of the fore part of the month had caused this condition. The statement is ventured that during a normal winter no unprime skins will be seen during the month of December.

During the greater part of January the weather was cold, with the result that the unprimeness threatened in the preceding month did not materialize until late in January. It is the writer's opinion that some of the finest pelts of the season were taken during early January.

*Weights of foxes.*—The following figures will be of interest and should be given special attention in the consideration of the recommendation which will be offered in connection therewith:

	Pounds.		Pounds.
Lightest male fox killed.....	7. 00	Lightest male fox released.....	10. 00
Heaviest male fox killed.....	22. 00	Heaviest male fox released.....	21. 00
Average male fox killed.....	13. 09	Average male fox released.....	13. 72
Lightest female fox killed.....	5. 00	Lightest female fox released.....	8. 00
Heaviest female fox killed.....	16. 00	Heaviest female fox released.....	19. 00
Average female fox killed.....	10. 10	Average female fox released.....	11. 00

Nearly all foxes handled were in good condition and carried heavy layers of fat. Except in rare cases, where a very vigorous young fox happened to weigh just within the minimum limit, all light-weight animals were killed. Only 9 such males and 11 females, weighing 10 and 8 pounds, respectively, were released as breeders; all others released were above those weights.

It is recommended that the minimum-weight limits for animals to be released for breeding be slightly increased; that the minimum for breeding males be set at 11 pounds and for breeding females at 8½ pounds, an increase of 1 pound on the former limit for each sex. Such a course will naturally cause more weights to approach the

minimum limits but it is possible that the average may again draw upward in a few years as a result of the practice. If at any time the average weights are found to be too near the minimum it will be a simple matter to revert to the former rule and nothing can be lost by the experiment. When the average weight of all male foxes is more than 13 pounds and the average weight of all female foxes is over 10 pounds, the minimum limits of 11 and 8½ pounds are but proper.

*Breeding reserve.*—The recommendation that the breeding reserve be increased to 225 pairs was made in the belief that such a change was the most certain manner in which the number of foxes on the island could be positively increased and, in view of the large number of foxes handled, the change could be well afforded this year. The release of 225 pairs this season should be followed (as food and other factors allow) by further small increases each season.

As in previous years, the breeding animals were selected with great care. Weight and general vigor, age, condition of fur, and depth of color in the fur were the principal points upon which an animal's fitness was decided. No old or crippled animals were released even though the fur was of the best.

*Prospect for coming season.*—There is no reason known at this time why the catch of foxes during the winter 1920-21 should not exceed the number taken this season by at least 200 animals. Ideal conditions attending, a catch of 1,000 skins plus 500 breeding animals is more than a remote possibility.

*Feeding of foxes.*—Feeding of the foxes was begun on October 13, 1919, is being continued at this time, and will not be stopped until late April. The food was put out in the usual manner in the neighborhood of the trap, the amount being gauged by the appetite of the animals. It was always the intention to place more food on the feeding ground than the foxes could consume in a single night. The largest amount consumed in a single night was approximately 1,600 pounds.

Referring to the possibility of needing whale meat for fox food during the coming winter, it is no longer felt that such a step will be necessary. After the experience of the past winter it is believed that if all seal meat not used as natives' food is carefully preserved as fox food and the accumulation judiciously fed during the necessary period that no shortage will be encountered. There should be, however, vigorous trapping in the early winter for the purpose of reducing the number of feeding animals.

No efforts will be spared toward making the supply of fox food as large as will be possible with the number and sizes of seals which will be available for killing.

*Lack of facilities.*—There is great and urgent need of better facilities for caring for the fox skins. Owing to the lack of room in the crowded shop, it is very difficult to handle more than 125 skins at one time. This not only gives poorer results but is important when we consider that a catch of 200 skins on the opening night of the season may be expected in the near future.

The proposed new shop will do much to relieve the lack of space and will provide a place for the storage of the skins while they are awaiting shipment.

#### PARASITES.

Informal discussion of the value to fox-farming operations of more information in regard to parasitism among foxes led to a request from the Biological Survey in 1918 that a collection of viscera of foxes and of other material for examination be made at the Pribilofs. The making of the collection was begun on St. George Island in December, 1918, and continued into 1919. Material was secured from 18 foxes, and in addition specimens of fox food were preserved.

Dr. B. H. Ransom, Chief, Zoological Division, Bureau of Animal Industry, rendered a report in February, 1920, based on a study of the collection, as follows:

The intestines and other viscera from 18 blue foxes from St. George Island of the Pribilof Islands, killed or dying during the season of 1918-19, have been examined for parasites and the following findings noted:

Ten of the foxes had tapeworms in the small intestine, the tapeworms being a species of the genus *Mesocestoides*, and apparently a new species, although this material is still being studied. These tapeworms were present as a rule in large numbers. The life history of the worms is not known, but from the distribution of the parasite it is surmised that the intermediate hosts are fishes. One of the foxes had one tapeworm head, the worm apparently belonging to the genus *Tenia*, but having only a part of one circle of hooks remaining on the head; this worm has not been identified, and

perhaps can not be identified on such a small amount of material in poor condition. Eight of the foxes were infested with ascarids, the large round worm of the small intestine, which is, at times, sufficiently numerous to cause serious damage. The damage due to ascarid worms is not only that which follows from their presence in the digestive tract but is also due, as recent investigations have shown, to injuries to the lungs occasioned by the passage of the larval ascarids from the blood stream to the air passages in the course of their migration through the body. One of the foxes had in the small intestine a number of dipterous larvæ which have not yet been identified. It is likely that these larvæ were not parasitic but were due to the fox having eaten some foodstuff, possibly meat, which had been flyblown.

In comment on the foregoing findings it may be said that a feature of considerable interest is the absence of any hookworms. Inasmuch as hookworm disease is one of the most serious pests to be met with in raising foxes or related carnivores, it appears that the island on which these foxes are being raised is a particularly favorable location from this standpoint. It would seem that conditions on the island are peculiarly unfavorable for maintaining a hookworm infection among foxes, or that the original stock placed on the island was fortunately free from hookworm. In any event it would appear to be worth while to take precautions to keep this island uninfested with hookworm either by not bringing in new stock which might be infected, or if new stock must be brought in by subjecting it first to careful fecal examination to ascertain the presence of hookworms, and the exclusion of infected animals until fecal examination following treatment had shown that the animals were free from infection.

Of the parasites already present in the foxes the ascarid is probably the most injurious, but this worm is readily removable by the use of oil of chenopodium accompanied by liberal doses of castor oil. The dose used for dogs is one-tenth of 1 mil of wormseed oil per kilo of weight of dog, or 1 mil of oil for a 22-pound dog followed immediately by an ounce of castor oil. The amount of damage due to the *Mesocostoides* is problematical. These tapeworms were present in very large numbers, in some instances forming a mass of worms which almost occlude the intestine. It is likely that these worms could be readily removed by treatment with oleoresin of male fern. The dose for dogs is 1 to 2 drams; for foxes it would be advisable to use smaller doses, perhaps 3 to 4 mils. Experiments indicate that contrary to what is sometimes said, the male fern may be followed immediately by an ounce of castor oil with good results.

An examination of the viscera other than the digestive tract does not disclose any parasites, nor was the seal meat, which was sent in as a sample of the food used by the foxes, found to be parasitized. The sea urchins were not examined, as we have no reason at present for believing that animals in this group need be suspected of being intermediate hosts or carriers of any sort for the parasites of foxes.

#### REINDEER.

The reindeer herds on St. Paul and St. George Islands maintained themselves in satisfactory condition during 1919. Limited use was made of them for furnishing food both for the natives and the Bureau's employees. The meat provides a welcome change of diet for all; it compares very favorably with beef.

A question having been raised as to the adequacy of the natural food supply on the islands for maintaining animals in larger numbers than already existed, the matter was looked into in some detail. It is now believed that no concern need be felt on this account for some years, even with the animals increasing considerably in numbers. For instance, it was found that there was an area of not less than 4 square miles on the eastern section of St. George Island covered with rich reindeer moss which had not been touched for months, if at all, during the season. Observations made on St. Paul Island indicate that the moss reproduces itself there much more rapidly than it does on the mainland of Alaska.

It is difficult to establish systematic methods of handling the reindeer on St. Paul and St. George Islands. The animals are wild and seldom approach within sight of the villages. To domesticate the

reindeer to an extent which would permit of their being driven to corrals at will, where selections could be made of animals to be killed and of those to be reserved for breeders, would require supervision and experience beyond present facilities. The herds, however, in their present status are very valuable; they yield a not inconsiderable amount of food and cost the Government nothing.

Owing to the wildness of the reindeer and the considerable expanse of territory over which they roam, the task of making even an approximately accurate count of them demands the suspension of other work to an extent which can not often be afforded. It was estimated that the herd on St. Paul Island at the end of the year 1919 consisted of 35 males and 129 females, a total of 164. Fourteen reindeer were killed on St. Paul for food in 1919. A rough census of the St. George herd was taken in March, 1919, with the following results: Males, 1 year old and over, 5; males, less than 1 year old, 19; females, 1 year old and over, 60; females, less than 1 year old, 27; a total of 111 animals. At the end of the year the herd numbered approximately 123, of which 18 were males and 105 females. Twenty-two reindeer were killed for food on St. George in the year 1919.

The totals of 164 for St. Paul and 123 for St. George give an aggregate of 287 reindeer on both islands at the end of the year 1919, a net increase of 18 over the corresponding total a year previous. In 1918, 20 were killed for food, and in 1919, 36.

#### PATROL OF NORTH PACIFIC OCEAN AND BERING SEA.

The Coast Guard cutters *Unalga* and *Bear* were on duty in the North Pacific Ocean and Bering Sea in the season of 1919.

The *Unalga* left San Francisco for the season's cruise April 20 and returned to that port October 30. In addition to other multitudinous duties of various kinds in the interests of the public welfare, the vessel rendered valuable service to the Bureau. Freight and mail were transported between Unalaska and the Pribilofs; employees were transported between St. Paul and St. George Islands; at St. Paul Island a quantity of salt was taken from the village to Northeast Point and a quantity of sealskins transported from Northeast Point to the village.

The *Bear* left Seattle for the season's cruise on May 15 and returned there November 10. From Seattle there were aboard as passengers four men employed by Funsten Bros. & Co., who were en route for the Pribilofs to assist in sealing operations. The *Bear* after arriving at Unalaska joined in the work of caring for the victims of influenza. In line with the precautions taken to prevent the introduction of that disease at the Pribilofs, it was deemed best that the vessel should not stop there on its way northward from Unalaska. The four passengers for the Pribilofs were accordingly taken to Nome where they later secured passage to Seattle on the *Victoria*. Southbound on October 20, the *Bear* called at St. Paul Island and took aboard one passenger and mail and freight for Seattle.

While pelagic-sealing operations in connection with the North American fur-seal herd have ceased, the presence of patrol vessels is necessary as a precautionary measure against the recurrence of illicit activities.



TRACTORS, TRAILERS, AND ROAD GRADER, ST. PAUL ISLAND.



The Bureau is pleased to make acknowledgment of the numerous courtesies extended by the Coast Guard in connection with Alaskan operations, and to express its appreciation of the earnest spirit of cooperation constantly manifested by the personnel of that service.

#### SEALING PRIVILEGES ACCORDED ABORIGINES.

A considerable number of fur-seal skins were taken in 1919 by Indians in connection with operations in the waters off the coast of Washington. The taking of the seals was in accordance with the privilege granted by the North Pacific Sealing Convention of July 7, 1911, and the act of Congress approved August 24, 1912, giving effect to that convention. In the matter of authenticating these skins, the Bureau had the assistance of Mr. A. D. Dodge, superintendent, U. S. Indian School, Neah Bay, Wash., and of Dr. Otis O. Benson, superintendent, Taholah Indian Agency, Taholah, Wash. Five hundred fifty-four skins were authenticated by Messrs. Dodge and Benson, all of which with one or two exceptions were secured in 1919. Of these skins 251 were from male seals and 303 from females.

#### SHIPMENTS OF SKINS FROM PRIBILOF ISLANDS IN 1919.

*Fur-seal skins.*—There were two shipments of commercial fur-seal skins from the Pribilof Islands in 1919. The first was on the *Saturn* and consisted of 106 casks containing 3,624 skins from St. Paul Island and 14 casks containing 389 skins from St. George Island, a total of 4,013 skins. The St. Paul skins were placed aboard the *Saturn* on May 21 and the St. George skins on May 6. The *Saturn* left the islands May 22. The skins reached San Francisco June 5 and were shipped from there June 6 via Southern Pacific to Ogden, Union Pacific to Kansas City, and Wabash to St. Louis. They arrived at St. Louis June 18.

The second shipment was made on the *Nanshan* and consisted of 863 casks containing 22,829 skins from St. Paul Island and 131 casks containing 3,356 skins from St. George Island, a total of 26,185 skins. The St. George skins were placed aboard the *Nanshan* on September 30 and the St. Paul skins about the same time. The *Nanshan* left the islands October 13 and arrived at Seattle October 26. Thirty-seven barrels of skins were shipped from Seattle to St. Louis by express, this being done at the request of Funsten Bros. & Co. to insure more prompt delivery of raw material to keep the dressing and dyeing plant in operation without interruption. The company paid the difference in cost of shipment by express over that by freight. The remaining 957 barrels were shipped to St. Louis by freight in four cars via Northern Pacific to Minnesota Transfer and Chicago, Burlington & Quincy to St. Louis.

In addition to the commercial skins shipped from the Pribilofs in 1919, there were also shipped on the *Nanshan* 19 specimen skins for the California Academy of Sciences. Three of these were from St. Paul Island and 16 from St. George Island.

*Fox skins.*—The fox skins taken in the season of 1918-19 were shipped on the *Saturn* in May. The shipment consisted of 119 blue fox skins and 25 white fox skins from St. Paul Island, and 548 blue fox skins and 5 white fox skins from St. George Island, a total of 697 skins. The skins were shipped to St. Louis by express from San Francisco June 5.

## SALES OF FUR-SEAL SKINS.

The fur-seal skins sold by the Department of Commerce in the calendar year 1919 were disposed of at St. Louis by public auction through the Department's agents, Funsten Bros. & Co. Two sales were held, April 28 and September 10, respectively. The total number of Pribilof Islands skins sold was 19,157 and the total price bid was \$1,501,603.50. All had been dressed, dyed, and machined before being offered for sale.

At the sale on April 28 there were also sold eight other fur-seal skins which had been confiscated by the Bureau. These eight skins, dressed, dyed, and machined, sold for \$75 each, or \$600 for the lot. These skins are not included in the detailed statement in respect to the sale of April 28.

At the sale on April 28, there were sold 10,102 skins from the Pribilofs. The total price bid was \$674,491. The maximum price was \$85 per skin; the average price was \$66.77 per skin, an advance of 29 per cent over the average of \$51.72 received the last preceding sale, October 7, 1918, and an advance of 50 per cent over the average of \$44.58 received at the sale on April 22, 1918.

At the sale on September 10, 1919, there were sold 9,055 skins from the Pribilof Islands. The total price bid was \$827,112.50. The maximum price was \$115 per skin; the average price was \$91.34 per skin, an advance of 37 per cent over the average of \$66.77 received at the last preceding sale, April 28, 1919, and an advance of 77 per cent over the average of \$51.72 received at the sale on October 7, 1918. The following tables give details and summaries in regard to the sales:

## SALES OF DRESSED, DYED, AND MACHINED PRIBILOF FUR-SEAL SKINS AT ST. LOUIS, 1919.

## SALE OF 10,102 SKINS, ST. LOUIS, APR. 28, 1919.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.	Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
1	50	Wigs.....	\$81.00	\$4,050.00	28	60	Extra extra large.	\$75.00	\$4,500.00
2	50	do.....	81.00	4,050.00	29	60	do.....	77.00	4,620.00
3	50	do.....	80.00	4,000.00	30	60	do.....	74.00	4,440.00
4	50	do.....	82.00	4,100.00	31	60	do.....	77.00	4,620.00
5	50	do.....	81.00	4,050.00	32	60	do.....	75.00	4,500.00
6	50	do.....	85.00	4,250.00	33	60	do.....	75.00	4,500.00
7	50	do.....	82.00	4,100.00	34	60	do.....	76.00	4,560.00
8	50	do.....	84.00	4,200.00	35	60	do.....	78.00	4,680.00
9	50	do.....	84.00	4,200.00	36	60	do.....	75.00	4,500.00
10	50	do.....	83.00	4,150.00	37	60	do.....	75.00	4,500.00
11	50	do.....	88.00	4,400.00	38	60	do.....	75.00	4,500.00
12	50	Wigs; cut, scarred, etc.....	60.00	3,000.00	39	60	do.....	74.00	4,440.00
13	50	do.....	60.00	3,000.00	40	60	do.....	79.00	4,740.00
14	50	do.....	62.00	3,100.00	41	60	Extra extra large; cut, scarred, etc.	59.00	3,540.00
15	60	Extra extra large.	79.00	4,740.00	42	60	do.....	57.00	3,420.00
16	60	do.....	77.00	4,620.00	43	60	do.....	58.00	3,480.00
17	60	do.....	78.00	4,680.00	44	60	do.....	61.00	3,660.00
18	60	do.....	76.00	4,560.00	45	50	do.....	62.00	3,100.00
19	60	do.....	76.00	4,560.00	46	70	Extra large	73.00	5,110.00
20	60	do.....	76.00	4,560.00	47	70	do.....	74.00	5,180.00
21	60	do.....	78.00	4,680.00	48	70	do.....	75.00	5,320.00
22	60	do.....	79.00	4,740.00	49	70	do.....	74.00	5,180.00
23	60	do.....	77.50	4,650.00	50	70	do.....	74.50	5,215.00
24	60	do.....	76.50	4,590.00	51	70	do.....	75.00	5,250.00
25	60	do.....	80.00	4,800.00	52	70	do.....	76.00	5,320.00
26	60	do.....	76.00	4,560.00	53	70	do.....	79.00	5,530.00
27	60	do.....	77.50	4,650.00	54	70	do.....	77.00	5,390.00

SALE OF DRESSED, DYED, AND MACHINED PRIBLOF FUR-SEAL SKINS AT ST. LOUIS, 1919—Continued.

SALE OF 10,102 SKINS, ST. LOUIS, APR. 28, 1919—Continued.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.	Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
55	70	Extra large.....	\$78.00	\$5,460.00	112	40	Extra extra large..	\$70.50	\$2,820.00
56	70	do.....	75.00	5,250.00	113	55	Extra extra large;		
57	70	do.....	77.00	5,390.00			cut, scarred, etc....	69.50	3,822.50
58	70	do.....	78.00	5,460.00	114	48	do.....	63.00	3,024.00
59	70	do.....	77.00	5,390.00	115	70	Extra large.....	68.00	4,760.00
60	70	do.....	78.00	5,460.00	116	70	do.....	66.50	4,655.00
61	50	do.....	77.00	3,850.00	117	70	do.....	70.50	4,935.00
62	45	do.....	77.00	3,465.00	118	70	do.....	70.00	4,900.00
63	70	Extra large; cut,			119	70	do.....	70.00	4,900.00
		scarred, etc.....	63.00	4,410.00	120	70	do.....	70.00	4,900.00
64	70	do.....	65.00	4,550.00	121	32	do.....	72.00	2,304.00
65	70	do.....	65.00	4,550.00	122	70	Extra large; cut,		
66	80	Large.....	74.00	5,920.00			scarred, etc.....	55.50	3,885.00
67	80	do.....	74.00	5,920.00	123	70	do.....	55.50	3,885.00
68	80	do.....	80.00	6,400.00	124	24	do.....	55.50	1,332.00
69	80	do.....	77.00	6,160.00	125	80	Large.....	61.00	4,880.00
70	80	do.....	77.00	6,160.00	126	80	do.....	59.50	4,760.00
71	80	do.....	77.00	6,160.00	127	80	do.....	62.00	4,960.00
72	80	do.....	77.50	6,200.00	128	80	do.....	70.00	5,600.00
73	80	do.....	78.50	6,280.00	129	80	do.....	69.00	5,520.00
74	80	do.....	79.50	6,360.00	130	80	do.....	69.00	5,520.00
75	80	do.....	78.00	6,240.00	131	80	do.....	68.00	5,440.00
76	80	do.....	80.00	6,400.00	132	80	do.....	69.00	5,520.00
77	80	do.....	83.00	6,640.00	133	50	do.....	67.00	3,350.00
78	80	do.....	81.00	6,480.00	134	45	do.....	70.00	3,150.00
79	50	do.....	79.00	3,950.00	135	80	Large; cut, scarred,		
80	80	Large; cut, scarred,					etc.....	55.00	4,400.00
		etc.....	60.00	4,800.00	136	80	do.....	50.00	4,000.00
81	80	do.....	64.00	5,120.00	137	80	do.....	50.50	4,040.00
82	80	do.....	65.00	5,200.00	138	90	Mediums.....	60.00	5,400.00
83	90	Mediums.....	69.00	6,210.00	139	90	do.....	63.00	5,670.00
84	90	do.....	70.50	6,345.00	140	90	do.....	62.00	5,580.00
85	90	do.....	70.00	6,300.00	141	90	do.....	61.00	5,490.00
86	90	do.....	75.00	6,750.00	142	90	do.....	58.50	5,265.00
87	90	do.....	73.00	6,570.00	143	90	do.....	61.00	5,490.00
88	90	do.....	78.00	6,570.00	144	51	do.....	59.00	3,009.00
89	90	Mediums; cut,			145	90	Mediums; cut,		
		scarred, etc.....	50.00	5,040.00			scarred, etc.....	40.00	3,600.00
90	90	do.....	58.00	5,220.00	146	90	do.....	37.00	3,330.00
91	50	Small mediums.....	60.00	3,000.00	147	90	do.....	39.00	3,510.00
92	50	III wigs.....	51.00	2,550.00	148	66	do.....	40.00	2,640.00
93	55	III extra extra large	53.00	2,915.00	149	94	Small mediums.....	50.00	4,700.00
94	45	III extra large.....	48.00	2,160.00	150	74	Small mediums;		
95	65	III—47 large, 16					cut, scarred, etc....	28.00	2,072.00
		mediums, 2 small			151	57	III—43 wigs, 14 ex-		
		mediums.....	49.00	3,185.00			tra extra large.....	39.00	2,223.00
101	45	Wigs.....	79.00	3,555.00	152	48	III extra large.....	40.00	1,920.00
102	45	do.....	77.00	3,465.00	153	79	III large.....	30.00	2,370.00
103	45	do.....	78.00	3,510.00	154	87	III mediums.....	27.50	2,392.50
104	45	do.....	77.00	3,465.00	155	85	do.....	27.50	2,337.50
105	45	Wigs; cut, scarred,			156	71	III small mediums.	23.00	1,633.00
		etc.....	57.00	2,565.00	157	26	IV—6 wigs, 2 extra		
106	43	do.....	62.00	2,666.00			extra large, 3 extra		
107	55	Extra extra large..	70.00	3,850.00			tra large, 15 large,	18.00	468.00
108	55	do.....	69.00	3,795.00	158	57	IV—24 mediums, 33		
109	55	do.....	68.00	3,740.00			small mediums.....	10.00	570.00
110	55	do.....	69.00	3,795.00					
111	55	do.....	70.50	3,877.50	10,102				674,491.00

SALE OF 9,055 SKINS, ST. LOUIS, SEPT. 10, 1919.

1	50	Wigs.....	\$97.00	\$4,850.00	15	60	Extra extra large..	\$105.00	\$6,300.00
2	50	do.....	101.00	5,050.00	16	60	do.....	104.00	6,240.00
3	50	do.....	100.00	5,000.00	17	60	do.....	105.00	6,300.00
4	50	do.....	101.00	5,050.00	18	60	do.....	107.50	6,450.00
5	50	do.....	103.00	5,150.00	19	60	do.....	104.00	6,240.00
6	50	do.....	105.00	5,250.00	20	60	do.....	110.00	6,600.00
7	50	do.....	102.00	5,100.00	21	60	do.....	109.00	6,540.00
8	50	do.....	104.00	5,200.00	22	60	do.....	107.00	6,420.00
9	50	do.....	106.00	5,300.00	23	60	do.....	107.00	6,420.00
10	50	do.....	105.00	5,250.00	24	60	do.....	106.00	6,360.00
11	50	do.....	115.00	5,750.00	25	60	do.....	109.00	6,540.00
12	35	do.....	107.50	3,762.50	26	60	do.....	106.00	6,360.00
13	50	Wigs; cut, scarred,			27	60	do.....	110.00	6,600.00
		etc.....	74.00	3,700.00	28	60	do.....	108.00	6,480.00
14	50	do.....	77.00	3,850.00	29	60	do.....	111.00	6,660.00

## SALE OF DRESSED, DYED, AND MACHINED PRIBILOF FUR-SEAL SKINS AT ST. LOUIS, 1919—Continued.

## SALE OF 9,055 SKINS, ST. LOUIS, SEPT. 10, 1919—Continued.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.	Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
30	60	Extra extra large.	\$111.00	\$6,660.00	84	80	Large; cut, scarred, etc.	\$80.00	\$6,400.00
31	60	do.	112.00	6,720.00				78.00	6,240.00
32	60	do.	111.00	6,660.00	85	80	do.	80.00	6,400.00
33	60	do.	110.00	6,600.00	86	80	do.	82.00	6,560.00
34	60	do.	112.00	6,720.00	87	80	do.	90.00	7,200.00
35	60	do.	115.00	6,900.00	88	90	Mediums.	85.00	7,650.00
36	60	Extra extra large; cut, scarred, etc.	97.00	5,820.00	89	90	do.	82.50	7,425.00
37	60	do.	95.00	5,700.00	90	90	do.	82.00	7,380.00
38	60	do.	95.00	5,700.00	91	90	do.	82.00	7,380.00
39	70	Extra large.	100.00	7,000.00	92	90	do.	83.00	7,470.00
40	70	do.	99.00	6,930.00	93	90	do.	83.00	7,470.00
41	70	do.	98.00	6,860.00	94	90	do.	83.00	7,470.00
42	70	do.	101.00	7,070.00	95	90	do.	83.00	7,470.00
43	70	do.	102.00	7,140.00	96	90	do.	83.50	7,515.00
44	70	do.	99.00	6,930.00	97	90	do.	83.00	7,470.00
45	70	do.	96.00	6,720.00	98	90	do.	83.00	7,470.00
46	70	do.	104.00	7,280.00	99	90	do.	85.00	7,650.00
47	70	do.	99.00	6,930.00	100	90	do.	83.00	7,470.00
48	70	do.	99.00	6,930.00	101	90	do.	83.00	7,470.00
49	70	do.	101.00	7,070.00	102	90	do.	83.00	7,470.00
50	70	do.	104.00	7,280.00	103	90	do.	83.00	7,470.00
51	70	do.	101.00	7,070.00	104	90	do.	84.00	7,560.00
52	70	do.	109.00	7,630.00	105	90	do.	82.00	7,380.00
53	70	do.	104.50	7,315.00	106	90	do.	85.00	7,650.00
54	70	do.	105.00	7,350.00	107	90	do.	83.00	6,640.00
55	70	do.	107.00	7,490.00	108	80	do.	86.00	6,880.00
56	70	Extra large; cut, scarred, etc.	95.00	6,650.00	109	80	do.	62.00	5,580.00
57	70	do.	87.00	6,090.00	110	90	do.	65.00	5,850.00
58	50	do.	95.00	4,750.00	111	90	do.	67.00	6,030.00
59	80	Large.	101.00	8,080.00	112	90	do.	66.00	5,940.00
60	80	do.	100.00	8,000.00	113	90	do.	66.00	5,940.00
61	80	do.	101.00	8,080.00	114	90	do.	65.00	5,900.00
62	80	do.	103.00	8,240.00	115	60	do.	66.00	5,940.00
63	80	do.	100.00	8,000.00	116	90	Small mediums.	68.00	6,120.00
64	80	do.	103.00	8,240.00	117	90	do.	69.00	6,210.00
65	80	do.	100.00	8,000.00	118	90	do.	66.50	5,320.00
66	80	do.	100.00	8,000.00	119	80	do.	50.00	3,500.00
67	80	do.	99.00	7,920.00	120	70	Small mediums; cut, scarred, etc.	50.00	3,250.00
68	80	do.	105.00	8,400.00	121	65	do.	57.00	2,850.00
69	80	do.	104.00	8,320.00	122	50	III wigs.		
70	80	do.	102.00	8,160.00	123	65	III—40 extra extra large, 25 extra large.	61.00	3,965.00
71	80	do.	101.00	8,080.00				52.00	2,860.00
72	80	do.	101.00	8,080.00	124	55	III—39 mediums, 36 small mediums.	42.00	3,150.00
73	80	do.	100.00	8,000.00	125	75	IV—8 wigs, 3 extra extra large, 4 extra large, 10 large, 4 mediums, 1 small medium.	22.00	660.00
74	80	do.	103.00	8,240.00	126	30	do.		
75	80	do.	101.00	8,080.00					
76	80	do.	103.00	8,240.00					
77	80	do.	100.00	8,000.00					
78	80	do.	102.50	8,200.00					
79	80	do.	101.00	8,080.00					
80	80	do.	102.00	8,160.00					
81	80	do.	102.00	8,160.00					
82	80	Large; cut, scarred, etc.	79.00	6,320.00					
83	80	do.	\$1.00	6,480.00		9,055			\$27,112.50

## SUMMARY OF TRADE CLASSIFICATIONS, OF PERCENTAGES OF TOTAL IN EACH CLASS, AND OF AMOUNTS RECEIVED AT SALES OF FUR-SEAL SKINS, ST. LOUIS, 1919.

Trade classification.	Sale, Apr. 28, 1919.			Sale, Sept. 10, 1919.			Total.	
	Num-ber.	Per-cent.	Amount.	Num-ber.	Per-cent.	Amount.	Num-ber.	Amount.
Wigs.....	1,067	10.56	\$78,211.00	743	8.21	\$71,288.50	1,810	\$149,499.50
Extra extra large.....	2,339	23.16	168,911.00	1,483	16.38	156,496.00	3,822	325,407.00
Extra large.....	2,067	20.46	145,320.00	1,409	15.56	140,098.00	3,476	285,418.00
Large.....	2,446	24.21	166,473.00	2,385	26.34	227,760.00	4,831	394,233.00
Mediums.....	1,859	18.40	103,743.00	2,513	27.75	199,596.00	4,372	303,339.00
Small mediums.....	324	3.21	11,833.00	522	5.76	31,874.00	846	43,707.00
Total.....	10,102	100.00	674,491.00	9,055	100.00	\$27,112.50	19,157	1,501,603.50

GRADES AND COMPARATIVE VALUES OF SEALSKINS.

As was done in the 1918 Alaska report in respect to the sealskins sold in 1918, record is made of the comparative trade classifications and prices obtained for the various sizes of sealskins sold in 1919. The following table gives the number and grade of skins of each category and the high, low, and average prices received:

COMPARATIVE VALUES BY GRADES AND SIZES OF SEALSKINS SOLD IN 1919.

Classes and sales.	Grade.	Number.	High.	Low.	Average.	Total.	Total number.	Average.	Total price.
Wigs:									
Apr. 28.....	I and II.	730	\$85.00	\$77.00	\$81.57	\$59,545.00	1,067	\$73.30	\$78,211.00
	Cut, etc.	238	62.00	57.00	60.21	14,331.00			
	III.....	93	51.00	39.00	45.45	4,227.00			
	IV.....	6	18.00	18.00	18.00	108.00			
Sept. 10.....	I and II.	585	115.00	97.00	103.78	60,712.50	743	95.95	71,288.50
	Cut, etc.	100	77.00	74.00	75.50	7,550.00			
	III.....	50	57.00	57.00	57.00	2,850.00			
	IV.....	8	22.00	22.00	22.00	176.00			
Extra extra large:									
Apr. 28.....	I and II.	1,875	80.00	68.00	75.40	141,367.50	2,339	72.22	168,911.00
	Cut, etc.	393	69.50	57.00	61.19	24,046.50			
	III.....	69	53.00	39.00	50.16	3,461.00			
	IV.....	2	18.00	18.00	18.00	36.00			
Sept. 10.....	I and II.	1,260	115.00	104.00	108.55	136,770.00	1,483	105.53	156,496.00
	Cut, etc.	180	97.00	95.00	95.67	17,220.00			
	III.....	40	61.00	61.00	61.00	2,440.00			
	IV.....	3	22.00	22.00	22.00	66.00			
Extra large:									
Apr. 28.....	I and II.	1,507	79.00	66.50	74.25	118,574.00	2,067	70.30	145,320.00
	Cut, etc.	374	65.00	55.50	60.46	22,612.00			
	III.....	93	48.00	40.00	43.87	4,080.00			
	IV.....	3	18.00	18.00	18.00	54.00			
Sept. 10.....	I and II.	1,190	109.00	96.00	101.68	120,995.00	1,409	99.43	140,098.00
	Cut, etc.	190	95.00	87.00	92.05	17,490.00			
	III.....	25	61.00	61.00	61.00	1,525.00			
	IV.....	4	22.00	22.00	22.00	88.00			
Large:									
Apr. 28.....	I and II.	1,825	83.00	59.50	73.41	133,970.00	2,446	68.06	166,473.00
	Cut, etc.	480	65.00	50.00	57.42	27,560.00			
	III.....	126	49.00	30.00	37.09	4,673.00			
	IV.....	15	18.00	18.00	18.00	270.00			
Sept. 10.....	I and II.	1,840	105.00	99.00	101.24	186,280.00	2,385	95.50	227,760.00
	Cut, etc.	480	82.00	78.00	80.00	38,400.00			
	III.....	55	52.00	52.00	52.00	2,860.00			
	IV.....	10	22.00	22.00	22.00	220.00			
Mediums:									
Apr. 28.....	I and II.	1,131	75.00	58.50	66.00	74,649.00	1,859	55.81	103,743.00
	Cut, etc.	516	58.00	37.00	45.23	23,340.00			
	III.....	188	49.00	27.50	29.33	5,514.00			
	IV.....	24	10.00	10.00	10.00	240.00			
Sept. 10.....	I and II.	1,960	90.00	82.00	83.99	164,630.00	2,513	79.43	199,596.00
	Cut, etc.	510	67.00	62.00	65.18	33,240.00			
	III.....	39	42.00	42.00	42.00	1,638.00			
	IV.....	4	22.00	22.00	22.00	88.00			
Small mediums:									
Apr. 28.....	I and II.	144	60.00	50.00	53.47	7,700.00	324	36.52	11,833.00
	Cut, etc.	74	28.00	28.00	28.00	2,072.00			
	III.....	73	49.00	23.00	23.71	1,731.00			
	IV.....	33	10.00	10.00	10.00	330.00			
Sept. 10.....	I and II.	350	69.00	66.00	67.40	23,590.00	522	61.06	31,874.00
	Cut, etc.	135	50.00	50.00	50.00	6,750.00			
	III.....	36	42.00	42.00	42.00	1,512.00			
	IV.....	1	22.00	22.00	22.00	22.00			
Apr. 28.....						10,102	66.77	674,491.00	
Sept. 10.....						9,055	91.34	827,112.50	
Both sales.....						19,157	78.38	1,501,603.50	

SUMMARY OF FUR-SEAL SKINS SHIPPED TO FUNSTEN BROS. & CO.

Beginning with the year 1913 all merchantable fur-seal skins shipped from the Pribilof Islands have been forwarded to Funsten Bros. & Co., St. Louis, Mo., for sale. The first sale, held in December, 1913, consisted of 1,896 salted skins. All subsequent sales have been of dressed, dyed, and machined skins. The table following records all shipments made to the firm in the years 1913 to 1919, inclusive, sales of skins, and balances remaining in the custody of the firm.

SUMMARY OF PRIBILO ISLANDS FUR-SEAL SKINS RECEIVED AND SOLD BY FUNSTEN BROS. & Co., ST. LOUIS, MO., AND BALANCES IN FIRM'S CUSTODY, 1913 TO 1919.

Approximate date of shipment from Pribilof Is.		Receipts			Sales.			Balances on hand.				
		Approximate date of receipt by firm.	Number of skins.		Date of sale.	Number of skins.		Food skins. <sup>a</sup>	Commercial skins. <sup>b</sup>	Total.		
			Food skins. <sup>a</sup>	Commercial skins. <sup>b</sup>		Total.	Food skins. <sup>a</sup>				Commercial skins. <sup>b</sup>	Total.
Aug. 8, 1913.....	1913.....	2,296		2,296		Dec. 16, 1913.....	1,806		1,806	2,296		2,296
Oct., 1914.....	1914.....	2,884		2,884						3,284		3,284
1914.....	1915.....	12		12						3,296		3,296
Sept., 1915.....	1915.....	3,000		3,000						6,296		6,296
Oct., 1916.....	1916.....	7,061		7,061		Sept. 20, 1916.....	1,900		1,900	4,396		4,396
Aug. 1, 1917.....	1917.....	4,882		4,882		Jan. 20, 1917.....	2,600		2,600	11,457		11,457
Dec. 17, 1917.....	1918.....	2,427		2,427		Apr. 18, 1917.....	1,500		1,500	7,957		7,957
June 22, 1918.....	1918.....		1,811	1,811		Oct. 8, 1917.....	3,230		3,230	12,839		12,839
Sept. 14, 1918.....	1918.....		3,542	3,542		Apr. 22, 1918.....	6,100		6,100	12,027		12,027
Oct. 6, 1918.....	1918.....		17,816	17,816		Oct. 7, 1918.....	2,000		2,000	5,927		5,927
Dec. 12, 1918.....	1918.....		1,978	1,978						5,373		5,373
May 21, 1919.....	1919.....		4,013	4,013		Apr. 28, 1919.....	3,882		3,882	3,927		3,927
Oct. 13, 1919.....	1919.....		26,185	26,185		Sept. 10, 1919.....		6,250	6,250	45		45
										30,442		30,442
										21,432		21,432
										47,572		47,572

<sup>a</sup> Skins taken from seals killed for natives' food prior to the termination on Aug. 24, 1917, of the 5-year period of restricted killings provided by the act of Aug. 24, 1912.  
<sup>b</sup> Skins taken subsequent to Aug. 24, 1917.  
<sup>c</sup> Final count of food skins at St. Louis showed 2 less than the Bureau's former record. The St. Louis count was accepted by the Bureau in accordance with letter of Jan. 24, 1920, to Funsten Bros. & Co.

## FUR-SEAL SKINS ON HAND DECEMBER 31, 1919.

In order to have available in concise form figures in regard to the number of fur-seal skins handled during the year and the number on hand both at the Pribilof Islands and at St. Louis at the end of the calendar year 1919, the following tabulations have been prepared:

ST. LOUIS RECORD OF SEALSKINS.<sup>a</sup>

On hand Jan. 1, 1919.....	29,080
Shipments received in 1919:	
January.....	7,482
June.....	4,013
July (from Washington).....	12
November.....	26,185
	<u>37,692</u>
Total.....	66,772
Sales during 1919:	
April.....	10,102
September.....	9,055
	<u>19,157</u>
Balance on hand Dec. 31, 1919.....	<u>47,615</u>

PRIBILOF RECORD OF SEALSKINS.<sup>a</sup>

On hand Jan. 1, 1919:	
St. Paul Island.....	3,796
St. George Island.....	389
En route (on board <i>Roosevelt</i> ).....	7,482
	<u>11,667</u>
Skins taken in 1919:	
St. Paul Island.....	24,053
St. George Island.....	3,763
	<u>27,816</u>
Total.....	39,483
Shipments during 1919:	
St. Paul Island.....	29,352
St. George Island.....	8,328
	<u>37,680</u>
Balance on hand Dec. 31, 1919 (St. Paul, 1,405; St. George, 412)....	<u><sup>b</sup> 1,817</u>
Grand total on hand Dec. 31, 1919.....	<u>49,432</u>

## SALE OF FOX SKINS.

The fox skins taken on the Pribilof Islands in the season of 1918-19 numbered 667 blue pelts and 30 white pelts, which, with the exception of 2 blue pelts withheld for exhibition purposes at Washington, were sold at public auction at St. Louis on September 10, 1919. The 665 blues brought \$130,274.50, an average of \$195.90 each, and the 30 white skins \$1,660, an average of \$55.33 each. The following table shows details in regard to the sale:

<sup>a</sup> When the shipment en route from the islands at the end of 1918 was checked out at St. Louis the number of skins was found to be 7,482 instead of 7,483, as stated on p. 114 of the corresponding report for 1918. It was also found when skins were packed on St. George Island in 1919 that 389 skins remained from the 1918 take, instead of 387, as stated on p. 109 of the printed report for 1918.

<sup>b</sup> A report from the agent and caretaker on St. Paul Island, dated Dec. 8, 1919, stated that counts of the skins on hand showed an excess of 9 over the number supposed to remain after all shipments. The shipment which reached the dressing and dyeing plant in November, 1919, had not been unpacked and checked at the end of the year, and part or all of this excess may be accounted for when final report is made on that shipment. In handling the large number of skins taken during the season, it seems practically impossible to avoid the occurrence of slight discrepancies in the counts.

DETAILS OF SALE OF 665 BLUE FOX SKINS AND 30 WHITE FOX SKINS FROM  
PRIBILOF ISLANDS AT ST. LOUIS, SEPT. 10, 1919.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
Blue fox skins:				
300.....	4	Extra extra fine.....	\$350.00	\$1,400.00
301.....	4	do.....	310.00	1,240.00
302.....	4	Extra fine.....	315.00	1,260.00
303.....	4	do.....	320.00	1,280.00
304.....	4	do.....	275.00	1,100.00
305.....	6	do.....	370.00	2,220.00
306.....	6	do.....	325.00	1,950.00
307.....	5	Extra large fine.....	335.00	1,675.00
308.....	10	II extra large dark.....	220.00	2,200.00
309.....	6	I extra large dark.....	300.00	1,800.00
310.....	8	do.....	265.00	2,120.00
311.....	8	do.....	265.00	2,120.00
312.....	10	I dark.....	295.00	2,950.00
313.....	10	do.....	260.00	2,600.00
314.....	10	II extra large dark.....	225.00	2,250.00
315.....	10	do.....	210.00	2,100.00
316.....	12	II dark.....	190.00	2,280.00
317.....	12	do.....	190.00	2,280.00
318.....	10	II extra large dark low.....	145.00	1,450.00
319.....	8	do.....	125.00	1,000.00
320.....	16	II dark low.....	100.00	1,600.00
321.....	9	I extra large blue.....	190.00	1,710.00
322.....	10	I blue.....	205.00	2,050.00
323.....	10	II extra large blue.....	215.00	2,150.00
324.....	10	do.....	195.00	1,950.00
325.....	10	II blue.....	190.00	1,900.00
326.....	10	do.....	135.00	1,350.00
327.....	10	II extra large blue low.....	110.00	1,100.00
328.....	10	do.....	110.00	1,100.00
329.....	10	II blue low.....	85.00	850.00
330.....	8	Dark silvery.....	395.00	3,160.00
331.....	15	III dark.....	47.00	705.00
332.....	6	Extra large fine dark.....	380.00	2,280.00
333.....	4	Extra fine dark.....	325.00	1,300.00
334.....	4	do.....	320.00	1,280.00
335.....	8	II extra large fine dark.....	275.00	2,200.00
336.....	4	II large fine dark.....	215.00	860.00
337.....	6	I extra large fine dark.....	275.00	1,650.00
338.....	8	I fine dark.....	285.00	2,280.00
339.....	8	do.....	280.00	2,240.00
340.....	8	do.....	250.00	2,000.00
341.....	6	do.....	240.00	1,440.00
342.....	10	II fine dark.....	205.00	2,050.00
343.....	6	I extra large dark.....	220.00	1,320.00
344.....	5	do.....	215.00	1,075.00
345.....	8	II extra large dark.....	180.00	1,440.00
346.....	8	do.....	170.00	1,360.00
347.....	10	I dark.....	230.00	2,300.00
348.....	12	do.....	210.00	2,520.00
349.....	12	II dark.....	190.00	2,280.00
350.....	12	do.....	185.00	2,220.00
351.....	12	do.....	205.00	2,460.00
352.....	13	do.....	175.00	2,275.00
353.....	12	I blue.....	210.00	2,520.00
354.....	14	II extra large blue.....	160.00	2,240.00
355.....	10	II blue.....	160.00	1,600.00
356.....	10	do.....	155.00	1,550.00
357.....	7	do.....	130.00	910.00
358.....	12	II blue low.....	115.00	1,380.00
359.....	10	do.....	105.00	1,050.00
360.....	8	I extra large silvery.....	270.00	2,160.00
361.....	7	II silvery.....	205.00	1,435.00
362.....	11	I and II pale.....	175.00	1,925.00
363.....	17	III blue.....	60.00	1,020.00
364.....	21	IV.....	28.00	588.00
365.....	13	V.....	5.50	71.50
366.....	4	I fine dark.....	400.00	1,600.00
367.....	8	II fine dark.....	260.00	2,080.00
368.....	6	I dark.....	280.00	1,680.00
369.....	8	I blue.....	200.00	1,600.00
370.....	12	II blue.....	205.00	2,460.00
371.....	8	II blue low.....	160.00	1,280.00
372.....	11	I and II dark silvery.....	335.00	3,685.00
373.....	5	I silvery.....	230.00	1,150.00
373A.....	2	II extra large fine dark.....	280.00	560.00
White fox skins:				
374.....	16	I.....	67.00	1,072.00
375.....	14	II Pt. low.....	42.00	588.00
Total.....	695			131,934.50

## JAPANESE SEALSKINS DELIVERED TO UNITED STATES.

The North Pacific Sealing Convention of July 7, 1911, provides that in respect to fur-seal skins taken annually upon Robben Island, or any other islands or shores of the waters covered by the convention subject to the jurisdiction of Japan, 10 per cent in number and value shall be delivered to the United States. In 1918 the Japanese take consisted of 555 skins. The same number were taken in 1919. The share of the United States for the two years was, accordingly, 111 skins. These skins were forwarded to the Bureau's agents, Funsten Bros. & Co., St. Louis, for sale. They arrived at St. Louis, March 15, 1920. Examination of the skins showed that they had been very carefully taken and cured. It is understood that the take of Japanese skins in 1918 and 1919 all came from Robben Island.

Information received informally from Mr. K. Ishino, of the Imperial Bureau of Fisheries of Japan, indicates that there were on Robben Island in 1919, between 11,000 and 12,000 seals, and that the seals on the Kuril Islands have gradually decreased in the past four or five years and have now almost disappeared. Mr. Ishino also stated that when at the Commander Islands in 1916 he determined that the Russian herd numbered about 50,000 animals. The Russian Government's report, however, claims only 30,000. In 1917 there were 800 seals killed on Copper Island, one of the Commander group. Mr. Ishino stated that sea otters are increasing among the Kuril Islands and that in 1919 he saw 300 and has reason to believe that there are at least 500 there. He advised also that sea otters are increasing about the Russian islands.

## FUR-SEAL CENSUS, PRIBILOF ISLANDS, 1919.

By G. DALLAS HANNA.

A census of the Alaska fur-seal herd was taken during the summer of 1919 by employing the methods which have been in practice for several previous years. These, together with the habits of the animals and the history of the herd have been fully described in the annual reports from 1914 to 1918, so that in order to avoid needless repetition these subjects will not be treated herein, except in so far as seems necessary to properly present the new data. Some new facts in regard to the natural history of the animals, learned in 1919, will be mentioned, however, in order to keep this phase of the subject up to date.

A complete count of bulls was made at the height of the breeding season. To facilitate the count, driftwood and paint markers were placed on some of the rookeries which are more difficult to count. While these were very helpful they only emphasized the need of permanent work of this character carried on with the erection of overhead observation positions.

After the breaking up of the harems, pups were counted on as many rookeries as possible in order to determine the average harem.

Preliminary harem counts (not tabulated herein) were made on St. George Island by C. E. Crompton and on St. Paul by the author. These proved helpful in the final counts and afforded a fair check on the work.

In the harem counts, H. D. Aller assisted on St. Paul and C. E. Crompton on St. George. The same men assisted in the pup counts on the same islands. Besides this Mr. Crompton made the pup count of Staraya Artil Rookery on St. George and Mr. Aller counted Polovina Cliffs Rookery on St. Paul.

### DIFFICULTIES ENCOUNTERED.

As the seal herd grows a census taken by present means becomes less and less accurate. This is necessarily the case because of the large masses of animals dealt with, and unless an elaborate system of markers and elevated viewpoints be established it will not be many years until the count of harems will give no more accurate an enumeration than an estimation by the area method. The construction of the necessary apparatus, however, is believed to be feasible, and in view of the accurate knowledge which can be gained in regard to the state of the herd it would seem to be very profitable. Under present methods of calculation the harem count is fundamental. If it be far wrong the entire census becomes an estimate with figures which look mathematically exact. When the herd was small the harems could be counted exactly, but this is not true to-day. Therefore the readers of this report should bear in mind that although figures for the different classes are given exactly, only round numbers are intended. A complete census is an absolute impossibility. A close approximation to

the truth is all that can be expected. The best census is a very careful estimate made by utilizing as many of the known factors in the biology of the species as possible.

The great difficulty in counting bulls is to find a point back of the large rookeries from which all the animals can be seen. In order to overcome the trouble we climb a high ladder which can be moved from place to place, and whenever the weather and sea will permit boats are utilized, because of the better view thus usually secured. But both of these methods are unsatisfactory and certain construction work has been outlined elsewhere. Possibly the work could be done with absolute accuracy from an airplane with the aid of photography, a means first suggested, it is thought, by Dr. Paul Bartsch, of the United States National Museum.

With the decrease in the number of bulls and the increase in the average harem in 1919 less difficulty was experienced in counting pups than in 1917 and 1918. The rookeries are so large on St. Paul now, however, that a complete pup count could hardly be attempted without a considerable force of men. And even then it is believed the loss which the herd would suffer from the count would not be warranted. If the persons intrusted with the census work can give the subject their undivided attention during the season the count of pups on a few of the smaller rookeries should suffice to establish the average harem, provided, of course, that the harem count be accurate.

#### SUGGESTIONS FOR FUTURE CENSUSES.

In connection with work on the fur-seal rookeries it is impossible to forecast even one year in advance the new problems which may be forthcoming and the difficulties which may arise to interfere with a satisfactory taking of the census. However, several years' experience have led to certain conclusions which may be worth recording for such use as future workers may care to make of them.

It is anticipated that the bull counts on St. George Island can be made with comparative ease at the height of the breeding season; no material increase in the idle and harem bull classes is expected for at least two or three years. Staraya Artil and North Rookeries are much more satisfactorily counted from a boat than from the land side if the weather is suitable for one to get out on the sea. Should it be necessary to count from the land however, the use of a long ladder is recommended in order to permit observation of the entire areas of the breeding masses. East Reef and East Cliffs Rookeries can be seen better from the water, but satisfactory counts can be obtained from the land. A considerable risk is run in the case of the latter rookery on account of the dense vegetation growing on a ragged slope. Should one slip here he would fall among the bulls and be in imminent danger of losing his life. However, should timidity be felt regarding the cliff, it seems entirely feasible for the person doing the counting to be supported from above with a rope. Zapadni Rookery can be counted by exercising the ordinary care one acquires in creeping upon the breeding rookeries; and the same is true in the case of South.

The much larger areas on St. Paul Island, however, can not be disposed of so easily. There is not likely to be any material diminution in the numbers of bulls, which are a constant menace to observers

during the height of the season counts. While this is the most important of all census work it is becoming less and less satisfactory because of extraordinary difficulties encountered. The larger rookeries can not be seen from a point on the land side. Heretofore the precarious utilization of a long ladder supported by guys has been resorted to. These guys must be held by men and if a bull should charge one of these men a most uncomfortable fall to the rocks below would result.

Temporary marks of driftwood and paint have been placed on the difficult rookeries the past few years. Time and labor, however, have not permitted this to be done in any but a cursory fashion.

A large amount of work needs to be done in order to make the bull counts of the future satisfactory. Concrete markers should be placed at regular intervals of at least 100 feet (better every 50 feet) on the following rookeries: Gorbach, Reef, Kitovi, Lukanin, Polovina, Morjovi, Vostochni, Zapadni, Little Zapadni, and Tolstoi. A marker 3 feet long, 1 foot square at the base, and 6 inches square at the top is suggested. It could be buried a foot in most places. It would be very desirable also to have a piece of 1-inch galvanized pipe 6 feet long set into each to facilitate handling the block and to make it much easier to see at the long distance from which counts must ordinarily be made.

Overhead runways for the observer to walk out to the crest of the beach line should be provided on most of the rookeries mentioned above. They need not be elaborate. All that is needed is a trestle-work 6 feet high and a walkway 1 or 2 feet wide. No hesitation need be felt because of the effect these structures would have on the seals. In 1919 two boats remained on Reef Rookery throughout the season and the seals paid not the slightest attention to them.

This construction work which has been recommended must be done at the earliest possible moment if satisfactory census figures are desired. It can not be done now, however, in time for use in 1920. The bulls arrive in May, which is earlier than men can ordinarily get to the islands. Snow then usually covers the ground and would prevent work of the character outlined. Such work, which would involve a considerable amount of labor, must be done after August 10 if it is to be done at all, during the season when the island force would be busy at other work. It is recommended, therefore, that at least five assistants be supplied the man who directs this work. One of these should be a good carpenter who could act as foreman, and the others should be laborers. All should be taken from the States. During the sealing season there is an abundance of work elsewhere on St. Paul for them to do. As stated, they would not be needed on the rookeries until after August 10.

Too strong emphasis can not be placed on the need of the work outlined above and on the absolute necessity of its being provided for wholly by outside labor.

It may be asked, why the large St. Paul rookeries can not be counted from a boat. It is not always possible to get out on the water for this purpose, but when it is I have chosen the means in preference to the ladder for Zapadni, Little Zapadni and Tolstoi. However, these rookeries are becoming so deep that it is practically impossible to get an accurate count of bulls from a boat. The areas are too broad and the seals are too compact therein.

As the number of bulls is reduced in the herd the counting of pups will become easier and the work can be undertaken somewhat earlier. If the force of men recommended is supplied in 1920 doubtless some of the larger rookeries can be counted again. But unless a thoroughly accurate and satisfactory count of harems can be made on a rookery the count of pups is not so valuable as it otherwise would be.

## PUPS.

## DISTRIBUTION OF PUPS IN 1919.

Rookery.	Date of counts.	Living pups.	Dead pups.	Total pups.	Per cent dead.
ST. PAUL ISLAND.					
Kitovi.....		3,512	53	α 3,565	1.49
Lukanin.....		2,712	76	α 2,788	2.73
Gorbach.....		11,878	430	α 12,308	3.49
Ardiguen.....		1,130	20	α 1,150	1.74
Reef.....		21,871	586	α 22,457	2.61
Sivutch.....		6,840	175	α 7,015	2.49
Lagoon.....	Aug. 11	430	15	445	3.37
Tolstoi.....		15,668	359	α 16,027	2.24
Zapadni.....		13,921	379	α 14,300	2.65
Little Zapadni.....		9,817	328	α 10,145	3.23
Zapadni Reef.....	Aug. 12	581	23	604	3.81
Polovina.....	Aug. 13	5,486	308	5,794	5.31
Polovina Cliffs.....	Aug. 14	2,148	61	2,209	2.76
Little Polovina.....		1,189	14	α 1,203	1.16
Morjovi.....	Aug. 14	2,953	88	3,041	2.89
Vostochni.....		29,480	1,383	α 30,863	4.48
Total.....		129,616	4,298	133,914	3.21
ST. GEORGE ISLAND.					
North.....		8,584	218	α 8,802	2.48
Staraya Artil.....	Aug. 2	5,582	164	5,746	2.85
Zapadni.....	Aug. 5	846	11	857	1.28
South.....	Aug. 5	68	.....	68	.....
East Reef.....	Aug. 4	2,345	22	2,367	.92
East Cliffs.....		5,297	121	α 5,418	2.25
Total.....		22,722	536	23,258	2.30
Total, both islands.....		152,338	4,834	157,172	3.07

α Based on estimated average harem.

The number of dead pups was ascertained on each rookery counted at the time the count was made. On those rookeries on which the cows and pups were estimated the number of dead was computed from the percentage of dead used in the 1918 report. The small increase in the average harem, especially on St. George, should have reduced the percentage of dead pups to a slight extent. On St. Paul, conditions were so little changed in this respect, however, that the difference would not overbalance variations due to the laws of chance. Therefore until average harems become as large as they have been in some former year (as 1916 for instance) when the death rate was determined for all of the rookeries it seems best to make no change in the percentages. The rookeries which were counted in 1919 gave no data upon which to base a reduction. In fact there was in some cases evidence of a slight increase in the number of dead pups.

## INCREASE OR DECREASE IN NUMBER OF PUPS IN 1919 FROM 1918.

Rookery.	Total pups, 1918.	Total pups, 1919.	Numer- ical increase.	Increase (+) or decrease (-).
ST. PAUL ISLAND.				<i>Per cent.</i>
Kitovi.....	2,540	3,565	1,025	+40.35
Lukanin.....	2,235	2,788	553	+24.74
Gorbach.....	9,486	12,308	2,822	+29.74
Ardiguen.....	792	1,150	358	+45.20
Reef.....	19,398	22,457	3,059	+15.76
Sivutch.....	6,325	7,015	690	+10.90
Lagoon.....	512	445	-67	-13.08
Tolstoi.....	16,725	16,027	-698	-4.17
Zapadni.....	11,460	14,300	2,840	+24.78
Little Zapadni.....	9,089	10,145	1,056	+11.61
Zapadni Reef.....	536	604	68	+12.68
Polovina.....	5,343	5,794	451	+8.44
Polovina Cliffs.....	1,882	2,209	327	+17.37
Little Polovina.....	1,491	1,203	-288	-19.31
Morjovi.....	3,335	3,041	-294	-8.81
Vostochni.....	31,468	30,863	-605	-1.92
Total.....	122,617	133,914	11,297	+9.21
ST. GEORGE ISLAND.				
North.....	7,011	8,802	1,791	+25.54
Staraya Artil.....	5,440	5,746	306	+5.62
Zapadni.....	806	857	51	+6.32
South.....	61	68	7	+11.47
East Reef.....	2,120	2,367	247	+11.65
East Cliffs.....	4,860	5,418	558	+11.48
Total.....	20,298	23,258	2,960	+14.58
Total, both islands.....	142,915	157,172	14,257	+9.97

A casual inspection of the foregoing table discloses a great variation in the growth of the various rookeries. It ranges from a loss of 19.31 per cent in one case to a gain of 45.20 per cent in another. Some of this variation might be attributed to the defects in the method of arriving at the number of pups on rookeries not actually counted, but it can not explain it all. A constant rate of increase simply is not a phase of rookery development, and this is the greatest objection to the use of a single breeding area as a type in census calculations.

## COWS.

## NUMBER.

The number of breeding cows is by inference the same as the number of pups, since but a single young is born annually. Although a birth of twins is unknown in the species, it is not believed to be entirely impossible from an anatomical standpoint and may on very rare occasions occur.

The figures for the pups show that there has been an increase of cows of 9.97 per cent from 1918. This figure is to be compared with 11.63 per cent for 1918.

The figures show that the average annual increase is between 9 and 10 per cent under present conditions. This is an exceedingly slow rate of growth for animals which live as long and breed as often as fur seals. It emphasizes the enormous loss the species suffers annually from some enemy of which we know practically nothing. It now seems certain that 50 per cent of all animals born are lost

before they attain the third year. Since an exceedingly small proportion is weak physically, it seems evident that the great loss is due to a predatory animal.

#### LOSS.

The loss of cows on the islands due to rookery conditions continues to be large, but a decrease from 1918 is noted. This result would naturally be expected from the increase in the average harem, although small, and the consequent less crowded condition. The dead cows found on five St. Paul rookeries numbered 15. The total alive on the same areas was 12,093. This proportion (0.001240) applied to the entire herd indicates a total loss of 195 cows. This number is to be compared with 213 for 1918, 129 for 1917, and 39 for 1916. With an increase in the average harem to about 40 there should be a material reduction in this loss.

The practice of killing seals up to August 10 grew up when the herd was smaller and much time could be taken in the segregation of the animals. The natives were thus provided with fresh food 10 days longer. At the present time the practice can hardly be excused on these grounds. The males which would ordinarily be taken in this period can be secured before, at least in large part, by a slight speeding up of the work.

#### AGES.

The maximum age of cows is yet unknown. Animals of the 1902 series (branded 1896 to 1902 inclusive) were observed in 1919 to the number of nine. This is a larger number than has been previously recorded for several years. Close watch was kept for them. This is considered a large number in view of the fact that the youngest are at least 17 years old and have passed through at least 10 years of pelagic sealing. The number branded of which records are available was 19,587. St. George brandings from 1898 to 1902, inclusive, are not available.

C. E. Crompton reported seeing a cow on Staraya Artil Rookery August 2, 1919, with the one bar across the back characteristic of the 1902 series and, in addition, a longitudinal bar on the left side. No record of such a brand was made on St. Paul Island, so it is probably a St. George seal.

Cows of the 1912 series were especially in evidence, possibly because branded animals were being searched for. Four were seen in one day on St. George. They have been seen on rookeries occasionally where it is known they were not born. This lends weight to the theory that the cows wander considerably from place to place, whereas it is known that adult males do not do so to nearly the extent that was formerly supposed. In less than half a dozen cases have males of this series been seen away from parent rookeries since they became 6 years old.

#### BULLS.

##### HAREM AND IDLE BULLS.

The count of bulls, harem and idle, made at the height of the breeding season furnishes the most reliable data obtainable at present upon which to base the census. From this the average harem can be

computed on the several rookeries with a reasonable degree of accuracy, providing the number of cows is ascertained for some of them; and it is possible to determine fairly well about what the average harem will be from the proportion of idle bulls found at the height of the season.

The enumeration of the bulls is conducted with increased difficulty each year. It seems likely that unless some means are devised whereby the animals on the large rookeries can be brought within view the work must be given up in a few years, except on the smaller areas and sections. If the plans which are under consideration, however, are carried out it is believed that in a few years it will be possible to make this count accurately regardless of the growth of the herd. In no other way is it believed possible to keep a sufficiently accurate check on the herd to determine quotas for killing in advance with the provision of just enough reserve for breeding purposes.

Owing to adverse weather conditions it was not possible to make a count of bulls on Sea Lion Rock (Sivutch Rookery). The number was taken as the same as found in 1918 since this area being circumscribed by natural limits forbids any great amount of annual change.

The following table shows the results of the count:

HAREM AND IDLE BULLS AND PERCENTAGE OF IDLE BULLS TO HAREM BULLS  
COMPARED TO AVERAGE HAREM, 1919.

Rookery.	Date.	Harem bulls.	Idle bulls.	Total.	Idle bulls to harem bulls.	Average harem.
ST. PAUL ISLAND.						
Kitovi.....	July 16	155	75	230	<i>Per cent.</i> 48.38	<i>Per cent.</i> 23.00
Lukanin.....	..do..	110	80	190	72.72	25.34
Gorbach.....	..do..	362	95	457	26.24	34.00
Ardiguen.....	..do..	46	18	64	39.13	25.00
Reef.....	..do..	720	162	882	22.50	31.19
Sivutch.....	(a)	230	90	320	39.13	30.50
Lagoon.....	July 17	17	6	23	35.29	26.18
Toistoi.....	..do..	538	154	692	28.62	29.79
Zapadni.....	..do..	546	246	792	45.05	26.19
Little Zapadni.....	..do..	344	145	489	42.15	29.49
Zapadni Reef.....	..do..	28	6	34	21.42	21.57
Polovina.....	July 15	192	102	294	53.12	30.18
Polovina Cliffs.....	..do..	96	48	144	50.00	23.01
Little Polovina.....	..do..	38	23	61	60.52	31.66
Morjovi.....	July 14	147	87	234	59.18	20.69
Vostochni.....	..do..	1,004	821	1,825	81.77	30.74
Total.....		4,573	2,158	6,731	47.19	29.28
ST. GEORGE ISLAND.						
North.....	July 21	225	21	246	9.33	39.12
Staraya Artil.....	..do..	124	14	138	11.29	46.34
Zapadni.....	..do..	27	6	33	22.22	31.74
South.....	..do..	5	3	8	60.00	13.60
East Reef.....	July 19	75	23	98	30.66	31.56
East Cliffs.....	..do..	129	14	143	10.85	42.00
Total.....		585	81	666	13.84	39.76
Total, both islands.....		5,158	2,239	7,397	43.40	30.47

<sup>a</sup> Count of 1918.

The most significant fact to be noted in the foregoing table is the falling off of the number of bulls. This was greatly desired by all who had the welfare of the herd in mind. Later counts showed that it was accompanied with an increase in the size of the harem, not a great deal

to be sure, but more than had been expected. It was not thought that the enormous excess of males which had been in reserve owing to the closed season of 1912-1917 could be noticeably reduced in a single season of commercial work; yet it was done and speaks well for the conduct of the business by the island authorities. It should be noted that not only the total number of bulls was slightly reduced but that the percentage of idle bulls to harem bulls grew less. This is the best evidence that the reasoning was sound which led to the conclusion in former years that a proportion of one idle bull to two harem bulls produced the minimum average harem; and that this latter is very close to 26, regardless of amount of male life, is a foregone conclusion.

## AVERAGE HAREM.

The counting of pups on certain of the rookeries enabled the determination of the average harem on the rookeries counted. The information derived therefrom, coupled with observation on the ground, led to the results given in the table below. For purposes of comparison the average harems in 1918 are given, showing graphically the increase in size of harems.

## AVERAGE HAREM IN 1919 FOR ALL ROOKERIES.

Rookery.	Breeding cows.	Harem bulls.	Average harem, 1919.	Average harem, 1918.
ST. PAUL ISLAND.				
Kitovi.....	3,565	155	a 23.00	a 20.00
Lukamin.....	2,788	110	a 25.34	a 22.35
Gorbateh.....	12,308	362	a 34.00	a 31.00
Ardiguen.....	1,150	46	a 25.00	a 22.00
Reef.....	22,457	720	a 31.19	b 28.19
Sivutch.....	7,015	230	a 30.50	a 27.50
Lagoon.....	445	17	b 26.18	b 20.48
Tolstoi.....	16,027	538	a 29.79	a 26.76
Zapadni.....	14,300	546	a 26.19	a 23.19
Little Zapadni.....	10,145	344	a 29.49	a 26.49
Zapadni Reef.....	604	28	b 21.57	b 19.85
Polovina.....	5,794	192	b 30.18	b 28.88
Polovina Cliffs.....	2,209	96	b 23.01	a 20.23
Little Polovina.....	1,203	38	a 31.66	a 28.67
Morjovi.....	3,041	147	b 20.69	a 23.00
Vostochni.....	30,863	1,004	a 30.74	a 27.74
Total.....	133,914	4,573	29.28	26.59
Total for rookeries counted.....	12,093	480	25.19	27.88
ST. GEORGE ISLAND.				
North.....	8,802	225	a 39.12	a 26.75
Staraya Artil.....	5,746	124	b 46.34	a 34.00
Zapadni.....	857	27	b 31.74	b 18.74
South.....	68	5	b 13.60	b 7.62
East Reef.....	2,367	75	b 31.56	b 21.41
East Cliffs.....	5,418	129	a 42.00	a 30.00
Total.....	23,258	585	39.76	27.65
Total for rookeries counted.....	9,038	231	39.42	19.91
Total, both islands.....	157,172	5,158	30.47	26.74

a Estimate.

b Pups counted.

The most significant information bearing upon the average harem is furnished by Polovina Rookery. In 1918 it had 185 harems and

5,343 cows, an average of 28.88. The number of harems on the entire island of St. Paul was less in 1919 than in 1918, but Polovina increased by 7. This, together with field observations, indicates that there was an excessive influx of bulls on this rookery, which operated to prevent the average harem in 1919 becoming as much larger than the general average as it otherwise would. In the light of the knowledge acquired on the migration of adult seals in 1919 it seems very plausible that the limited driving and killing from this place would tend to preserve here a larger excess than on rookeries where commercial operations are more extensive. In other words, the absence of driving and killing of males on a rookery hauling ground seems in general to tend to preserve a surplus which in later years floods the rookery. The same factor would be in operation at Northeast Point, which was not driven during the closed season and not fully driven in 1918.

#### SIZES OF BULLS.

The actual size of some adult bulls which appear in the early drives of the season has been variously estimated. There is great variation in animals full grown both in weight and length. The heaviest bull weighed 604 pounds after being bled; many of them exceed 550. One animal measured 87 inches from the tip of the nose to the base of the tail, and practically all that approached maturity exceeded 72 inches. These results lead to the conclusion that the maximum size of early-arrived full-grown rookery bulls is about  $7\frac{1}{2}$  feet in length and 700 pounds in weight. The average is about  $6\frac{1}{2}$  feet in length and 550 pounds in weight. It therefore seems clear that the 7-year-old animals of the 1912 branded series were not in 1919 nearly grown. It now seems to be true that an animal able to hold a harem on a crowded rookery must be at least 10 years old. No 7-year-old was noted in 1919 which would even come into the category of idle bulls.

#### SURPLUS BULLS.

The surplus-bull class is fast disappearing, and 1919 is probably the last year it will be of sufficient importance to be considered. In addition to the old-age loss of 20 per cent which has been allowed, it seems altogether probable that 50 per cent has been lost through natural causes. Of course this has not all taken place in the one year, but is the cumulative loss, of an individual age class, for instance, from the fourth to the seventh year. Heretofore there has been absolutely no basis for the computation of such a loss; it was considered to be small and did not enter into the computations. After 1920 it is believed information will be available which will enable the loss to be stated fairly accurately for the third to the fourth years and less so subsequently; possibly it will necessitate a revision of the losses arbitrarily adopted below the third year. It will probably not materially change the loss of 50 per cent the first three years, however, as each year's work seems to indicate that this is very close to the actual condition.

The assumption of five breeding years for the males does not seem as yet to need revision. Certainly when bulls are abundant and there is great strife on the breeding grounds an animal must be well developed and at least 8 to 10 years of age before he can hold a position,

and five years of fighting will probably wear him out. When they are less numerous and there is but little fighting to be done the breeding period is certainly much longer. A 7-year-old bull is sufficiently developed sexually to have a harem, and it is not doubted they will do so when the average harem shall have increased to about 40. When this occurs it will necessitate the assumption of less than 20 per cent annual old-age loss of bulls.

#### ENEMIES.

The only enemy of which we can be sure is the killer whale. The voracious attacks of this animal on the fur-seal pups have been too well described to need repeating here, but they would not have to continue long to account for the entire loss.

The urgent need of combating this animal is easily seen. Out of 150,000 animals born in 1919, 75,000 are sure to perish before they are of any value to the herd or to man. At the present value of furs these would be worth over \$5,000,000. Of course all of the enemies could not be eliminated in any one year, but it is quite evident that it would be financially profitable to make a determined start.

It also is desirable in this connection to point to the paucity of information about the fur seals at sea. The animal is so exceedingly valuable that it is very desirable to have its habits and habitats thoroughly investigated. There may be other enemies just as bad as the killer, but any such conjecture emphasizes our ignorance.

#### INTERISLAND MIGRATION OF MALES.

In 1914 and 1915 it was determined beyond question or doubt that 2 and 3 year old males haul out indiscriminately on any hauling ground on either island. This was learned by clipping the hair from the heads of branded seals. On St. Paul the right side was clipped and on St. George the left; this made it possible at a later date to identify the animals which had been handled. The same thing had been determined, perhaps less satisfactorily, a great many years before by clipping the ears of pups.

It was supposed from this that there was indiscriminate mixing among the older classes, and little attention was given the subject until 1919.

In the commercial operations of 1918-19 it has been noted that only in two or three instances have branded males of the 1912 series been seen on rookeries other than those upon which they were marked in 1912; but they have appeared in respectable numbers on those.

The absence of large males on the St. George hauling grounds in 1919 in the numbers which were expected led to a close inquiry into the subject. Constant effort was made to secure a quota which had been tentatively set, but the 6-year-olds and over were not available. Upon my arrival from St. Paul in census study this was particularly noticeable and was borne out in the bull counts and average-harem computations.

## COMPLETE CENSUS OF FUR SEALS AS OF AUGUST 10, 1919.

Pups, counted and estimated.....	157, 172	
Breeding cows, 3 years old and over, by inference.....	157, 172	
Harem bulls, counted.....	5, 168	
Idle bulls, counted.....	2, 239	
Yearlings, male and female, estimated:		
Pups born in 1918.....	142, 915	
35 per cent deducted for natural mortality.....	50, 020	
Yearlings, both sexes, beginning 1919.....	92, 895	
Yearling females, 50 per cent, Aug. 10, 1919.....	46, 447	46, 447
Yearling males, beginning of 1919.....	46, 448	
Yearling males killed in 1919.....	4	
Yearling males, Aug. 10, 1919.....		46, 444
2-year-olds, male and female, estimated:		
Yearling females, Aug. 10, 1918.....	41, 608	
20 per cent deducted for natural mortality.....	8, 321	
2-year-old females, Aug. 10, 1919.....		33, 287
Yearling males, August 10, 1918.....	41, 595	
Yearling males killed, fall of 1918.....	2	
Yearling males, end of 1918.....	41, 593	
20 per cent deducted for natural mortality.....	8, 318	
2-year-old males, beginning of 1919.....	33, 275	
2-year-old males killed in 1919.....	194	
2-year-old males, Aug. 10, 1919.....		33, 081
3-year-old males, estimated:		
2-year-old males, Aug. 10, 1918.....	30, 159	
2-year-old males killed, fall of 1918.....	14	
2-year-old males, end of 1918.....	30, 145	
5 per cent deducted for natural mortality.....	1, 507	
3-year-old males, beginning of 1919.....	28, 638	
3-year-old males killed in 1919.....	15, 042	
3-year-old males, Aug. 10, 1919.....		13, 596
4-year-old males, estimated:		
3-year-old males, Aug. 10, 1918.....	9, 117	
3-year-old males killed fall of 1918.....	552	
3-year-old males, end of 1918.....	8, 565	
5 per cent deducted for natural mortality.....	428	
4-year-old males, beginning of 1919.....	8, 137	
4-year-old males killed in 1919.....	2, 390	
4-year-old males, Aug. 10, 1919.....		5, 747
5-year-old males, estimated:		
4-year-old males, Aug. 10, 1918.....	7, 114	
4-year-old males killed fall of 1918.....	229	
4-year-old males, end of 1918.....	6, 885	
5 per cent deducted for natural mortality.....	344	
5-year-old males, beginning of 1919.....	6, 541	
5-year-old males killed in 1919.....	1, 259	
5-year-old males, Aug. 10, 1919.....		5, 282

6-year-old males, estimated:

5-year-old males, Aug. 10, 1918 . . . . .	11,941	
5-year-old males killed, fall of 1918 . . . . .	148	
	<hr/>	
5-year-old males, end of 1918 . . . . .	11,793	
5 per cent deducted for natural mortality . . . . .	589	
	<hr/>	
6-year-old males, beginning of 1919 . . . . .	11,204	
6-year-old males killed in 1919 . . . . .	2,213	
	<hr/>	
6-year-old males, Aug. 10, 1919 . . . . .		8,991
Surplus bulls, counted and estimated:		
Breeding bulls in 1918 . . . . .	7,788	
20 per cent deducted for old-age loss . . . . .	1,557	
	<hr/>	
1918 bulls remaining in 1919 . . . . .	6,231	
	<hr/>	
Breeding bulls in 1919 . . . . .	7,397	
1918 bulls remaining, deducted . . . . .	6,231	
	<hr/>	
Increment of new bulls in 1919 . . . . .	1,166	
6-year-old males in 1918 . . . . .	13,755	
Surplus bulls in 1918 . . . . .	17,110	
	<hr/>	
Total surplus bull stock for 1919 . . . . .	30,865	
Deduct number killed, fall of 1918 . . . . .	64	
	<hr/>	
Surplus bulls at end of 1918 . . . . .	30,801	
20 per cent deducted for old-age loss . . . . .	6,160	
	<hr/>	
Remaining surplus for 1919 . . . . .	24,641	
7-year-olds and over killed in 1919 . . . . .	4,238	
	<hr/>	
Total surplus in 1919 . . . . .	20,403	
Increment of new breeding bulls in 1919 deducted . . . . .	1,166	
	<hr/>	
Surplus bulls in 1919 . . . . .	19,237	
Estimated 50 per cent loss due to fighting and natural causes . . . . .	9,618	
	<hr/>	
Surplus bulls, Aug. 10, 1919 . . . . .		9,619

RECAPITULATION.

Pups . . . . .	157,172
Cows . . . . .	157,172
Harem bulls . . . . .	5,158
Idle bulls . . . . .	2,239
Yearling females . . . . .	46,447
Yearling males . . . . .	46,444
2-year-old females . . . . .	33,287
2-year-old males . . . . .	33,081
3-year-old males . . . . .	13,596
4-year-old males . . . . .	5,747
5-year-old males . . . . .	5,282
6-year-old males . . . . .	8,991
Surplus bulls . . . . .	9,619
	<hr/>
Total . . . . .	524,235



## SPECIAL INVESTIGATION OF COPPER RIVER SALMON FISHERY.

By HENRY B. WARD.

### GENERAL DESCRIPTION OF REGION.

The Copper River, which empties into the Gulf of Alaska at approximately the highest point of the crescent of shore that forms the northern boundary of the gulf, has long been known as one of the important salmon streams of Alaska. The records of its yield are found in the publications and other documents of the Bureau of Fisheries and need not be recounted here. The value of the fisheries on the flats at its mouth and in its course has led to active competition for the fishing rights of the district and to the multiplication of canneries, as well as boats and gear engaged in catching the salmon that visit it annually.

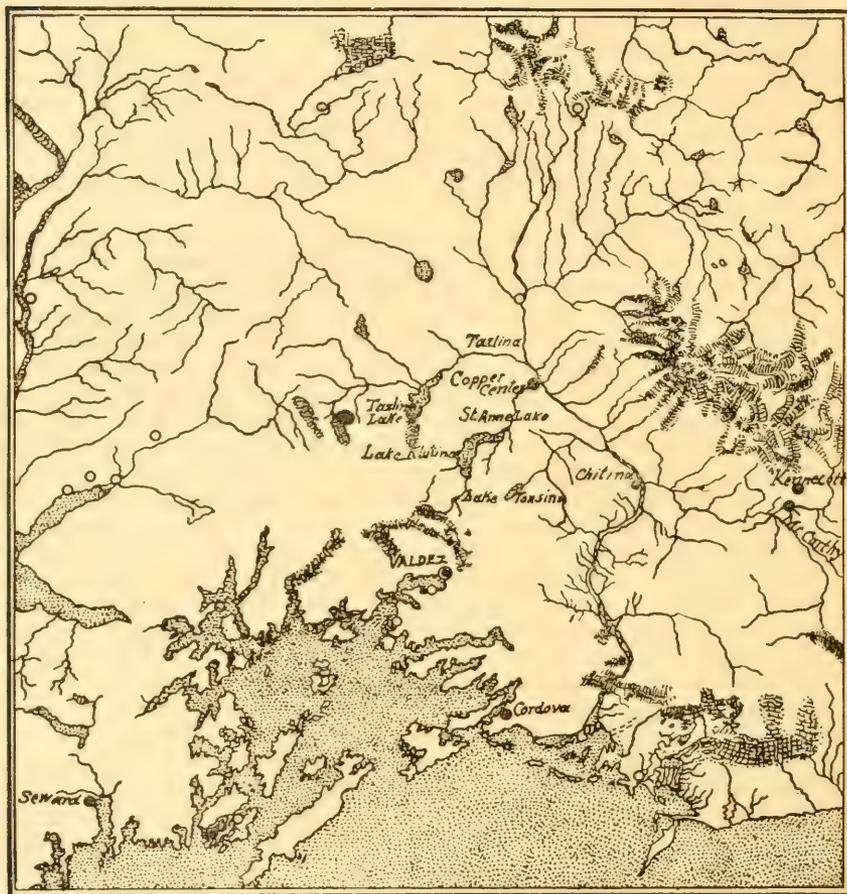
The effect of the steady and increasing draft upon its fish supply resulted in protests that culminated in hearings held by the Bureau of Fisheries in 1917 and in 1918 with a view to determining the necessity of limiting or prohibiting commercial fishing for salmon in the river itself, with its tributary streams, and in its delta waters.

The evidence presented at these hearings was in part contradictory and indicated an unfortunate lack of precise knowledge with reference to the conditions that prevailed. There was especial lack of information with reference to the location and extent of the spawning grounds to which the salmon resorted on their ascent of the river, and it was decided to extend the knowledge of the situation by making a study of the stream and its main tributaries, with a view to determining precisely where the fish went and what conditions they found for spawning. It was with this purpose in view that the party spent six weeks in the Copper River Valley and its vicinity, gathering information by inquiry from those well acquainted with the region, but especially by a study at first hand of the river and its tributaries, so far as the time sufficed for this purpose. A brief statement regarding the territory itself will serve to give proper orientation for the account of the work which follows.

The Copper River has its source in a large glacier on the northern slope of Mount Wrangell, and after flowing a short distance northward through a narrow valley comes out into the broad gravel-floored area known as the Copper River Basin, which stretches from the northern slope of the Chugach Mountains to the foothills of the Alaska Range. In this plain the river turns gradually in a huge circle around Mount Wrangell as a center, and about 50 miles from it, until it reaches a point almost directly south of the mountain and 40 miles from it. Here it is met by the Chitina River, flowing in from the eastward. In the course of its circle around Mount Wrangell the Copper River receives a number of important tributaries—the Chistochina, the Gakona, and the Gulkana Rivers from the north, and the Tonsina, Tazlina, and Klutina Rivers from the west.

From the point of its union with the Chitina, the Copper River flows almost directly south through a narrow valley, at one point constricted into a real box canyon, but nowhere possessed of a wide

basin, and confined so closely by the Chugach Mountains that the streams tributary to it are short and turbulent, often blocked by impassable falls within a short distance of the point where they join the main river. Furthermore, in the 70-mile stretch from the mouth of the Chitina to the delta, the Tielkel and the Tasnuna from the west and the Bremner from the east are the only streams of any particular size. These factors have an important bearing upon the question of the spawning places of the salmon.



Copper River Valley.

The Copper River itself is heavily silt laden, and its waters nowhere and at no time during the period of migration are clear enough to afford a view of the fish, except where the salmon break the surface in their movements. During its course through the plateau it is more or less spread out in numerous channels intercepted by sand bars and islands, and even through the mountains the same characteristics manifest themselves wherever the steep, rocky slopes on the east and west are sufficiently separated from each other to afford any opportunity for the deposit of a sand-and-silt plain. While short

stretches are apparently quiet, the stream even here runs with considerable swiftness, and for the major part of its course is so rapid as to be cutting and shifting its channel constantly, while at a few points its turbulent waters dash over the rocks in its bed with such violence that the current offers a most formidable obstacle even to the progress of powerful fish like the salmon.

Just above the delta, about 30 miles distant from the flats, the stream makes an abrupt angle to the west and again to the south in passing the Childs and Miles Glaciers, which approach it directly from the east and west, and which seem to have formerly confined it very narrowly, since they were separated by only a mile at the narrowest point. At present an enlargement of the stream, known as Miles Lake, intervenes between the two glaciers. It is 4 miles long, and more than half that wide. Below it the river traverses a broader plain, within which its channels are constantly shifting, and expands into a network that stretches into the delta, involving an area of flats and sloughs that in the extreme is not less than 12 or 15 miles wide. These channels communicate directly with those of the Martin River, a smaller glacial stream to the eastward, and less intimately on the other side with streams from the Sherman Glacier, although farther westward various channels interlace over a common mud plain until they connect, in fact, with the channel of the Eyak River at the extreme west of this flat low-lying shore of mud and sand.

Supt. J. R. Russell, of Birdsvew, Wash., was detailed to assist in this work. Prof. W. A. Oldfather, of the University of Illinois, went along as assistant. The party was augmented at Copper Center by the addition of Frank H. Carroll, who had been secured as guide and packer for the part of the work covering the trip through the wilderness.

A collapsible boat was taken for use on the lakes. It proved exceedingly difficult to transport, and yet without it it would have been impossible to secure the essential information on the lakes and at the spawning grounds.

#### CHRONOLOGICAL OUTLINE OF TRIP.

The party reached Cordova the morning of July 17, 1919, on which date the author had an extended conference with E. M. Ball, from whom he learned at first hand important facts concerning the general situation. The following day was devoted to an inspection of Eyak Lake in which some red salmon were spawning at that time. On July 19 a visit was paid to Eyak cannery on the flats near the mouth of the river and the fish taken by their fishermen were carefully studied. On July 20 the writer met Arthur H. Miller, who is in charge of the work of the Bureau of Education among certain natives of Alaska, and discussed with him the evidence concerning the run of red salmon on the Copper River in so far as it was furnished by the experiences of the native fishermen. During that and previous days incidental visits were made to the plants of the salmon-packing companies located at and near Cordova. Thereby opportunity was offered to inspect fish coming from the flats of the Copper River and to compare them with fish brought in from other localities in the district.

Since the railroad schedule of two trains per week was entirely inadequate for any work on the upper river, arrangements were made for a speeder to carry the party over the road as desired. The first trip was made on July 21, to the head of the Abercrombie Rapids, many stops being made to take views of the stream and to study the currents and probable course of the fish in ascending the river. Especial attention was paid to the Abercrombie Rapids themselves, and both banks of the stream were examined carefully. Along the railroad track were various dipping stations at the margin of the water where men were at work; these places were inspected closely and studied from various aspects of the problem. The other side, formerly fished by the Carlisle Packing Co., but now closed territory, was not visited, as it could be reasonably well studied from the top of the west bank. The problem of fishing in these rapids is discussed at another point.

On July 22 a visit was made to Clear Creek, a tributary on the east side of the Copper River, where the railroad crossed it at Mile 43. Redfish were spawning there, and a careful study of this stream was made, the peculiar conditions of which are discussed in another section of this report.

July 23 was spent at the plant of the Abercrombie Packing Co. in an examination of the fish and a comparison of them with the material studied at an earlier date as noted above. On the following days this comparative study was carried further by the examination of new material in the canning plants at Cordova. At the same time equipment and apparatus were prepared for the trail and packed.

The party left Cordova for the trip to the interior early on the morning of July 26. On the way north stops were made to investigate small streams emptying into the Copper River from the west, also certain small lakes that lie between the Tasnuna River and the north wall of its valley. They are located in the alluvial plain near the junction of the river with the Copper, and despite reports show no evidence of being waters in which the salmon were about to spawn or of having served such a purpose previously. The small tributaries on the west which were said to carry salmon showed no trace of fish at that time and no evidence of spawning during that season. It seems probable that they are not used by the red salmon, though some are not unlikely to furnish spawning places for the silver salmon which run up later.

An entire day was devoted to the study of Long Lake which has been reported as an important spawning ground for salmon. The results of the investigation are discussed in a separate section of this report.

On July 29 the party left the railroad at Chitina and investigated the lakes there and the small stream that joins them with the Copper, which are certainly good spawning grounds for the red salmon as shown by the record of observations, given later in this report. The party left that day for Copper Center, reaching the road house at the latter point late in the evening. The following day was devoted to an investigation of adjacent portions of the Copper River and of the Klutina, which joins it at Copper Center. An opportunity was given to observe the methods of fishing practiced by the natives there and to confirm by general testimony the statements concern-

ing catches of salmon made this year and last year as had been reported previously. The salmon wheels used by the natives are crude contrivances but are well located and undoubtedly give reliable evidence concerning the movements of the salmon and the number of fish which go upstream. They are kept under continuous observation and are visited fairly regularly by the women, so that even if the men are away on hunting trips or working on the road, the records of the wheel represent its continuous service. There can be little doubt that in 1918 the run of salmon was so small as to furnish only very scanty supplies of fish to the natives, even though the number of wheels at work was several times greater than before. During the season of the investigation the run had been much larger and some families had already caught and dried an adequate supply of fish to carry them over the winter. Some wheels continued to work even until the party returned to this point in September, and furnished a regular supply of food for the natives. All persons interviewed agreed that the run of fish had been good and that it was very much larger than the year before. By cable message received that evening, Mr. Russell was called back to Cordova for conference with Field Assistant O'Malley and did not participate in the later work of the party until August 11.

On July 31 the pack train was loaded and the party started on the trail up the north bank of the Klutina. Because of an accident that threatened to be serious, it was necessary to send the guide back to Copper Center on the following day, and the party did not reach the camp at the foot of Lake Klutina until late in the afternoon of August 5. The camp was located on the river half a mile below the outlet of the lake and directly across the stream from a large eddy in which salmon were seen jumping and above which an old camp and drying rack gave evidence of previous salmon-catching operations by both natives and white men. The following day was devoted to a study of the southeast shore of the lake and the tributaries emptying into it and to fishing in the eddy opposite camp. On August 7 the red salmon caught in the eddy were studied and further examination was made of the tributary streams near the outlet of the lake. The largest stream, known as Salmon Creek, which is the only one of any considerable size, evidently constitutes an important spawning ground for red salmon and is discussed in detail later.

The northeast shore of the lake was carefully studied on August 9 when camp was moved to a point near the mouth of St. Anne Creek. The streams which empty into the lake along that stretch are very small. At that season the outlets were choked with logs and débris. The amount of water flowing from them was limited, and the area available for spawning purposes under any circumstances must be insignificant. No traces were found in the lake or in the streams mentioned near the lake of present or previous spawning activities on the part of red salmon. August 10 was devoted to a study of the lower section of St. Anne Creek, where red salmon both spawning and spawned out were numerous. One king salmon was also seen floating downstream. The details of that examination are given at another point. On August 11 camp was moved to the head of the lake and the west shore studied carefully en route. No evidence of the presence of salmon or of spawning activities was seen until the party,

augmented by the return of Mr. Russell, reached the extreme southwest angle of the lake. There the salmon were jumping in numbers in water near the shore where camp was located.

The extreme tip of the lake is bluntly truncated and receives the waters of both the Hallet River and the upper Klutina. The latter empties into it through numerous channels and the former by a single stream, which, though it originates to the westward and traverses a valley separated from the Klutina by a considerable mass of mountains, enters close to the west channel of the Klutina and parallels it for a stretch such that it seems to be at first sight a part of the Klutina complex. The valley of the upper Klutina is broad and flat and traversed by a series of connecting channels; it is occupied also by a considerable number of small lakes. Both the sloughs on the flat and the channels are significant factors in the spawning of the red salmon. The conditions are discussed in the section devoted to the upper Klutina.

The party spent nearly a week in the investigation of that region and left on August 19, stopping at the old camp on the lake shore near the mouth of St. Anne Creek. Opportunity was then given to examine that stream for the second time and to note the contrast with conditions observed a week earlier. On August 20 camp was moved again and the party proceeded to St. Anne Lake, where a two-day stop was made. That lake is evidently very important for the fishery problems of that region and is described in detail in another section. It took two days to cross from St. Anne Lake to Lake Tazlina, where the party camped near the outlet late in the afternoon of August 23.

A study of the southeast shore of the lake showed only scanty evidence of the presence of red salmon. Near the place where the shore turns sharply toward the south is a fair-sized creek, but neither this nor the larger stream which was nearer camp yielded any evidence of the visitation of red salmon during that season. Only a single dead redfish was seen floating in the lake in the trip of 10 miles from camp to the angle, and only two were found lying on the beach in the same distance. Although the guide stated that two Norwegians, who camped near the angle of the lake some years ago, caught plenty of redfish in a net set in an eddy near their camp, there was no evidence of the presence of any number of fish at the time of the visit. It would have been worth while to stop at that point to test the condition of the waters in which they had fished at an earlier date, but circumstances prevented. A few more fish were encountered along the beach near the south end of the lake, but none were seen living or floating in that section, and the few small streams which empty into the lake along that shore yielded absolutely no evidence of present or past spawning activity of the red salmon. During the period of the visit to the head of the lake the shore was pounded by a surf such as to indicate its unfitness for salmon spawning. If by chance any fish had reached that region and spawned, their activities were misdirected, for the eggs would have had no chance to develop. However, there is no reason to suppose that they ever attempt to spawn along that section of the lake, and, in fact, all of the fish that were seen along the entire southeasterly shore of the lake might easily have been dead fish floating at the surface, carried into that territory

by storms and winds, even though the shore is 5 miles distant from the opposite shore where later salmon were found in certain streams.

At the head of the lake the foot of the glacier is separated from the lake water by a strip of sand and gravel practically entirely without vegetation and at most not 2 miles wide. The channels that carried the glacial water to the lake are evidently shifting and unstable and hence entirely unfitted for the spawning of the salmon. Conditions in such respect were sharply contrasted with those found at the head of Lake Klutina. While each of the channels was studied camp was located on the west side of the lake at a point similar to that utilized for a camp at the head of Lake Klutina. Although the net was put out at that point and maintained at several near-by positions during the entire stay, not a single fish of any kind was caught nor a dead salmon found on the shore anywhere.

On August 26 camp was moved to a point near the mouth of the Nelchina River, and the shore intervening between the two places was studied. No evidence of any kind was obtained to indicate the present or previous presence of salmon at any point along the strip from the head of the lake to the mouth of the Nelchina River. The Nelchina is split up into a considerable number of channels, and it would have required more time than was available to have made a careful study of them. It is reported that red salmon ascend that river for spawning, but there was no evidence of their presence in the stream in the very brief observation made in passing.

On August 29 the lower Mendeltna River was explored, and living red salmon not yet spawned out were found. The number was not large, and there were no dead fish on the shore in the lower regions of the stream nor any fish skeletons or bear trails along the shore to indicate that fish had been more abundant there earlier in the year. It is said that the red salmon ascend to lakes some 12 to 15 miles upstream in which they spawn. In the absence of trails it would have been impossible to make the trip upstream without a larger expenditure of time than was available, so that the questions of the number of fish which utilized the stream for spawning purposes, the suitability of the river for such a use, and the numbers actually present all had to be left for future determination. That night camp was located close to the outlet of Lake Tazlina at a cabin known as the home of a former prominent Copper River Indian called Tazlina Johnny. The place was not inhabited, because of his death last winter. It was evident that regular and successful fishing operations had been carried out at that point in previous times. A net was set from stakes which had been located evidently for salmon fishing in a very small indentation of the shore near the cabin, and within a short time a considerable number of fish were secured. The largest male was not fully ripe, and all of the fish were in good condition, though not so large and well nourished on the average as those caught in Lake Klutina. They were carefully examined and data recorded for comparing them with the fish obtained at other localities. It is worthy of special notice that fish were still running upstream there and were not yet fully ripe, although it was the end of August.

On August 31 the return trip was begun down the valley of the Tazlina River. Inasmuch as the trail for the greater part of the way was some distance from the river, there was no opportunity to study

the stream or to get evidence concerning the possible presence of salmon in it at that time. The country was too difficult and the time too short to justify any attempt to follow the stream or to work in it between the lake and its junction with the Copper. When Copper Center was reached on September 4 the natives were still catching some red salmon in the Copper above the mouth of the Klutina, but according to their views the run had practically ceased. Only one salmon wheel was seen still fishing in the stream.

The return trip was made without further attempt to study the salmon problem in the field, but in crossing Clear Creek (Sept. 6) salmon were seen still spawning in the waters near the bridge where they had been studied nearly seven weeks earlier. However, the records of the fishermen and statements of the inspectors located at Abercrombie Rapids indicated clearly that in the main stream the run of red salmon had ceased and practically only silver salmon were being caught.

Along the south shore of Eyak Lake near Cordova, a large school of red salmon was seen on the spawning beds in one of the shallow bays. There was no opportunity to examine into their condition, but it did not look as if all were spent fish.

#### CLEAR CREEK.

Clear Creek is a small tributary which, coming from the northeast, flows into the Copper River near its mouth. It rises in the mountains lying immediately east of the river, and its headwaters seem to be in Goat Mountain. Where the railroad crosses the stream at Mile 43 the channel is about 100 feet wide and 1 to 3 feet deep. It preserves this character from that point to its junction with the Copper River, which is distant  $1\frac{1}{2}$  miles by stream, but considerably less in a direct line from the railroad bridge. The creek has a moderate flow of water which, at the time of our visit, was absolutely clear and free from any traces of glacial material. The bottom consists of gravel, with occasional small patches of mud, but no rock bottom was found. The current is moderate and fairly constant, being everywhere sufficiently noticeable to preclude the possibility of construing it as equivalent to a lake and yet at no point violent. The party walked down the stream to its junction with the Copper River. A few salmon were playing around near the railroad bridge and had evidently been at work sweeping out nests and preparing the ground for spawning. The fish were not fully ripe, although some males had begun to assume a bright coloring. A few red salmon were seen at various other points in the creek, but no large number in any one group until a point was reached three-fourths of a mile from the bridge and below a stretch of ripples in the stream where two or three groups aggregating at least 200 fish were found. They showed little fungus and only very occasional evidence of physical injury. All were in good condition, and a few of them were taking on the brilliant red of the mature male. Numerous bear tracks were seen along the shore, and trails led down through the grass and alder thickets to points where these animals had evidently been watching for fish. No evidence was obtained that the bears had been successful in their efforts to catch the salmon, and the banks were entirely free from half-eaten fish and skeletons such as were seen in other places later.

After returning to the railroad bridge a trip was made upstream far enough to reach the point at which it emerged from the narrow valley in the mountains where it originated. The stream was admirably adapted to be the spawning ground for the salmon, and its waters were already well occupied by fish approaching maturity. Two hundred yards above the bridge was a group of about 100 fish of all colors, a majority of which were well marked with red. Every few yards farther another school was brought to light, varying in size in a manner apparently well related to the area available in that particular pool or curve of the stream. About a mile or less above the bridge the stream flowed through a low flat area where its gentle current suggested lake conditions. It was slow and quiet as well as warmer than the water in the stream below. This stretch was shallow and bordered by rushes and sedges, and near it were some little sloughs communicating with the main creek where there was an abundance of green algae and some clumps of water grasses. In these places large numbers of salmon fry were found. They were chiefly sockeyes, though some young silver salmon were captured also. Near the mouth of the canyon the valley was about one-half mile wide, the stream winding with a more rapid flow as it descended from the mountains. The topography of the country clearly showed that there was no lake on the stream above that point, and there the creek showed no evidence of the presence of salmon. In fact, none were seen above the slow quiet stretch passing through the boggy area. The temperature in the quiet stretch was from  $1^{\circ}$  to  $2^{\circ}$  higher than in the water below, and the reason was soon found in the presence of seepage areas and springs in the bottom of the stream where water entered in sufficient quantities to make the volume of flow near the railroad bridge two or three times that which was present at the place where the stream passed through the swamp. Clear Creek was visited again on September 6 when on the way back to Cordova. Spawning salmon were still present in the water near the railroad bridge. There was no opportunity at that time to investigate them or the stream further.

#### ABERCROMBIE CANYON AND RAPIDS.

In view of the conflicting statements concerning the actions of the salmon ascending this part of the stream, the author devoted especial attention to the conditions found there. At the time of the first visit on July 21 the stream was high and, though it did not present absolute maximum conditions, it gave a clear general idea of the difficulties which the salmon have to meet during the periods of high water. Upon returning in September the water had subsided very distinctly and it was easy to compare the conditions then existing with those seen on the former visit. Furthermore, visits were made to the canyon on several occasions during the first week of study of the Copper River. In that time the varying weather conditions affected noticeably the height of the water. Taking all things into account it seems certain that the conditions were not greatly modified by changes in water level and that the salmon that ascend the stream are subject to similar if not identical difficulties whether they go up at high water or low.

It is true that the shifting of the level makes it possible to fish from certain platforms at one stage of the water and necessitates moving them as the water level varies. It is also stated by the fishermen that some places which are good fishing stations at one water level do not yield any considerable number of salmon when the water level has changed. But such statements as these deal with details of the situation and not with the real problem. The drop in the canyon is considerable. Within a distance of  $1\frac{1}{2}$  miles the water descends approximately 50 feet. The west bank of the river is very steep and made up almost exclusively of large broken rock fragments. As these lie they build scallops in the bank that are of varying size. Walking along the rocks near the water's edge one can see very distinctly that the current of the river is checked very radically near the shore and at some points actually takes the reverse direction from that in midstream. All sorts of minor variations are seen when one takes into account the changes near the bank in their relation to the general stream flow.

On the opposite side, which was not visited, conditions are more radical, because the bank slopes on the average more gently and ridges of loosely piled rock extend out into the stream for little distances. Especially prominent were two basins that opened into the stream at several points and are known as the Big Bear Hole and the Little Bear Hole. They show, even from a distance, quiet water circling round and round. In the center of the stream the current is much broken by what are evidently huge rocks in the bed of the river.

After having watched the course of the current carefully and having measured as nearly as possible the velocity in midstream, the author felt that no salmon could successfully surmount the rapids there for any considerable distance. The water is so murky with sediment that one can not see the body of the fish even when the back fin breaks the surface, and one is forced to draw conclusions concerning the behavior of the salmon from that which has been observed on clear streams where the actions of the fish could be definitely followed by the eye. It seems altogether likely that salmon endeavoring to pass the rapids will dart from point to point, forcing their way through the brief spaces where they are compelled to subject themselves to the full current, and resting behind a rock or in an eddy, or at least seeking a place close to the bank where the current is retarded considerably. There is little doubt that in such places fish will hang until, summoning their energies for a new dash, they make the next point of rest, and will repeat the process until they have reached the top of the rapids. Since it is not possible to see the fish even through a relatively thin volume of water, it seems altogether likely that they are oblivious to the movements of the dip net as it sweeps through one of these resting places and scoops out a part of the group waiting there. While it is true that the most effective net fisherman has his net in the water only a fraction of the time, it seems probable that he secures a much larger percentage of the fish than has been estimated by various observers previously. Inasmuch as the fishermen are distributed fairly numerous along the west bank of the rapids, and inasmuch as the fish will necessarily take a considerable time to surmount the rapids even under the best of conditions, it seems likely that during the time in which dipping is being carried on



FIG. 1.—SALMON DIP-NETTING STATIONS, ABERCROMBIE CANYON, COPPER RIVER.



FIG. 2.—DIP-NETTING SALMON, ABERCROMBIE CANYON, COPPER RIVER.



the dip netters will get nearly all of the fish that are passing upstream on that side.

Some persons interviewed thought that many fish went upstream through the center. As an evidence of this they asserted positively that they had seen the back fins of the salmon breaking the surface far out and even at the center of the current. There is no reason to doubt this statement in so far as it rests upon an observation made, for the observers were careful and conscientious men, and in numerous instances, no doubt, they had seen the back fins of the salmon appear above the surface and disappear below it at considerable distances from the bank. On the other hand the inference drawn seems open to grave doubt. Let it be remembered that no one can follow the course of the fish even for a short distance after the fin has once passed below the surface of the water. Furthermore, in such cases the fin is in sight for a moment only, appearing and disappearing almost instantaneously. The author has often seen similar appearances in other places and has found them connected with conditions entirely different from those that were inferred in this case.

Salmon attempting to ascend an extended rapids against a powerful current make a dash through a stretch where they feel the full force of the stream, and if they are diverted from their path by some swerving of the current, or if they fail to select precisely the right direction to bring them under shelter before the energy of their dash has subsided, they are caught by the full force of the stream and carried downward. It is easy to interpret such conditions when one can follow the fish in water that is more or less transparent. Under the circumstances here it is evident that the direction of the fish can not be followed unless the fin is visible and the brief period in which it can be seen is no index whatever of the general movement of the fish. Under the conditions as they exist at present there is no doubt that a considerable number of fish ascend the stream along the east bank, resting in the large eddies referred to previously. Even if fishing on the west bank eliminates a considerable percentage of the run, the protection offered by the east bank will probably allow a goodly number of fish to make their way upstream unhindered, though there is no evidence at hand to indicate whether the majority of the fish choose the one bank or the other. It is not impossible that conditions at the base of the rapids tend to divert the major portion of the run to one bank rather than to the other. In such a case the results of leaving one bank unfished where the other is fished assiduously will vary from those stated under the assumption that the run is more or less equally divided between the two shores of the stream.

Of course, it is possible that the bed of the stream, by virtue of the large rocks in it, may have a more or less protected channel for the passage of the fish. But even in this case, the current will necessarily be more powerful along the bottom than it is at the sides near the surface, and there seems to be no reason to think that in this particular place conditions in the bed of the stream are exceptionally favorable for the ascent of the salmon; and unless they are more favorable than surface conditions would lead one to expect, salmon will hardly be able to use that path. So far as could be ascertained, conditions at the center, either in the surface or bottom waters, will be much the same at all stages of the stream. On the other hand, shore condi-

tions will vary much with the stage of water, and it may well be that one bank will be more advantageous for the fish at one level and the opposite shore at another water level. The situation deserves further study.

Unquestionably that stretch of water affords a most serious obstacle, and, indeed, the only serious obstacle which is found to the ascent of salmon in the Copper River. It doubtless delays them considerably, and repeated efforts may be required to carry the fish through the entire course of the rapids. Such a condition would exercise a significant influence on the success of the dip netting carried out there.

#### LONG LAKE.

This body of water, which lies close to the railroad and parallel with it, has been frequently mentioned as an important spawning ground for the salmon of the Copper River. Starting in on the outlet creek a mile or two below the lake, the party walked upstream in the water nearly as far as the lake itself. At that time (July 22) the stream was so small that it is doubtful if any red salmon could ascend it. The bottom was rocky in places and the passageway badly choked by logs and brush. The stream bed had an average width of possibly 6 or 7 feet, and the water averaged about 6 inches in depth. An abundance of fish food was noted, caddis-fly larvæ being common. Several small fish were stirred up that measured probably 4 or 5 inches in length and one Dolly Varden trout 8 inches long was seen distinctly. A single group of a few timid fish fry apparently working downstream seemed to be young silver salmon, but none of these could be captured. A deep, well-worn bear path at one point indicated that some animal was looking for the arrival of food fish.

At the lake a settler reported that the earliest run of salmon recorded previously was on July 28 some six or seven years ago. "About a million salmon," according to his estimate, used to enter the lake, but since the cannery had been established at the canyon hardly any fish had come up. The normal run here used to be between August 1 and early October. At one time in October he counted over a hundred salmon entering the lake within 10 minutes. In 1917 the first fish arrived on August 16. In that group, which played near the railroad trestle before passing out into the middle of the lake, there were 17 salmon according to actual count.

A motor boat in which to make a survey of the entire lake was secured from the settler. The water seems to be fairly deep everywhere, the shores going off steeply and having only insignificant stretches of gravel bottom in shallow water where spawning would be possible. The depth of the lake taken by line is said to vary from 60 to 100 feet. It is apparently fed by springs, and there are no permanent streams to carry silt into it. At the head of the lake was a small shallow area in which grayling were found building nests and apparently getting ready to spawn. At two other points there were gravel beds of insignificant size on which spawning would be possible. Certain places showed good evidence that salmon had spawned on this gravel in previous years. A few young salmon fry were seen. Most of these were silvers and a very few were red salmon

It is difficult to accept seriously any statement that the lake was visited under the best of conditions by a million fish. The total available spawning area for all kinds of salmon would not accommodate 2,500 fish, and unless the habits of this particular run are different from those recorded for salmon elsewhere, there are no other parts of the lake in which spawning could be carried out effectively. It is, of course, possible that some fish (not red salmon) may drop back into the outlet creek and spawn there, but the area available for this purpose is also relatively insignificant. All in all it was clear that Long Lake should not be considered as a significant spawning ground for salmon, and it seemed likely from the conditions indicated that the fish which spawned there were silver salmon rather than sockeyes.

For a small number of fish the lake would be a good spawning ground. It has a drainage basin of limited extent. There is no stream of any sort flowing into it, and at most the few rivulets that come from melting snow banks would be the only sources by which silt and débris could be introduced. Under these conditions the water is clear and the level of the lake is undoubtedly very stable, so that those eggs which are deposited have a good chance to develop properly. On the other hand enemies are common, as the lake is reported to be the best fishing ground for grayling that can be found in the entire region. As there are no considerable shallow areas and no plant growths to afford protection, all young fish must be readily subject to capture by the grayling, especially since the waters are so clear. This condition probably obtains throughout the entire open season.

#### CHITINA CREEK.

The creek which empties into the Copper River just below Chitina passes under the railroad track a few steps beyond the passenger station at that town and just short of the roundhouse. It flows down through the town of Chitina from two lakes in the valley a short distance above the town. As the railroad approaches the station it skirts a small lake into which the creek empties and from which a continuation of the stream connects it with the Copper River a couple of miles south. At that time (July 29) fish were jumping actively in the lake south of the track, where probably 300 to 500 fish were schooled. According to the statements of the railroad employees the salmon had been coming up for some time. The creek is very small, being only from 4 to 8 feet wide with an average depth of 6 to 10 inches. The stream passes through the town and is nearly blocked at several points. Above it the bed was full of drift and bowlders and the average drop in the stream, which was about 1 foot in 10, made it evidently difficult for the fish to work their way up. Some fish were seen in almost every pool along the course of the creek and they were working hard to get upstream despite the obstacles which the conditions presented. They were on the whole well colored and would have been ready to spawn in two weeks. Previous to this date there had been an abundant run of fish, for 200 were counted drying on racks at one point on the bank and other empty racks bore evidence of having been recently filled with fish that had been removed. Residents reported a good catch.

It is a quarter of a mile in a straight line and several times as far by the windings of the creek from the lake near the railroad station to the first lake in the valley above the town. This lake is about a quarter of a mile long and shallow. No salmon were seen and no evidences of their presence at any time were discovered. Salmon were traced up the creek something like one-half or two-thirds of the way to this lake. Some were found spawning at a point where a large cold spring emptied into the creek. In passing through a tract which has been cleared for farming purposes and which lies somewhat more than halfway from the town to the first lake, the bed of the creek is very badly filled up with débris and brush. It has been used as a dumping ground and a mass of brush and cuttings taken from the cleared land has been thrown into the creek, constituting an effectual barrier to the passage of the fish. It is evident that it would be impossible at the present time for salmon to ascend beyond this point. It was stated that previously they used to go up to the lake itself. Several schools of young salmon were seen in the creek, but in all no large number of them was found. A resident on one piece of land through which the creek passes stated positively that there were very many more fish there this year than last year and that everybody had enough fish for their purposes.

It is evident that unless some attention is paid to this stream by local authorities it will soon cease to be of any significance whatever as a resort for spawning fish. The clearing of the land and the filling of the channel, which is a convenient receptacle for any material to be disposed of, have limited the fish to a fraction of the territory which they probably utilized previously. Furthermore, on the bank of the lake which lies near the railroad track just below the town is a large oil tank from which, according to apparently reliable reports, drip and waste spread at times over large parts of the water surface. Evidence was readily found showing damage done to the life of the lake by this means. It is clear that while this might not interfere very much with the spawning of the salmon, especially when the water level was high enough to permit the spawning fish to pass promptly through the lake and up into the creek beyond the town, yet it would be a very serious condition for the young fish when they drop out of the creek soon after they emerge from the gravel in the spring and seek to find in the lake means of livelihood during the considerable period of growth before they turn downstream into the river on their trip to the sea. All in all this region, which serves at present as a good spawning ground for 1,000 to 2,000 fish and which yields probably a catch several times as large to natives and citizens for various purposes, is likely to be seriously depleted within a short time if indeed the run of salmon in it is not entirely destroyed.

#### LOWER KLUTINA RIVER.

The Klutina River is an exceedingly rapid stream for some distance above its junction with the Copper River at Copper Center. It shows almost a constant succession of rapids, and the bed contains many large rocks, so that it would be difficult to make any detailed study of the stream, but this is not important because its character evidently precludes the possibility of its being utilized as

a spawning place or even as a resting place for the salmon during migration. They can find opportunity to rest for a brief time behind rocks or in the small pools that recur practically everywhere in the course of the river, but once having entered the ascent of the stream they will not find it practicable to delay long or in considerable numbers until they reach what is known as the big eddy, which is an expansion of the river with a number of islands and several channels. It is located several miles from the outlet of the lake; between it and the lake the stream flows more gently and with unbroken water of considerable depth. There are also several eddies formed by expansions of the stream or by stretches of water lying behind projecting tongues of the bank. One of the most favorable is opposite the camp and about one-half mile below the actual entrance into the lake itself.

On the projecting shore, upstream from this eddy, is a large clearing with the remains of cabins, occupied by prospectors and miners originally, but since then utilized for various purposes. Salmon-drying racks and net racks as well as fish platforms and net stakes in the eddy indicate that this point has often been visited previously for the taking of salmon and their preparation. The activities in this line are said to have been carried out by Indians in part but most extensively by an outfit that fed dog trains here and at that time attempted to bar the river by stretching across it a fence of wire netting. The strength of the current and the amount of driftwood coming down promptly carried out the netting, but the efforts to take fish by nets set in the eddy are said to have been very successful.

During the time spent at that camp, fish were constantly jumping in the eddy on the opposite shore and occasionally in the water near the shore above and below the eddy. It seemed as though the red salmon gathered there to rest in their migration; they certainly were abundant, for on one occasion, in setting out a net only 50 feet long, two salmon were entangled in it before the entire net had left the boat. At another time one dozen fish were caught in an hour. They were all well-colored, fine, large fish and were measured carefully, examined, and utilized to obtain scales for future study.

The fish were jumping in this region, not only during the day but also during the night and to some extent along both shores of the river, so that migration was active at the period of the visit to this point.

#### SALMON CREEK ON LAKE KLUTINA.

About  $1\frac{1}{2}$  miles from the outlet of Lake Klutina on the southeast shore the stream known as Salmon Creek enters the lake. Its water is visible some little distance away from its mouth, which is partly hidden in low, boggy, and spruce-covered shores. The stream itself is clear and entirely free from glacial waters so that where it flows into the lake a transparent streak can be followed for some little distance before it mixes thoroughly with the milky-white waters of the lake itself.

From a distance of at least one-quarter mile, on approaching the inlet, a large brown bear was seen feeding on the shore. Alarmed by the approach of the party he scurried off into the forest, but a half-eaten salmon was found at the water's edge where he was first

seen. Bear trails led through the swamp in various directions, coming out to the shore in many places; in fact almost every little point or solid tuft of ground at the edge of the water had been utilized by bears as a feeding place. The tracks were visible in the mud, and the skeletons or parts of dead fish lay in abundance in the trail near the water's edge. While this was the only bear actually seen feeding on the creek, evidence seemed to indicate that a considerable number of these animals were in the habit of visiting the stream and feeding on the salmon.

Because of the statements made by residents, and especially by cannery men in Cordova, that the brown bear was the greatest enemy of the salmon and contributed "much more than the canneries" to the destruction of the fish, particular attention was paid to the problem here and at other points visited. It is certainly true that on visiting such a stream and looking over the banks one gets the impression that the bear has exacted a heavy toll from the spawning salmon.

On the other hand, when an actual count was made of the fish, it appeared that even considering each of the uncertain fragments as representing an entire fish that had been eaten, the total consumption was not very large in comparison with the number in the stream. Of even greater importance is the fact that practically all the fish seen on the shore were such as had been almost, if not entirely, spawned out and seemed to represent the half-dead fish which after spawning had floated up from the nests in the deeper pools and had been carried by the current near the shore where the bears could reach them. This statement should naturally not be interpreted as indicating that the bears never catch fish before spawning or during the period when they are only partly spawned out. What happens earlier in the season could not be definitely told by conditions at the time of the investigation, when the stream contained fish not yet ripe as well as those partly spawned out and many that were completely exhausted and were merely floating near the surface, making only an occasional movement and incapacitated to escape, but at that period the fish caught by the bears were almost exclusively spawned out. Furthermore, among the carcasses that could be identified, the majority of the fish on which the bears had fed were males. Indeed, many spent fish were picked up from the water without the least difficulty. They were the only ones that at that time came near the surface or banks of the stream, whereas the spawning fish stayed down on the nests in deeper water and were both shy and quick to evade any attempt at approach.

A large number of dead salmon were also seen fungused and marooned on the bottom in the broader lakelike portions of the outlet. Live salmon were found nest building and spawning at almost every suitable point in the course of the stream. The party walked up along the bank and through the bed of the creek for something over a mile. The stream flows over a bottom composed of coarse gravel and water-worn stones in an endless series of short meanders separated by little ripples that left a deeper pool about every 10 yards. In each of these pools from 20 to 30 red salmon were grouped together. The fish showed various stages of maturity from such as were hardly colored at all to those that were already half spent. Including those scattered along the shore there were more dead than

live fish and the dead fish were in every stage of disintegration. A conservative estimate of the fish seen in the course of the distance traversed would put the number of live fish at 3,500 and of dead fish at 5,000.

From the contour of the surrounding country it was evident that the creek extended for a long distance without any material change in character. The fish were as abundant at the end of the walk upstream as they were at the start, and it seems probable that the entire stream for several miles at least was equally favorable for spawning and equally well populated by the fish. All in all, the creek deserves its name and reputation as a fine spawning ground for red salmon. In the course of the trip one moderate sized grayling and one very young fish (kind undetermined) were seen. There were no schools of fry or fingerlings representing last year's spawning and no numbers of other fish that would be unfavorable to the development of the young salmon.

This shore of the main lake was followed as far as the center of the crescent. There was no other stream that possessed any beach outlet with enough water to float a salmon, and there were only two or three points where even a minimum inflow of water at this time of the year was detected. Evidently all fish that came to this section of the lake must spawn in this one creek. On the way to and from the creek mouth salmon were observed jumping in the open lake water. They were always relatively near the shore and were apparently following up the lake to the mouth of Salmon Creek. Jumping salmon were not observed at any point along the shore beyond the mouth of the creek, so far as the shore of the lake on that side was traversed, nor in the open lake away from the shore.

The configuration of the country was such that having studied the shore halfway along the southeast side, it was unnecessary to continue on that side up to the head of the lake. Beyond Salmon Creek there is evidently no other stream on the southeast shore which is large enough to be of significance in the problem being studied.

#### HEAD OF LAKE KLUTINA AND UPPER KLUTINA RIVER.

From camp, which was only half a mile along the shore from the mouth of Hallet River, numerous trips were made through the channels and sloughs at the head of the lake and up the Upper Klutina River itself. That the spawning grounds of the salmon were in proximity was evidenced by the number of dead salmon on the shore. A hundred such fish were counted within 200 yards. Many of the bodies had been partially eaten by bears, and bear tracks were abundant in the vicinity. Both at evening and during the first night salmon were seen and heard jumping near the camp, and a trip in the boat alongshore disclosed a small clearwater inlet with numerous living fish playing around, a few dead and spawned out floating on the water, and some nests, although not much of the available space had yet been occupied. A very small rivulet ran into this inlet, and the water was perfectly clear, being thus in sharp contrast with the milky water of the lake in general. The clear water ran out into the lake underneath the milky water, thus betraying its markedly lower temperature.

The guide reported that on August 19, 1917, when this region was examined previously, the lower part of the inlet, which at the time visited contained mixed water or at least milky water on the surface, was then entirely filled up by clear water, and salmon were seen spawning on the bottom. In paddling about in this region at one time, through an eddy of clear water stirred up by the oars, a single nest was seen on the bottom with ripe fish playing around it.

A trip up the Hallet River along the bank for a considerable distance showed that the water was very shallow and the channel subject evidently to frequent shifting; little or no evidence of fish was found. If the salmon ascend this stream, they must go for some distance, since conditions are entirely unfavorable for spawning in the region traversed, and also for a considerable distance farther—in fact, as far as the stream could be followed with the binoculars from the vantage point of a mountainside overhanging the valley.

On August 14 the gill net was put out in the bay between camp and the inlet just described. In an hour's fishing 24 female and 39 male red salmon were taken. The net was placed about 200 to 300 feet from the shore. The fish were mostly ripe, large, well nourished, and free from mutilation. These fish were examined, as was also a series picked up on the shore that represented salmon nearly or entirely spawned out. Although dead, they were reasonably fresh and in good condition. It is noteworthy that some of the dead females were not spawned out, as they still contained from 50 to 200 eggs.

The bluntly rounded southern end of Lake Klutina is indented by a considerable number of inlets or sloughs, some of which represent river outlets and others of which are blind indentations in the broad delta formed by the material brought down from the glaciers, in part by the Hallet, but much more largely by the Upper Klutina. One of these, lying farthest to the west and just at the point where the shore turns sharply toward the north, has already been described. The indentations were carefully examined, since they constitute most important spawning grounds for the salmon that visit this part of the lake. Their significance will be apparent from a brief statement of the conditions as found. The most westerly has already been described. Next to this, and about 250 yards farther on, is a clear-water inlet without visible inflow but apparently supplied by seepage water from the sides or bottom. It is approximately 5 feet deep near the mouth where it joins the lake. Large numbers of living and dead salmon were seen in the inlet or lying on the bottom.

This was, in fact, a most ideal spawning place, with good bottom, well protected by heavy timber on all sides. The irregular wedge-shaped area, gradually contracting as it penetrated into the forest, seemed to be not only thoroughly protected against storms but for some reason free from the floating timber that, driven on shore, formed a tangle just above the present lake level along most of its shore line. The majority of the living fish seen here were ripe, and fully as many lay around that were dead and spawned out as were living in the water. This inlet was about 50 feet wide at the mouth and preserved a depth of 3 to 5 feet almost to its head. Possibly it is an old river channel, but if so it has grown up so perfectly that no indication of its connection with present channels of the river could be detected.

About 200 yards farther west was a similar inlet, smaller in size, being only 15 feet in width and 2 to 3 feet in depth. The water became clear about 50 yards from the outlet. In this inlet, which is a small affair with a good gravel bottom and no visible inflow, lying just outside the mouth of the west branch of the Upper Klutina, several nests were observed, 25 or more dead fish lay around, and about half as many living fish were playing in the water.

A striking contrast with these conditions was afforded by a big slough with several long arms which was situated 100 yards farther on. It had a good gravel bottom, well cleaned off, with a width of about 75 feet, and the water was 3 to 5 feet deep. There was a very scanty inflow over a small beaver dam near the head. Much more plant growth was present than in the other inlets previously visited. Several ducks were seen feeding in the waters, and a couple of little fish darted away in front of the canoe. This slough was really a lateral pocket from the westernmost branch of the Upper Klutina River, which, in fact, empties into the lake jointly with it. This branch of the river was explored at a later date, and the account may be left here in order to continue a description of the series of inlets.

Turning again eastward along the rounded southern end of the lake, the next inlet proved to be another arm of the Klutina. In paddling up this arm for a considerable distance, some shallow lateral pockets were explored all of which proved to be filled with milky water and contained frequent patches of grass and brush. In these were seen no signs of salmon nor, indeed, of any other fish. This branch of the Klutina soon became very narrow, with brush projecting clear across the channel of the shallow stream, which increased in swiftness until further progress became impracticable.

Some 200 yards farther on another small arm of the Klutina, called the Third Channel, was encountered. After working up a few hundred yards without seeing any signs of fish whatever, the party was compelled to turn back because of obstructions. This is clearly an old and well-established channel of the river.

Nearly half a mile farther along the fourth channel was entered. It was broken up into numerous smaller winding channels, which were swift and shallow and which joined and separated at brief intervals. The variation in depth and the swiftness of the current made navigation exceedingly difficult. Small overflow ponds lay here and there on the flats, some still connected with the stream, others evidently filled at a higher stage and now separated from the channel by sand bars. A couple of small rocky islands separated this group of channels from the main stream of the Upper Klutina River, which lies almost against the mountain on the east side of the valley. This main river is broken into fragments by bars, some easily seen, and others lying just below the surface, not visible in the muddy water. This channel carried more water than all of those seen previously. In it the current was powerful, but relatively smooth. This branch of the river was followed up for a couple of miles without showing any evidence of the presence or movement of salmon. No streams emptying into it were found, and the bays and backwaters were all of them devoid of traces of salmon, either present

or in the past. No evidence whatever could be procured that the fish frequent this channel or use it as a means of ascent to small lakes connecting with this branch higher up near the glacier from which this stream originates.

At a later date a trip was made up the west branch of the Klutina. The banks of this branch were well marked and firm. They are lined by spruces, which for a considerable distance are large and thickly set. The water in the channel is relatively deep, and all features combine to show that it is an old channel which probably at some recent time carried much more of the flow of the stream than at present. The channel is tortuous, but follows in general the base of the mountains on the west side of the Upper Klutina valley. From this to the present main channel of the river, which lies on the east side of the valley, the ground is nearly flat, composed of glacial silt, and intersected by occasional cross-channels. Small lakes, communicating with one branch or the other, lie on this flat, and are surrounded in places by alder thickets that at that time were not entirely out of water. Along the west side trees are more numerous and larger and the land has evidently attained more stable conditions than exist on the main channel on the east side of the valley.

The old west channel is frequently barred by beaver dams, which in some places are so numerous as to have formed a labyrinth of channels in which it is difficult to find one's way. In places successive dams were not more than 10 or 12 feet apart, and while some of them were only a foot in height, one was found which represented a vertical height of between 4 and 5 feet. Various ponds or small lakes that lay on the right or left of this channel were examined, but no traces of spawning fish or of past spawning activities were found. Most of these ponds owed their origin evidently to beaver dams, and in some cases their maintenance was very clearly due to such obstructions. They were adequately supplied with vegetation, but were evidently not frequented by many fish. Field notes indicate that one grayling about 10 inches long was observed, but no other fish of any size or kind was seen, until on the return trip, as the boat was lifted over one beaver dam, a female red salmon was seen wriggling up the face of the dam. There was not opportunity to investigate all of the lakes in this upper valley or to follow all of the small branches that led off from the river, but the stream was evidently not used at this time by any conspicuous body of fish, or something of them should surely have been seen. Furthermore, no evidence was found of the previous activity of salmon in this region, whereas in other places such evidence was present even at times when the fish themselves could not be found. The conclusion was reached, accordingly, that this region was not one in which much spawning took place. At the time of the trip the water was slightly milky. The guide reported that in 1917 this branch carried only clear water. The point was found at which the water was contaminated by a small quantity flowing in from the opposite side of the plain, and above the point where this material was received the stream was perfectly clear. It would seem that this branch of the Klutina, with its lakes and gravel bed, might afford good spawning places for considerable numbers of fish.

## ST. ANNE LAKE.

St. Anne Lake, which lies at the head of the stream bearing the same name, is surrounded by low banks, and at the lower end especially is bordered by swampy and boggy shores. It has the form of a long oval, being 5 or 6 miles in maximum length and a mile or a little more in width.

The lake is very shallow at the lower end, being nowhere more than 4 or 5 feet in depth and having for the most part a depth of less than 3 feet. The bottom is richly overgrown with water plants, among which the Charas are conspicuous. At various points growths of different types reach to the surface, making veritable reefs of vegetation that are favorite feeding grounds for myriads of waterfowl. In the shallow portion of the lake fish are very abundant. Large ling cod lay on the bottom within easy reach and could be gaffed without difficulty. Moderate-sized whitefish played about in the open water at middle depth and schools of small fish, probably whitefish, darted away rapidly as the canoe approached the point where they were resting.

The water swarmed with various aquatic organisms. Plankton animals and plants were so abundant as to be conspicuous to the naked eye and on one of the days (Aug. 21) the lake was covered with a delicate water bloom produced by a minute unicellular alga (*desmid*). By reason of the aquatic life characterized above, this lake is by all odds the most suitable place seen on the trip for the development of young fish.

A single dead king salmon was found floating in the lower section of the lake in front of the knoll on which the camp was located. Several red salmon, nearly ripe, were seen in the outlet creek only a few yards below the lake, but otherwise no trace was found of any kind of salmon in all the stay on the lake. The party rowed along the west shore as far as the head of the lake. The net was put out in deep water at two points in the north half of the lake and caught only a number of large suckers which were about ready to spawn. The east shore seems to be largely, if not exclusively, formed by banks of glacial clay without rocks or stones. The west bank is stony, being made up of angular fragments and not composed of rounded or water-worn gravels. Along the stony west shore search was made for evidence of salmon nests, either new or old, and for salmon fry as well as for spawned-out fish.

It is perhaps not strange that young salmon were not found, because at this period it is likely that any which might have been present earlier in the year would already have started on their migration downstream to salt water. But despite the fact that fish nearly ready to spawn were seen so near the lake in the outlet stream there was no trace of the fish themselves in the lake and no evidence of their having utilized the territory for spawning purposes previously.

The water of the lake must produce immensely large quantities of young organisms which serve for food of the salmon fry. Undoubtedly these are carried down the outlet stream in considerable numbers and serve in that way to maintain the fry that are hatched in St. Anne Creek.

This lake is deserving of further study, and in case it is proposed to set aside any reservations in that section of Alaska, St. Anne Lake should certainly be included because of its remarkable fitness for supporting fish life.

## SUMMARY.

Copper River and its tributaries may readily be subdivided into a small number of regions which differ distinctly in character and probable relation to the spawning of the salmon that visit the region.

1. A group of small tributaries flowing into the river on the west side between the mouth and the town of Chitina.—These streams are all very short, rather turbulent, and not supplied with lakes to which salmon can ascend for spawning. While lower reaches of these streams may be utilized by silvers that come late, there is good reason to think that they play no part in the red salmon production of the river.

2. Chitina Creek, with its small lakes.—This creek belongs in a sense to the series of short streams entering the lower river from the west, but it differs from all the rest in having attached to it a series of permanent lakes that are accessible.

3. A series of three tributaries of some size which enter from the west, and which possess conspicuous lakes.—These are the Tonsina, the Klutina, and the Tazlina Rivers. Tonsina Lake was not visited, but Klutina and Tazlina Lakes and Rivers, with their tributaries were studied in detail. They constitute undoubtedly the most important spawning grounds visited, and perhaps the most important connected with the Copper River system.

4. The upper Copper River, with its tributaries, the Gulkana, the Gakona, the Mentasta, and others, which lie north of Copper Center.—There are many lakes on these tributaries, and it is likely that in normal seasons salmon are abundant in this region. This territory was not visited.

5. The Chitina River, with its tributaries.—In this region only Long Lake was visited, and it does not seem to deserve the merit as a spawning place for salmon that has been attributed to it. Many reports were heard of salmon being abundant in various subordinate streams and lakes connected with the Chitina. Some of these reports were very definite. One of them, which was current later than the visit to that region, was investigated by J. E. Most, superintendent of the cannery at Abercrombie. The account concerned lakes on clear streams that run into the Neena and ultimately into the Nizina. According to Mr. Most's statements, the lakes are small and are fed by numerous clear streams, all of which contain some salmon. His observations led him to think that there were some 3,000 fish in this vicinity at the time of his visit, about the middle of August.

6. The tributaries of Copper River on the east between its mouth and Chitina.—Clear Creek has already been discussed. It is a small stream, but the only one in that stretch which was reported to be significant as a spawning ground for salmon. The Bremner, which is the largest stream on the east side of the river in this stretch, is said to carry a good many salmon, but opportunity was not given to visit it nor any of the other streams in that vicinity.

7. Lake Klutina.—This is a most important spawning ground for the red salmon. Salmon Creek, on the southeast shore, several inlets at the head of the lake, and St. Anne Creek, at the northwest angle, form the actual spawning territory. The red salmon were well advanced in spawning on Salmon Creek August 6, on St. Anne Creek August 10, and at the head of the lake a week later. Spawning had

practically ceased in St. Anne Creek on August 19. This indicates that the Lake Klutina salmon probably come from the early run in the Copper River.

8. Lake Tazlina.—This lake affords no opportunities for red salmon to spawn apart from the Nelchina and Mendeltna Rivers, which are said to carry salmon lakes on their courses some distance beyond Lake Tazlina. Red salmon not yet entirely ripe were entering Lake Tazlina and ascending the Mendeltna River on August 29, indicating that this region is supplied by the late run in Copper River.

9. Red salmon reach both Lake Klutina and Lake Tazlina in splendid condition. Most of them are not mutilated at all, and even the few that show injuries are only slightly affected.



# SPECIAL INVESTIGATION OF SALMON FISHERY IN CENTRAL AND WESTERN ALASKA.

By C. H. GILBERT and HENRY O'MALLEY.

## LETTER OF TRANSMITTAL.

SEPTEMBER 20, 1919.

The COMMISSIONER OF FISHERIES,  
*Washington, D. C.*

We inclose herewith a report on the salmon fisheries of central and western Alaska, based on our observations in the field during the past summer, taken in connection with the history of the district in former years.

We have stated at length our conviction that the industry has now reached a critical period, in which the salmon supply of Alaska is threatened with virtual extinction, unless a radically new administrative policy be substituted for the one now in force.

The crisis is made more acute by the exhaustion of the salmon fisheries in Puget Sound, due to prolonged overfishing in the face of persistent warnings like the one we here present concerning Alaska. The numerous well-equipped canneries of this southern district are confronted by the necessity of suspending operations in the near future. Their supplies and machinery will become available for the Alaska field, which they will certainly invade wherever promising sites can be obtained. Unless effective governmental control can be secured to prevent further invasion of a district which already suffers the evil results of unrestricted competition, certain disaster will befall the salmon fisheries of Alaska.

Respectfully submitted.

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## GENERAL SITUATION AND SUGGESTED REMEDIES.

During the season of 1919, the writers visited the Copper River, Cook Inlet, Bristol Bay, Ikatan and King Cove, the Karluk River, and Kodiak. With the exception of Chignik, which was not visited, these localities comprise all the most important fishing districts in central and western Alaska. They form the home par excellence of the most important species of Alaska salmon, the sockeye or red salmon; and they produce some 90 per cent of the entire Alaska sockeye pack. Also, they are wholly dependent on this species. In central Alaska, it is true, not unimportant packs of pinks and chums are now put up, but it remains true of central Alaska, as it does to an even greater extent of western Alaska, that the continued existence of the salmon industry is dependent on the preservation and maintenance of the red-salmon runs.

These have been drawn on heavily since the earliest days of the salmon industry in Alaska. The red salmon alone was then sought as the only species having any considerable commercial value. Other species were taken incidentally or to fill out the pack where red salmon in a given year were not to be obtained in adequate numbers. A market for chums and pinks was developed progressively but slowly with later years. Not until 1911 did the combined packs of all the other species slightly exceed that of the red salmon alone.

With this species at first the only salmon in demand, it is natural that the streams of central and western Alaska were among the earliest exploited. Canneries entered the field in 1882, when one was constructed on the Kussilof River in Cook Inlet and another on the Karluk River, Kodiak Island. Others followed in rapid succession. In 1899, 25 canneries were operated in central and western Alaska: The Copper River supported 4; Cook Inlet, 2; the Karluk River, 6; Alitak, 2; Afognak Island, 2; Chignik, 3; Orzenoi, 1; Thin Point, 1; and Nushagak, 4. In many of these localities, salteries had been in operation for a number of years before the canneries were built. Thus the principal red-salmon districts of central and western Alaska were already occupied at that date and have been assiduously fished for 30 years or more. The question of how well the sockeye colonies have sustained the exactions of the commercial fisheries during this long term of years is pertinent.

The subject is complicated and difficult to handle. Each stream in this vast area has its own wholly independent run of fish and has had its individual history. One stream may have been overfished to the point of exhaustion, while others in the same district may have maintained their runs unimpaired. So long as undeveloped territory remains and may be gradually drawn on, the total or mass statistics from a given district give no answer to the question of depletion. Nothing short of individual stream statistics are adequate, and even these must extend over a term of years, during which the manner of fishing and the amount of fishing gear employed each year are accurately given. Unfortunately, no such statistics are published and available, yet they would form the essential foundation for any well-considered scheme of conservation. Without such a body of statistics, legislation to protect and maintain the fisheries must be a groping in the dark. The Bureau of Fisheries should at once proceed to gather annually, under a skilled statistician, a well-planned body of data, referring where possible to individual streams. These should be collated in tabular form, digested, and published.

The preservation of the salmon supply to the rivers of Alaska concerns most vitally the body of consumers which constitute the general public. It is contrary to their interests that the fisheries be ruthlessly exploited and an important source of highly valuable food be placed in jeopardy, greatly diminished, and in time totally destroyed. The importance of sea foods will increase with the years, as grazing lands grow more and more restricted and flocks and herds continue to diminish. Yet now, in a period of comparative abundance, through sheer heedlessness and childish improvidence, this country is in danger of permitting the virtual destruction of the most important sea food it possesses—one which the ocean provides without cost and brings to its very doors.

The trend of events, at least, should be ascertained and an opportunity given wisely to safeguard paramount interests before irretrievable harm has been done. To this end it is essential that wherever possible stream statistics be prepared and that they be made public year by year. It will then be possible to learn how well the public trust is being administered. Should such statistics prove a progressive depletion of the salmon supply in any or in all districts, it is to be hoped public sentiment will be aroused and would find expression, demanding adequate protective legislation.

There has been no time in the history of the industry when precautionary measures have been so imperatively demanded as at the present. Development in the early days was often delayed and checked by the low price of the canned product and the ease with which the market could be overstocked. But during the later years, and especially since the beginning of the Great War, with unlimited demand for canned salmon and unheard-of prices prevailing for all the grades, there has been an unexampled expansion of the business. Whereas, in 1914 there were 82 canneries operating throughout Alaska, in 1918 the number had increased to 135. Everywhere, capital was seeking new cannery sites. Competition for the existing supplies of salmon was greater than ever before. New fields were entered where such could be found. But for the most part, the old fields were further invaded, although they were already fully occupied and carried no reserve supplies that could safely be spared. With the price of raw fish greatly advanced, the fishermen became more eager. They could afford to carry on their operations later in the season when the run was at the ebb, and constantly they gleaned more closely. No one can doubt that larger proportions of the spawning runs during this period have been captured for commercial uses, while smaller and smaller contingents have been able to win their way to the spawning grounds, there to make necessary provision for all future runs. It has been and still is a situation full of danger.

Even before the recent startling expansion of the industry, all disinterested observers held that in central and western Alaska a safe level of production had been reached, if indeed in many localities it had not already been passed.

Does anyone doubt that the wonderful Karluk River has suffered impoverishment since the days when it was easily able to produce year after year without interruption packs of 150,000 to 200,000 cases of red salmon? A comparison of the early days with the average packs of the last years is convincing that, whether or not on the Karluk bad is now giving place to worse, the river is consistently on a lower level of production than formerly. It is as though a wheat field should be held down to half its normal yield because the seed was begrudged.

Is the Copper River run not rightly considered in a precarious condition with adequate remedial measures not yet in sight? And are there not poor prospects ahead, now that fierce competition recently has been permitted for the small but highly productive red-salmon streams in Olga Bay? The Chignik has also been a wonderful stream and is still a valuable property despite the abuses to which it has been long subject. But does anyone believe it could stand the further drain of sharp rivalry which may at any time accompany the advent of an additional cannery?

Have not Ikatán and Morzhovoi Bay already suffered with six canneries contending with purse seines and traps for their not unlimited supply?

Mention need only be made of the formerly productive stream that enters Nelson Lagoon; and of the Bear River and Sandy River, which formed the main dependence of the canneries at Port Moller and in Herendeen Bay. Everyone knows they are far along the road

toward depletion, even though they may exhibit an occasional flare-up into a season of greater activity.

These are all clear-cut cases of overfishing with the resultant partial destruction of the runs of fish. And the end is not yet. So long as the high price of canned salmon continues, be assured that aggressive capital will seek an opening. Wherever a run of any size remains and may be further exploited, or wherever apparently an opportunity presents itself to force with profit an entrance into a field already overdeveloped, this will be done, and invariably the result will be a sharper rivalry for fish and a further decline in the run.

It is customary in these discussions to lay the responsibility for depletion at the doors of the canners, and to criticize them sharply for their rapacity. Something can be urged, doubtless, for this point of view: especially in the earlier days was this true when competition was in its infancy and fish were to be had for the taking, yet nevertheless streams were barricaded to prevent the ascent of the salmon, and other practices were indulged which constituted a cut-throat policy, foolishly and needlessly adopted.

But despite all this, the responsibility has rested from the beginning and now rests fairly and squarely on the shoulders of the Congress and the general public. The present administration of the fisheries appears based on the expectation that men will hold back their hands where a further profit can be made. It is witless to expect them to do so. The administration of public affairs can not be made to depend for success on men's voluntarily foregoing a profit. There are those, doubtless, who would relinquish private gain in the public interest, but it need not be contended that they are in the majority. And whereas it might appear that in the salmon business private interests would counsel moderation in the hope of securing the perpetuation and the permanency of the industry, such in fact is not the case. It would boot them nothing to permit most liberal numbers of salmon to escape their nets. So long as the public throws this field open to unrestricted competition, and so long as there results keen rivalry for every fish that swims, no individual canner can accomplish anything toward the protection of the streams. Whatever he spares for spawning purposes, his competitors will thankfully accept and place in cans. He is powerless to conserve either the public interest, or even—should he be sufficiently enlightened to see it—his own private interests, by listening to any counsels of moderation. If fishing grounds or fishing rights could be leased or assigned, and property rights acquired which would become valueless should the fishing greatly decline, cooperation with the authorities to preserve the fisheries could confidently be counted on. But so long as the present policy is maintained, and the canners have only what they can seize and can hold with every man's hand against them, there can be but one final outcome. Total exhaustion of the fisheries will occur; if not to-morrow, then the day after.

It can not be too often nor too strenuously insisted on that the dangers which confront the Alaska salmon industry are inherent in the very plan which the Congress has adopted for its administration. The only effective remedy lies in altering the groundwork of this plan, in treating the fishery resources in practice as well as in theory as the property of the public, and in administering them in the inter-

ests of the public rather than apparently in the interests of those who seek to exploit them.

They could be so handled as to insure their permanency and yet leave their operation in private hands. Treat the canneries as exercising quasipublic functions. License them to operate within restricted limits and on a specified scale, neither of these to be modified without direct authorization. Let no more operate within a given field than can do so while still maintaining the run at its *maximum of production*. Produce readjustments as these are shown necessary. Permit further expansion wherever evidence shows that this can safely be done. Restrict the output further wherever the danger point is approached. Permit all the salmon to be taken for commercial purposes that can with certainty be spared, but maintain a constant safety factor in favor of the spawning beds. *Maintain the runs at their maximum of production*. The salmon that could safely be spared from such runs would be vastly more than the utmost gleanings when depletion has occurred. Whenever restriction of the output becomes necessary, recognize the equity of the operators in that region as soon as the policy adopted shall again permit a degree of expansion. In this manner, the packers would cooperate with the Government under such conditions that it would be to their interests, equally with those of the public, to conserve the runs of salmon.

It may be urged that however meritorious such a plan might appear if the industry were in its infancy, it would be wholly impracticable to apply it under conditions as they now exist. But if the principle be once accepted, work can gradually be directed in the desired direction with immediate benefit to the situation. The present laws can be modified so as to diminish predatory competition. It can be required that existing canneries shall secure a license to operate in specified territory with a given amount and kind of gear. It should be discretionary with the Secretary of Commerce to license or refuse to license new canneries, or to permit or refuse to permit further expansion on the part of those already operating. And if on full investigation it should appear that any region is being dangerously drawn on, the Secretary should have authority to curtail production to any necessary extent. At present his jurisdiction covers only the streams themselves and a narrowly limited area about their mouths. But in many districts the harm is caused by excessive fishing in salt-water channels and in other restricted bodies of water which form the approaches to the streams.

Provision should be made in the laws that fishery sites can be licensed under suitable conditions, and that property rights vest in such sites under prescribed regulations. The nature and the amount of gear that may be operated on such site should be specified in the license. They should include trap locations, set-net and stake-net locations, fish-wheel locations, and seining beaches. Unless certain conditions were met these locations should revert to the public; otherwise they should be the property of the licensees so long as they could be operated without detriment to the salmon supply. But it should be within the discretion of the Secretary to limit or entirely to suspend the use of any location when such course should appear necessary.

Some of these provisions are already in force in the States of Oregon and Washington, where the discretionary power lodged in the

Commissioner of Fisheries exceeds that conferred on the Secretary of Commerce.

Further improvements can be made in the Alaskan field by making more adequate provision for the enforcement of the laws. Not only are our fishery statutes now pitifully inadequate, but they are unusually and unnecessarily made difficult of enforcement. The Commissioner of the State of Washington and those authorized by him exercise the power to arrest violators of the fishing ordinances, and they can seize any fishing appliance, including boats, traps, nets, and fish wheels, used in violation of the provisions of the act. But the agents of the Bureau, intrusted with the enforcement of the Alaska laws, have neither power to arrest nor authority to seize illegal gear. If it had been deliberately planned to hamper them in the interests of violators of the laws, it could not have been done more effectually.

#### BRISTOL BAY AND RED-SALMON RUN OF 1919.

The season of 1919 has proved the most complete failure in the history of Bristol Bay. Not only was the run smaller than ever before chronicled, but it was almost equally deficient in all the streams of the district. This has usually not been the case heretofore. The poor Nushagak run of 1907 was accompanied by fully average packs on the Kvichak and the other streams of the east side of the bay. In 1911 there was a poor Nushagak run and also a rather poor pack on the Naknek-Kvichak, but the Ugaguk had the largest pack ever made to that date. The Nushagak was far below average in 1912 and the other rivers all well ahead of all previous records. Only the Kvichak was deficient in 1915 and only the Nushagak in 1916.

From this it appears that the runs have varied independently of one another, thus favoring the assumption that in each instance the cause of failure was local in its nature, and not general. But in 1919 the situation seems different. The decrease in numbers of red salmon was marked, almost without exception, throughout central and western Alaska. Throughout the red-salmon district a marked deficiency was shown, which culminated in Bristol Bay. To account for this, it seems necessary to assume some widely distributed agency, which probably operated throughout these districts during the life of the salmon in the sea. It appears impossible to conceive that there should have been such a wide coincidence in unfavorable local conditions as would be required to explain the occurrence.

The run of 1919, in all the affected areas, was derived in part from the brood of 1915, but more largely from the brood of 1914. So far as is indicated by the pack of 1914, no cause can be assigned for the 1919 shortage. The pack was near its maximum in every Bristol Bay river except the Ugashik. If the four-year period and the season of 1915 be considered, a better case can be made out; for the Kvichak-Naknek pack of 1915 was reduced nearly to half that for the preceding three years; and although the Nushagak yield of 1915 was above the average, the escape to the spawning grounds, tallied at the Wood River weir, was the smallest ever reported. However, in 1915, both the Ugaguk and the Ugashik made favorable records, and

when it is considered that throughout this district the red salmon mainly mature at 5 rather than at 4 years of age, the improbability is manifest of explaining the shortage of 1919 by anything which occurred in 1915. The question whether in general the Bristol Bay streams give evidence of overfishing must now be considered.

#### HAS THE KVICHAK-NAKNEK DISTRICT BEEN OVERFISHED?

There is an unbroken series of pack statistics for the Nushagak River, reaching back to 1893, and for each of the other rivers of Bristol Bay since 1904. Some allowance must be made for a certain degree of inaccuracy, because fish were in some measure reported in favor of the district in which they were packed, regardless of where they were captured. No attempt is made to disentangle the Kvichak-Naknek complex, for the fishery is conducted to a large extent in the open off the mouth of the Naknek River and farther to the south, and contains Naknek and Kvichak fish in unknown proportions. This is equally true at both the Ugaguk and the Ugashik Rivers, for the great Kvichak migration sweeps past the mouths of these rivers, and fishing in these cases also is partly done in the open. It can not be said then that stream statistics for the eastern shore of Bristol Bay are wholly reliable, the element of doubt increasing as the mouth of the Kvichak is approached. The three rivers are very similar in their lower courses, with wide stream beds at high tide, choked with sediment; and at low water having extensively exposed sand and mud flats with greatly restricted channels. Fishing has always been freely permitted, practically without restriction, in all these streams, and while the statistics do not of themselves give reliable data, there are probably few who will assert, and fewer yet who believe, that these rivers now carry the body of salmon they formerly produced.

But in spite of inaccuracies, which detract from their value as stream statistics, they constitute a highly valuable record. Extending as they do over a period of 15 years, during all of which intensive fishing has been in progress, it would seem they should furnish unequivocal evidence of general serious depletion, if such had occurred. Had the manner of fishing and the amount of fishing gear employed remained relatively constant during this period, most valuable deductions could have been drawn. But the amount of gear employed has more than doubled and the fishing grounds have been pushed farther and farther into the open bay. What the effect of these changes has been must remain in some degree a matter of speculation. The Ugaguk responded to the more intensive fishing in 1911 and the Kvichak-Naknek in 1912, with greatly increased outputs; and these were maintained at the higher level for seven successive years, with the single exception of 1915, which was a partial failure on the Kvichak. The Kvichak-Naknek produced in 1912 nearly 14,000,000 red salmon, whereas 9,500,000 had been the largest number previously obtained during any year. Approximately the same number were captured the following year in 1913. From the eggs that were furnished in these two years of increased pack there resulted the run of 1917, when the Kvichak-Naknek yielded over 15,500,000 red salmon. The fact that a largely increased pack was thus possible, and that it could be maintained without serious interruption into the second cycle, when the effects

of the increased pack should become apparent, indicates that these rivers had not been fished to their full capacity prior to 1911 and 1912. It seems clear that more than 9,500,000 fish could be spared from the spawning beds without imperiling the run. But it does *not* indicate that the new level of production is a safe one, and can be maintained indefinitely. What could be safely spared in excess of 9,500,000 fish may have been taken, and a considerable number in addition. The new level has not been arrived at through any reasonable process. There was no knowledge of the situation which warranted such increase with any assurance it would not be fatal to the future runs. No precautions whatever were taken in the matter. Everything was haphazard, in accordance with the customary policy. All the fish which could be caught were taken without any heed to the future. It was known that it was impossible to catch them all, and it was vaguely hoped—if the matter was given thought at all—that, whatever be done, enough would escape to keep the run going. Fishing was conducted without limitations of any kind. The amount of gear was limited only by what could be profitably employed. Fishing was permitted in all the rivers as well as in the open bay. There was no close season to afford needed protection. Such has been and still is the policy. If a new method of fishing could now be applied which would make it possible to capture 20,000,000 fish from the Kvichak, the 20,000,000 fish would be cheerfully captured annually for five years until returns would be had in the next cycle of years, and then the damage would be appraised.

Fear that the danger point may have been reached on the Kvichak-Naknek is based on the fact that all efforts that have been made to increase the yield during the last seven years have been without result. Fully one-third more gear has been used in subsequent years than was used in 1912, and the only result has been to divide the fish more finely among a larger number of fishermen. Each net averages for the season a smaller number of fish, and the grand total is not increased. Such a result always indicates dangerous ground. It usually means that the use of increased quantities of gear is necessary in order to maintain the pack at the high level which it has once reached. In most cases a reduction to the earlier number of gill nets would entail a marked decline in the pack, showing that the total run of fish has suffered a reduction. Do the packers in the Kvichak-Naknek district believe that they could reduce their boats and nets to the numbers employed in 1912 and still continue to catch 14,000,000 or 15,000,000 red salmon in a season? If they maintain that they could do so, it seems strange indeed that they continue to incur this enormous additional expense each year in the certainty that it brings no returns. If the present number of nets is, on the contrary, essential, it means that each year there is a closer and closer gleaning from the spawning run in order to maintain the pack, and it means, furthermore, that the spawning run is already so greatly reduced that with the utmost efforts no considerable contribution can be secured from it.

This must be considered a dangerous situation, which can not continue without finally producing a greatly diminished run of fish to these rivers. It is not known what is the least number of spawning fish which will keep up a run to full size in any district, but such a minimum would vary widely in different years. Some seasons are far less favorable than others, both on the spawning beds in the lakes,

where the fingerlings live for one or two or three years, and in the sea. The number of spawning fish which would be adequate in favorable years, it must be recognized, would fail utterly to produce a run when the eggs, the fingerlings, and the growing fish in the sea had been exposed to unusually severe conditions and to more formidable attacks from their innumerable enemies. This is not unsupported theory. It is a necessary deduction from all the observations and all the experiences of those who have studied the sequence of the seasons in the fisheries.

A safety factor on the spawning beds is for this reason essential. Unfavorable seasons come without warning. They may be scattered, with wide intervals between, or two or more may come in quick succession. Unless there is spared each year for spawning purposes a number materially greater than are ordinarily sufficient, unfavorable seasons will declare themselves as failures which otherwise would have been saved by what in ordinary seasons constitutes an excess production of young. Such excess production must be maintained in order to be safe.

When increase of gear fails to produce material increase of pack there is danger that the safety factor has been abolished, if indeed no worse has been done. On the Kvichak-Naknek the 1917 yield of nearly 16,000,000 fish does not demonstrate that 15,000,000 could safely be taken in 1912. Other river basins have been watched during the progress of depletion. The sequence of events is always the same. Decreased production is accomplished by increase of gear. Fluctuations in the seasons become more pronounced. Good seasons still appear in which nearly maximum packs are made. But the poor seasons become more numerous. When poor seasons appear no attempt is made to compensate by fishing less closely. On the contrary, efforts are redoubled to put up the full pack. The poorer years strike constantly lower levels, until it is apparent to all that serious depletion has occurred.

It can not be affirmed with certainty that the extremely poor season of 1919 has been due to a combination of overclose gleaning and of unfavorable general conditions, but it is believed that such has been the case. The year in any event might have been one of less than average yield, but the extent of the disaster would have been mitigated if a generous safety factor had been hitherto provided. The result of the year can not be foretold. The escape to the spawning beds must have been far below the average of recent years. It may have fallen below the minimum which is necessary to keep up the run even in favorable years. If so, the results will be serious in 1923 and 1924—bad even if the general conditions meanwhile prove propitious, far worse should they again prove unfavorable. Bad years more certainly reproduce themselves when spawning has been dangerously reduced.

The dangers of the situation with the present scale of operations continued have been pointed out, but on the Kvichak-Naknek there is danger of further increase. The region is recognized as the last great stronghold of the red salmon, the greatest producer in the world. Other canneries continue to appear; all are likely to increase their scale of operations; more gill nets will constantly be employed. The prospects are unfavorable unless restrictions are imposed while yet there is time.

NUSHAGAK RIVER AND WOOD RIVER CENSUS.<sup>a</sup>

The Nushagak River has had a different history from that of the Kvichak and the smaller rivers which enter along the eastern shore of Bristol Bay. It was the first to be exploited and very early reached its maximum of production. The five years from 1900 to 1904 produced a slightly greater yield than the succeeding five, from 1905 to 1909. From 1910-1914 there was a material reduction of about 3,000,000 fish below the preceding period, and the five-year period which came to a close with 1919 shows approximately the same reduction. Yet during these periods there has been great increase in gear and a complete shifting of the fishing grounds to the channels outside Ekuk. Not only has increased fishing produced no increased returns, it has been accompanied by a small but unmistakable falling off in the pack. To this extent the situation on the Nushagak is more disquieting than on the Kvichak.

The decreased packs on the Nushagak, as seen in five-year periods, are due to the more frequent appearance of poor years. From 1900 to 1904 the poorest yield of any year was 4,125,000, which was not far below the average of the last two periods. From 1905 to 1909 the poorest yield during one year was 2,500,000. From 1910 to 1914 there was one year with less than 4,000,000 and one with less than 3,000,000; while in 1915 to 1919 there is one year with less than 4,000,000 and another probably with not to exceed 2,000,000—the latter certainly the smallest yield in 20 years, despite the enormously increased gear.

No one can doubt that there is here evidence of close gleaning from an early period, with the percentage of escape reduced to smaller dimensions and with little provision made for any safety factor. When in any stream the crests of the pack grow lower and the troughs deeper, retrenchment is called for. It is our belief that this condition is now declaring itself on the Nushagak.

The Wood River census of salmon which have escaped the commercial fisheries and are about to enter the spawning area of the river has been taken annually since 1908, with the exception of 1914. The actual number of fish escaping and the proportion these bear to the total run have varied widely during these years. Omitting from consideration the year 1908 and making allowance for an escape, of which there is no record in the Nushagak, the Igushik, and the Snake, the percentages of escape may vary approximately from 7 to 25, with an average perhaps in the neighborhood of 15 per cent. It is this 15 per cent only which would be subject to further inroads resulting from increase in amount of fishing gear. As the spawning reserve grows less and less, the capture of any considerable part of it becomes more and more difficult by open fishing of the kind employed at Nushagak. Some amount of escape is nearly always provided by adverse weather conditions, which usually slow up fishing at some time during the season and may even cause its virtual suspension for a short period. In addition a few fish pass around and through the forest of nets, impossible as that may appear, and some pass through the nets themselves. Many show net marks, indicating the manner of their escape, and many others must pass through the meshes unscathed; for the average size of the fish captured in the upper bay, or reaching the weir at the foot of Lake Aleknagik, is much below the

<sup>a</sup> Upon recommendation of Dr. C. H. Gilbert, it has been decided to discontinue the Wood River census. See p. 33.

average for the fish captured in the outer bay. Where thus selected for their small size there will be more four than five year fish and more females than males. The latter may present an added source of danger, for if in the escape females largely predominate they may be unable to find males with which to pair, and their eggs may remain sterile. There are no observations on the spawning grounds which cover this point. It is possible that the male remains active for a longer period and will mate repeatedly, but it is not known that such is the case.

The escape through nets must present a fairly constant factor, but the amount of escape attendant on unfavorable fishing weather varies widely with the season. Some years are much more conducive to close gleaning than others. In 1915 the commercial capture was above the average, amounting to more than 5,500,000 fish; but the escape of less than 260,000 fish was the smallest then reported. The cannery pack of 1917 was practically the same as in 1915, but the escapement in 1917 was four times as great; in 1916 the escapement was nearly twice as great, although the commercial yield in 1916 was only about three-fifths that of 1915.

One reason is here apparent why such indifferent success is met with in predicting future runs on the basis of commercial packs of salmon. It is the number that escape to the spawning beds that have their influence on a subsequent generation, not the number sealed in cans, and the latter would often give a very erroneous basis for estimating the former.

It would seem, however, that where the escapement itself has been reliably ascertained for a number of years, a basis should be at hand for successful prophecy, with a fair degree of accuracy. The belief is generally held that increase in number of spawning fish up to the full capacity of the spawning beds will result in an increased run. The spawning beds of the Wood River chain of lakes to which there must have resorted in the old days 5,000,000 fish or more, can not be held fully populated by any number that have escaped the nets during recent years. A million fish at least should certainly find room to spawn in this great watershed without serious interference with one another's nests.

If they can do so, then the larger the number that spawn within these limits, or any more extensive areas of profitable spawning, the greater should be the resulting schools of fingerlings that pass out to sea in the spring and summer and the larger the returns in adult salmon when these come back to spawn.

If it should be assumed, however, that only half a million or a quarter of a million could profitably spawn, and that any larger number merely increased the wastage on the spawning beds and contributed nothing to the crop of fingerlings, on this basis and this basis only could a complete failure to establish a relation between increased spawning escapements and the larger size of the resulting runs be understood.

The Wood River experiment was inaugurated for the purpose of throwing light on this and on other problems, among them some of the most important that confront the commercial fisheries and fish propagation. If the experiment could establish the percentage of returns which could be expected under natural propagation from a given number of spawning fish; or, stated differently, the lowest percentage of escape that could be relied on to maintain the run intact, a sound basis would be laid for scientific handling of the fisheries. The results, both scientific and practical, would be far-reaching, and the conduct of the experiment all the more should be

above question. It was most unfortunate, for this reason, that Wood River was selected for the purpose. Its disadvantages were clearly seen and were discussed by Marsh and Cobb, in their report of the operations during 1908. The Wood River is not the only red-salmon stream tributary to Nushagak Bay. The main Nushagak, the Igushik, and the Snake also contribute their quota to the schools of fingerlings passing seaward through Nushagak Bay, and each of them receives its percentage of the escapement from the fisheries conducted in the open bay. It is not known what their respective percentages amount to. The streams have never been racked and the escapement tallied. It is currently believed that their runs, individually or even combined, are less important than the Wood River run, but the approximate number that must be added to the Wood River tally to produce the annual escapement from the entire fishing district is wholly a matter of conjecture. The salmon bound for these four streams enter Nushagak Bay together and are indistinguishable. Those captured by the commercial fisheries include members of all four colonies commingled, in their due proportions. What these proportions are no one knows. The chronicled escapement is for Wood River alone. It is evident that the total escapement from the commercial fishery and the proportion which this escape bears to the total run can only be obtained by assuming certain values for three unknown streams. Marsh and Cobb have done the best that can be done with a bad situation by assuming what they consider maximum and minimum values for the escapements to the unknown rivers. Interesting results are obtained in a field in which previously there has been no information, but the elements of uncertainty which reside in all conclusions based on the incomplete data of this experiment unfit them for either practical or strictly scientific purposes. Had it been practicable to rack each of the rivers and to obtain a census of the escapement into each, there would now be something certain on which to build. But the enterprise would be unnecessarily arduous. The desired results could be more easily achieved by abandoning the Wood River experiment and choosing for the purpose some river like the Chignik or the Karluk, where all the spawning fish of a given fishing district enter a lake or lakes through a single channel. But the Wood River census has not given us with any certainty the number of spawning fish which are necessary to maintain the Nushagak run, nor is the number known even approximately.

Marsh and Cobb have stated that although the census figures may not have absolute value, they can safely be used for purposes of comparison between one year and another. If this were true, we could still use them for purposes of prediction, as discussed in a preceding paragraph. If the total escapement from the Nushagak fishing grounds was always, year after year, the Wood River escape multiplied by a constant factor, the Wood River figures would be just as valuable for purposes of prediction as though we knew what the factor in question was. If the Wood River escape in a given year were half that of the previous year, we could then be assured that the entire escape for the district was half that of the previous year. But unfortunately, even for this purpose, the figures are unreliable. No constant factor can be assumed. Such assumption would register belief that the runs to the four rivers would in different years always vary in the same direction and to the same amount.

The mere statement of the case disproves it. Even the tributaries of one river vary widely year by year in the proportion of the total run which enters each of them. If this be true of the tributaries of a single river, how much more probable of four separate rivers, which join only at their mouths. It is certain that they would vary independently and that the oscillation might be of large dimensions. Due to manner of fishing, one of these rivers might experience a progressive reduction of its run that was not felt by the others. Prior to 1908, the Wood River fish ran the same gantlet in the outer bay as did those bound for the other rivers, and in addition were subjected to further reduction by traps and gill nets operating the entire length of Wood River. The main Nushagak and the Snake Rivers, at least, were wholly free from this further drain; their proportion of escape was demonstrably higher, and their runs should have fared better. In this complicated case, then, not only the natural oscillations in the runs to the different rivers, which might be at any given time in opposite directions, but also the possibility of progressive changes in the run of any of them, due to its different history must be contended with. If the Wood River run should for a term of years diminish relatively to the others, its escapement would diminish relatively to the escapement to the other three streams.

For these reasons, there has not been an attempt to establish a relation between the size of the Wood River escapements and the size of the resulting runs of salmon to the Nushagak with any high degree of expectation. There are too many unknown factors entering into the equation. Only on the assumption that the Wood River run so far overshadows the sum of all the others that the latter may be considered negligible, is the expectation warranted that close positive results can be achieved.

It is noted at the outset that the recorded escapement from 1908 to 1912 showed an alarming progressive decrease both in actual numbers of fish and in percentage of escape, but the five-year period that follows gives scant evidence of correspondingly decreased runs. It is also noted that the largest escapement by far—that of 1908—was responsible for the four-year fish of 1912, and the latter was one of the very poorest runs within the 10-year period under investigation. The 1908 spawning escape was recorded as 1,600,000 fish. The year 1912 had the very low record of 325,000 to reach the spawning beds, yet it produced the five-year contingent of the run of 1917, which furnished the largest run of any year since 1908. These are glaring failures, and indicate clearly enough that no such close relation exists between spawning escape on Wood River and the Nushagak run as will warrant predictions regarding the latter.

But if search is made for correspondences, which have a high degree of probability in their favor, such can be found. The years 1911 and 1912 were jointly responsible for 1916, when the total recorded run was the next to the smallest during the period of 10 years. The escapes both in 1911 and in 1912 were far below the average; in fact, with one exception they were the two poorest recorded escapes in the 10-year period. Whatever may be thought of the higher escapes, it looks as though the 325,000 of 1912 and the 354,000 of 1911 were sufficiently below an acceptable minimum to make a decided impression on the total run to Nushagak Bay. The possibility of a chance coincidence can not be eliminated here, and there is no similar case with which to check up. No other instance is recorded in the series

in which two exceptionally undersized escapements were in sequence, so that one would produce the four-year fish and the other the five-year fish of a later run.

The smallest escapement of the series was in 1915, when only 259,000 fish passed the Wood River weir. These furnished the four-year fish for 1919, the worst of all years on the Nushagak. Unfortunately, there is no record of 1914, the source of the five-year fish for 1919, so it can not be told whether two very small escapements again cooperated.

One other instance is worthy of attention. There is no record of the escapement in 1907, which was the year before the series began, but as the commercial returns of that year were the smallest from 1900, when fishing began on a large scale, to 1919, it is fair to assume that the escape in that year was very small. But 1907 produced the four-year fish for 1911, which was the next smallest year on record, and the five-year fish for 1912, which was the third smallest year. In this connection, the year 1920 on the Nushagak will possess unusual interest as showing how many five-year fish will have been produced by the smallest escapement of the series, that of 1915.

While admitting the possibility in all these cases of the chance association of numbers and giving due weight to that possibility the entire series is impressive as indicating on the whole a causal connection between size of spawning escape and size of resulting run; but the relation seems sometimes modified and sometimes effectually masked by the intervention of the other factors discussed on previous pages.

#### RECOMMENDATIONS FOR BRISTOL BAY.

Reasons have been assigned for the belief that the red-salmon pack in Bristol Bay has reached, where it has not passed, its maximum. It is believed that it is in danger of decline with the present scale of operations continued unchanged, and it seems probable that the present scale will be augmented. It is contended that some of the usual precautions should be taken to provide a larger spawning escape in this district. In no other salmon fisheries, except in certain portions of Alaska, are all effective restrictions removed, and unlimited fishing permitted, without seasonal or weekly close seasons, or protected areas. It is recommended:

1. That the Bureau of Fisheries seek to have the present law amended in such way that no Alaska districts will be relieved from the requirement of a weekly close season of 36 hours, during which no fishing is permitted. Bristol Bay is now one of several specifically exempted regions. No valid reason aside from the desires of the salmon packers can be assigned in any of these cases. All are in need of the protection that would be afforded by this regulation.

2. That all the Bristol Bay rivers be closed to commercial fishing at all points above their mouths, and that the mouths of these streams be determined by the Secretary of Commerce in his discretion, and that suitable marks be erected.

3. That a further attempt be made to enforce the provision that fish should be canned or otherwise preserved within 48 hours after their capture. One of the worst and most wasteful features of the Bristol Bay fisheries is the custom, during heavy runs, of permitting the daily capture of fish far in excess of the capacity of the cannery, with resulting daily accumulation of stale fish. This is done in anticipation of a slackening of the run, which will permit the cannery to catch up with its hoard of fish. But the run sometimes continues

for an unexpected period, and the weather may turn exceptionally warm. Then the staled fish of the accumulated lot must be canned each day, or one or more days' catch must be thrown away. The regulation should be so enforced that not more than one day's surplus shall be on hand at any time. This would remove all dangers from the Bristol Bay pack and would at the same time be a powerful aid to conservation of the fisheries.

#### PORT MOLLER AND HERENDEEN BAY.

These localities could not be visited during the past summer, but one of the authors investigated the source of the runs of red salmon to this region in 1918, and found that contrary to the opinions of some packers the Bear River and the Sandy River produced, during that year at least, all the red salmon there captured. The Bristol Bay run in 1918 was very large, but no part of it skirted close in shore as far to the southward as Port Moller. Whether it ever has done so must now be judged by indirect evidence. For three years in succession, including 1919, yields of red salmon from this district have been very poor. Still, the amount of the decline is not as great as appears from the pack report of the only company which has operated for a term of years in the Bear River region. The Pacific American Fisheries captured about 1,125,000 red salmon off Port Moller in each of the years 1915 and 1916. In 1917 their capture was reduced to about a quarter of a million, and in 1918 it had recovered to half a million. But 1917 is the year in which the three canneries of Herendeen Bay began to compete for the Bear River and Sandy River salmon, which prior to that date had been solely at the disposal of the Pacific American Fisheries. If prior to 1917 the latter company were in fact, as seems probable, capturing a very large percentage of the available fish and if the total escape were very small the advent of the new companies could do little more than subdivide the year's product among the four participants. Making comparison on this basis, it is seen that whereas the catch in 1915 and 1916, by the Pacific American Fisheries was about 1,125,000 fish, in 1917 the combined captures of the four canneries were nearly 800,000 red salmon and in 1918 over 950,000 red salmon.

While the reduction in these years is notable and, in connection with the reduced pack which has followed in 1919, gives ground for grave apprehensions concerning the future yields of Bear and Sandy Rivers, it was not unexampled. Fully as great has been the falling off in many other overfished rivers. From this point of view, there is no necessity for assuming in explanation of the occurrences the former participation of any portion of the Bristol Bay run.

From another point of view, such participation becomes improbable. It is alleged to have occurred in 1915 and 1916, two years in succession, and then in subsequent years to have failed to make itself felt at the mouths of these rivers. According to this theory, the stream of Bristol Bay fish moved farther from shore and became inaccessible to this part of the coast on the very year in which new canneries began operations there, and this diversion of the run has continued each year since that time, irrespective of the size of the Bristol Bay run, which was larger in 1917 and in 1918 than in the two preceding years.

Taking all the known facts into consideration, it is believed that the red-salmon captures in the Bear River region have been local fish bound for Bear and for Sandy Rivers and that the reductions

which have undoubtedly occurred in these runs have been the result of previous overfishing.

A partial suspension of the fishing operations in this region is recommended to permit a recovery of the run, but there seems to be no way of enforcing more stringent restrictions under the present law. No fishing is conducted in Bear or in Sandy Rivers, nor within the prescribed distance outside the mouths of these streams. But owing to the favorable configuration of the beaches and offshore slopes, and the considerable stretches of coast off which these fish school up before entering fresh water, the purse seines are very effective. These, with the two traps located at the legal distance either side of the mouth of Bear River, come perilously near effectually blocking the passageway to the river.

This is another instance of the hopeless insufficiency of the present law, which places beyond the jurisdiction of the Secretary of Commerce the salt-water approaches to the mouths of the rivers, however seriously the form of fishing there may menace the salmon supply.

#### IKATAN AND MORZHVOI BAYS.

A brief visit to this district produced certain observations in continuation of those made by one of the authors the preceding season.

No red-salmon stream exists in Ikatan Bay, or in the immediate vicinity, toward which the red salmon captured in that region are headed. The heavy schools which pass near the Ikatan beaches are bound elsewhere and dip into the bay for unknown reasons. Similar movements of migrating salmon are known elsewhere, as for example, considerable numbers of Karluk fish which school off the southern shore of Uyak Bay. At Ikatan their movements may conceivably have some relation to the opening of False Pass into the upper end of Ikatan Bay. False Pass is the only channel east of Unimak Pass, which connects the Pacific with Bering Sea. Tidal currents rush through this pass with great velocity, and a certain admixture of the waters of the two seas undoubtedly occurs. Whether any physical feature is here presented which forms a passing attraction to the migrating fish, can not be stated.

Although the Ikatan fish are bound elsewhere, they are not bound for Bristol Bay, nor is it believed they traverse False Pass in any numbers. They belong to the southern side of the peninsula and find their spawning grounds principally in Morzhovoi Bay and at Thin Point. So, although not spawning in Ikatan waters, they are local communities of fish destined for small streams which are at no great distance. In all cases of this kind, care must be exercised not to overfish the district and exhaust the runs. The danger of doing this is always magnified when local conditions render the schools of salmon particularly susceptible to attack. In many districts, the spawning runs first become evident when they school immediately off the mouth of the river. If fishing conditions are there unfavorable the percentage of escape will probably be large. But the Morzhovoi and Thin Point fish, which school up off Ikatan, pass before long beaches in which traps can be driven, and in waters where the purse seines are effective. They sustain a double attack, either of which is of great magnitude. Here again, it seems impossible adequately to protect an important school of fish, because no authority to restrict fishing along the salt-water channels has been conferred on the Secretary of Commerce. Yet it is believed possible wholly to

destroy this run for commercial uses by continuing the policy of unrestricted competition which now exists. A third cannery has recently been constructed to draw on this run and is planning an increase in its operations. And three other canneries, situated unfortunately where adequate supplies were locally not available, have sent fleets of purse-seine boats to Ikatan. It is believed the district can not sustain fishing on such a scale, but it is not possible, under the existing law, to devise a remedy.

#### KARLUK RIVER AND LAKE.

An examination of Karluk Lake and River was made July 25 and 26, the observers walking across the trail from the head of Larsen Bay to a point on the Karluk River, proceeding thence by boat and on foot to the lake. After inspection of all the spawning beds along the lower half of the main lake, the river was descended to its mouth, by boat. It was regretted that time did not permit an examination of the upper half of the main lake and of the smaller lake and its tributaries.

On the way up river from the portage to the lake but few salmon were seen, but at the narrowed lower end of the lake, immediately above the outlet, a large school of salmon was found, consisting of fish that were not yet completely ripe and ready for spawning. These fish were lying relatively still, unless disturbed, when they would rush off in a body, with a great roar of breaking water. It was estimated that there were between 2,000 and 3,000 fish in this school.

Passing along the western shore of the lake, scattered salmon were found, and schools of no great size were about the mouths of all the small creeks that dash down the abrupt slopes on that side of the lake. Salmon were trying to ascend all these small streams, making frantic efforts to pass up through the broken water which forms a series of waterfalls and rapids among great rocks and coarse boulders. These streams seemed wholly unfitted for spawning. They were short, violently rapid wherever seen, and appeared to be without quiet gravelly reaches where spawning could be successfully accomplished. The shallower portions of the lake, in depths where fish frequently spawn, were on the west side also for the most part totally unsuited for spawning. The bottom was thickly covered with coarse cobblestones and boulders, without finer materials in which nests could be excavated. Here and there were gravelly or sandy beaches of small extent, but none of those on the west side of the lake gave evidence of being extensively used by the salmon.

Crossing to the eastern shore, there were found larger and longer streams, rapid brawling creeks, with coarse bowldery beds, but far more practicable than the creeks of the west side. As the mouths of the streams were approached, dead salmon that had drifted out after spawning lay thick on the bottom of the lake, and upon wading up the rough beds of the creeks, dead salmon were found lying everywhere, lodged among the bowlders or stranded on the shallows. Spawning, however, was vigorously in progress. The creeks were fairly beset with living fish seeking to spawn among their dead comrades, while off the mouths were small schools, from which a constant series of recruits passed up the rocky incline to take the place of those exhausted and dying. No gravel bars or quiet reaches were seen, and while these streams were the least unfavorable of those observed entering the lower half of the lake, it seemed incredible that any large

number of salmon could successfully conceal their eggs in the narrow sand intervals between the rocks. As a matter of fact, loose eggs were seen passing down the current to the lake.

The eastern shore of the lake in its lower portion has long stretches of sandy and gravelly beaches, which seem well suited to serve as spawning beds, so far as the nature of the sediment was concerned. But the salmon did not congregate along this shore except at the entrance of larger or smaller creeks, and there was no evidence that these beach gravels were availed of to any considerable extent.

One of the lowest streams to enter on the eastern or right shore of the lake had a very different character from the others. It was a short stream, apparently not more than a mile in total length, and was spring-fed. Near the upper end it expanded to cover a basin which contained several acres, and at that time was 2 or 3 feet deep. Below this so-called lake, the channel was gently inclined, with a series of pools connected by gently-flowing stretches. Near the mouth the slope became steeper, but the stream was never turbulent.

This creek has certain characteristics that on cursory examination seem to fit it for hatchery purposes. Natives affirmed that it does not freeze in winter, being unlike all the other creeks in this respect. It contained but few spawning salmon, however, fewer than any other stream examined, a circumstance that can not be accounted for, unless possibly the temperature of the spring-fed stream was lower than is found in the other tributaries of the lake.

The salmon seen near the outlet of the lake, those around the shores, and those living, dead, and dying in and about the streams, are estimated at 5,000 or 6,000. It is impossible to give any opinion as to the adequacy of the escape to the lake during the present season.

On the way down the river, especially in the very rapid portion below the point where the trail makes off to Larsen Bay, many fresh-run red salmon were seen working their way up against the current, or resting under the lee of the coarse boulders, which almost everywhere form the bottom of this portion of the river. There were no eddies of consequence along the banks, and the salmon were distributed throughout the width of the river. It was impossible to form any estimate of the numbers present, but there must have been many hundreds of them in the river.

The writers were impressed with the unfavorable nature of the grounds examined, by their small extent, and by the unbroken succession of spawning fish which continue to occupy these small creeks during the long season. Enormous waste of eggs must accompany this condition, and as the test of the efficiency of any hatchery lies in its advantage over natural propagation, under the local conditions in which it operates, it is believed that a red-salmon hatchery on Karluk Lake would operate to the very material advantage of the salmon run.

It is recommended that a thorough survey be made of the lake and river during the fishing season of 1920 by a party of two, one member being a practical hatchery man and the other a scientist. A survey should be made of a transportation route from Larsen Bay to the lake, a hatchery site should be selected with full knowledge of the conditions throughout the year, and the distribution of the salmon should be studied throughout the lake spawning beds. As accurate a census as possible should be made of the spawning fish.

# FISHERY INDUSTRIES OF THE UNITED STATES

REPORT OF THE DIVISION OF STATISTICS AND METHODS  
OF THE FISHERIES FOR 1919

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By LEWIS RADCLIFFE

*Assistant in Charge*

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Appendix X to the Report of the U. S. Commissioner of Fisheries for 1919

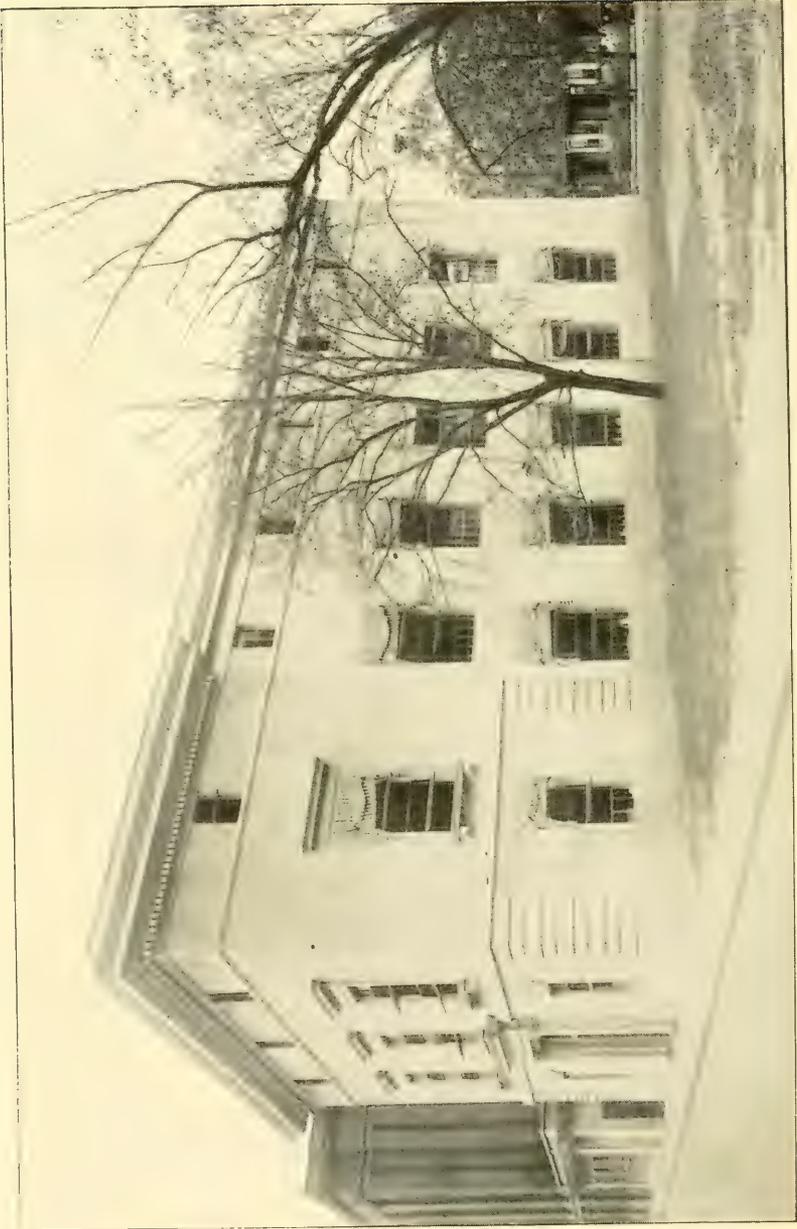


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FISHERY PRODUCTS LABORATORY, WASHINGTON, D. C.

# FISHERY INDUSTRIES OF THE UNITED STATES.

## REPORT OF THE DIVISION OF STATISTICS AND METHODS OF THE FISHERIES FOR 1919.

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By LEWIS RADCLIFFE, *Assistant in Charge.*

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### INTRODUCTION.

On the basis of canvasses of the fisheries made in the last decade, the present annual production of fishery products in the United States, including Alaska, is estimated to be about two and one-half billion pounds, valued at approximately 80 million dollars to the fishermen,<sup>1</sup> an industry employing more than 200,000 persons. For the fiscal year ended June 30, 1918, the value of the imports of fishery products was \$26,268,014 and of exports, \$57,017,427.

Among the important functions of the Division of Statistics and Methods of the Fisheries of the Bureau of Fisheries in its relations with the commercial fisheries are the following: (1) Studies of the methods of conducting fishing operations for the purpose of effecting improvements and revealing the use of unnecessarily destructive or unprofitable methods; (2) the development of improvements in the methods of handling, distribution, and marketing of fishery products; (3) technological investigations of the underlying scientific principles governing the preservation of fishery products in order to standardize methods and effect improvements and economy of operation, to determine feasibility of preserving fishery products by untried methods, and to discourage the use of unsatisfactory, wasteful, or uneconomical practices; (4) to introduce useful foreign methods or processes of capture, preservation, and utilization of fishery products; (5) to develop the use of the by-products of the fisheries and the unutilized products of the sea to the greatest economic advantage; (6) to increase the demand for the little used or neglected fishes and fishery products for food; (7) to collect the statistics of the fisheries and fishery industries; (8) to study the vessels and boats employed, for the purpose of effecting improvements; (9) to study and develop fishing grounds and fisheries for hitherto unutilized fishes; and (10) to disseminate information bearing on the commercial fisheries. For the conduct of its work in these fields during the fiscal year beginning July 1, 1919, Congress appropriated \$15,000.

### SUMMARY OF OPERATIONS.

During the year the Bureau has aided in the development of fisheries for black drum, sharks, and porpoises and in increasing the

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<sup>1</sup> The value of Alaska's fishery products in 1918 as prepared for market was \$59,154,859, but the estimated value of the fish to the fishermen was only about \$11,000,000, which is the amount included in the estimate given above.

use of black drum, grouper, mussels, red drum, whale meat, and other neglected fishery products for food. By means of practical demonstrations and lectures, many persons have been more fully acquainted with the dietetic qualities of fish, have been encouraged to use this wholesome food in larger quantities, and have been shown that certain of their prejudices against its use were without foundation.

Efforts to increase the use of the by-products of the fisheries to the most economical advantage have been continued. The more extended use of fish and shrimp waste, its manufacture into fish meal as an animal feed, the use of the hides of sharks, porpoises, and other unutilized aquatic animals for leather, the drying of shark fins for the oriental trade, and the like have been encouraged. Analyses have been made of the liver oils of several species of sharks, of tuna oil, etc., to determine more definitely their individual properties and the uses to which they appear best suited.

The construction of the Fishery Products Laboratory in Washington, begun in December, 1918, was completed the following June, and the equipment of it is practically complete. Various important investigations have been inaugurated, such as a technological study of the methods of salting fish, experiments in the recovery of old salt and brine for reuse, a preliminary examination of some of the features of foreign methods of freezing fish in brine, development of possible methods for the production of essence d'Orient from the scales of native fishes, and some preliminary tests of the practicability of putting noncommercial sponges to commercial uses. At its experimental laboratory at San Pedro, Calif., methods of canning the Pacific coast mackerel have been developed, considerable attention has been given to canning other local fish, such as barracuda, bonito, and rockfishes, and the fishing industry of that coast has been given all possible assistance.

Detailed statistics of the vessel fisheries centering at Boston and Gloucester, Mass., Portland, Me., and Seattle, Wash., have been collected and the results published in the form of monthly and annual bulletins for trade use. A statistical canvass of the coastal fisheries of the South Atlantic and Gulf States for the calendar year 1918 was begun early in 1919 and nearly completed by the end of the year. In addition, canvasses of the shad fishery of the Hudson River for 1919 and of the shad and river herring fishery of the Potomac River, also for 1919, have been made. With the exception of the coastal fisheries of the South Atlantic States, the present report contains the results of these canvasses, together with the detailed tables of the canvass of the fisheries of the Great Lakes for the calendar year 1917 and the fishery products received at the Municipal Fish Wharf and Market, Washington, D. C., for 1919. Statistics of Alaska fisheries are collected annually and published in the Bureau's annual report on Alaska Fisheries and Fur Industries.

The inadequacy of the present personnel for this division's part of the Bureau's work has called for the maximum of service from its members to complete the program outlined above. This has been given loyally at a time when higher compensation and much more adequate returns for their labor could have been obtained elsewhere.

### AID IN DEVELOPMENT OF FISHERY FOR BLACK DRUM.

The black drum (*Pogonias cromis*) is a predacious fish, very destructive of oysters, particularly on cultivated beds, where the oysters occur singly and may the more readily be seized and crushed. This species is quite common on the South Atlantic and Gulf coasts, migrating northward along the coasts of the Middle Atlantic States in summer. It not uncommonly reaches a weight of 60 pounds or more. Complete data as to the movements of the fish and the possibility of establishing a regular fishery have been lacking, and the demand for the fresh fish has been insufficient to care for the catch. In fact, the fishermen frequently avoid taking it in their nets. An examination of samples of canned black drum indicates that it is excellent for this purpose, resembling the meat of poultry.

Wishing to provide persons interested in the development of the fishery with more detailed information as to localities in which the fish might be taken in commercial quantities and as to seasons of abundance, an assistant was detailed to visit the principal fishing centers on the Gulf coast. On the Florida coast south of Tampa the black drum is reported to be plentiful for about four months of the year, beginning with April, and at Cedar Keys, throughout the year, being taken principally in Withlacoochee Bay, on Port English, and Waccassassee and Suwanee Bars. Cedar Keys would, therefore, appear to be the most promising point on the Florida coast for a fishery. To the westward conditions are less favorable, the fish being very scarce at Pensacola. At Mobile, Ala., the fish is said to be plentiful throughout the year, but up to the present season there had been no demand for it. At Biloxi and Gulfport, Miss., it is scarce; in Louisiana waters some are taken throughout the year, but no large schools are observed. At Galveston, Tex., a few are taken in all months. Corpus Christi supports a fishery, but the demand has lately fallen off as a result of publicity wrongly intimating that the fish were unfit for food. At Point Isabel about 70 per cent of all fish taken are reported to be drum. These are taken throughout the year with pocket nets; that is, drag seines provided with pockets. The seines are 300 to 500 feet long of No. 24 cotton twine, 1 $\frac{3}{4}$ -inch bar mesh. Point Isabel appears, therefore, to be the most promising place on the Gulf for a fishery. Fish from this point and from Mexico are re-iced and shipped to market from Brownsville, Tex., the fishermen receiving about 2 cents per pound for the catch.

### INCREASING THE USE OF FISH AS FOOD.

#### DEMONSTRATIONS IN FISH COOKERY.

In previous reports attention has been called to the practical demonstrations and lectures in fish cookery initiated by the Bureau in May, 1918. These were intended to extend the use of cheaper, more abundant species in each locality, to introduce appetizing, inexpensive methods of cooking fish while conserving labor and eliminating the use of expensive cooking fats and oils, and to encourage the use for food of parts of the fish usually discarded. At the beginning of 1919, the holdings of fish in the cold storages of the country were about double normal, with the result of imminent danger that large quantities of these fish saved during the war period would have

to be destroyed for lack of markets. On this account demonstrations on the west coast were brought to a close in January, 1919, and the demonstrators detailed to the middle west, giving a series of demonstrations in St. Louis, Chicago, Minneapolis, St. Paul, Cincinnati, and Cleveland. At these meetings special attention was directed to the value of frozen fish for food, particularly to the little-known varieties with whose merits the average housewife was unacquainted.

A successful series of demonstrations was later given in Boston and Cambridge, Mass. To enable local agents of the States Relations Service of the Department of Agriculture to profit from training in this field and extend its benefits to their respective communities, one of the Bureau's assistants gave demonstrations in Key West, Miami, West Palm Beach, Titusville, and St. Augustine, Fla.; in Savannah, and Valdosta, Ga.; at the Agricultural and Mechanical College of Mississippi; and before a gathering of State agents in Washington, D. C.

It is the consensus of opinion, as attested to verbally and by letter by those attending the demonstrations, that the housewives are very grateful to their Government for its interest in their problems of providing wholesome protein food at low cost. The value to the trade, as evidenced by reports of increased demand for fish in places in which demonstrations have been given, is well vouched for. During the year in which this work was conducted more than 125 demonstrations were held, by means of which approximately 15,000 persons were reached directly and many more indirectly.

In reviewing the work, consideration should be given to the fact that protein is the high-priced element of food; that fish compares favorably in protein content and digestibility with meats; that our estimated annual per capita consumption of meat is more than 160 pounds, while that of fish is only about 18 pounds; and that our fisheries annually yield millions of pounds of food fishes which are not so marketed, due in large part to lack of demand by the consuming public. Although the value of these demonstrations has been attested by the consumers, home demonstration agents, the trade, and others, and although the Bureau has been urgently requested to continue this work, it was compelled to abandon it in June for lack of funds.

In addition to the practical demonstrations in the field, experiments have been made to determine the best methods of preparing various fishery products for the table. This has been confined largely to products with which the housewife was little acquainted. Such information has been supplied directly to the trade or used in the preparation of economic circulars. A cookbook on fishery products has been prepared, but will be broadened in scope before it is published.

#### GROUPERS.

The groupers occur in abundance on the east coast of Florida and on the snapper banks in the Gulf of Mexico, where they outnumber the more highly prized red snappers. Until quite recently the snapper fishermen were required to limit their catch of grouper to from 10 to 25 per cent of the fare because of lack of demand. Gradually this percentage was increased until during the war period, when the number of vessels operating and men engaged were considerably reduced,

the demand equaled or exceeded the catch. With the return of men and vessels to the fishery, production again exceeded demand.

With the object of preventing needless waste of these fish and increasing efficiency of operations with reduction in cost of product to the consumer, the Bureau undertook to develop larger markets which would absorb the entire catch. For this purpose it issued an illustrated placard recommending these firm, white-meated fish and an economic circular containing recipes for preparing them for the table, and detailed an assistant to aid in encouraging the use of these fish in cities in the South. In this campaign particular attention was given to encouraging dealers to handle the groupers, to instructing them in the best methods of preparing the fish for sale, and to increasing their use by restaurants and cafés. Groupers are usually shipped headed and gutted. For sale to the consumer it appears desirable to skin the fish and remove the fins. They are then suitable for filleting. These operations, as described in Economic Circular No. 44, follow:

Lay the fish on its side, with the head end pointing toward you and the back toward the knife hand (the hand with which the operator uses the knife). Insert the knife to a depth of 1 to 1½ inches behind the end of the back fin and draw the length of the fish, cutting close to the fin, thus severing the skin and the flesh from tail to head.

Turn the fish end for end, laying it on its other side, and repeat as above, drawing the knife along the length of the fin from the head to the tail. Using a piece of burlap to prevent the hand slipping, or a pair of pliers, catch the back fin at the front end and pull it out.

Turn the fish, tail pointing from you and the belly toward the knife hand. Grasp the pectoral fin, the fin just back of the gills, in the free hand and thrust the knife into the fish just back of it and cut both ways. The collar bone, which is thus cut loose, is removed by pulling on the fin. The small, thin bone remaining, which connects the hide and meat, is removed with a stroke of the knife. Repeat the operation on the other side.

Turn the fish, tail pointing toward you and the belly toward the knife hand. Complete the splitting of the fish, and remove the belly fins. With pliers or a piece of burlap catch the corner of the hide at the head end nearest the back and strip off by pulling toward the tail. Repeat the process for the other side and complete the removal of the skin and tail by a stroke of the cleaver at the base of the tail fin.

It appears that the results which the Bureau expected to accomplish have in a measure been negated by other factors, such as labor difficulties.

#### INCREASING THE USE OF BY-PRODUCTS OF THE FISHERIES.

The development of uses for the by-products of the fisheries and the unutilized products of the sea to the greatest economic advantage represents one of the most promising fields for research and for increasing the Nation's resources open to the Bureau. Although handicapped through lack of provision for the permanent employment of an adequately trained technologist and for funds, it has continued its efforts in this field in so far as its limited facilities will permit and has achieved results cited in the following pages which indicate the importance of the work and the possibilities of saving fishery products possessing a value many times the cost of the service. Among its activities mention should be made of the results of its efforts to increase the use of fish waste and waste fish for conversion into oil and scrap for fertilizer, to encourage the production of fish and shrimp meal as an animal feed, the use of the hides of fishes and other unutilized aquatic animals for leather, the development of a fishery for sharks, and the reestablishment of fisheries for porpoises, sea lions, hair seals, and other unutilized aquatic animals.

## FISH OILS.

The demands and uses for fish oils are increasing and the prices are unusually high. Among the various uses are the following: Drying oil in paints and varnishes, stuffing grease for leather, in soap-making, lubricating compounds, tempering steel, screw-cutting, and cordage manufacture, for medicinal and illuminating purposes, in the manufacture of rubber substitutes, top dressings for automobile tops, awnings, tents, and the like, in lard substitutes, etc., after hydrogenation.

In recent years the annual production of fish oils has ranged from about 5 to 6 million gallons. Of this, more than half is menhaden oil, whale, sperm, and herring oil being produced in appreciable quantities with smaller amounts of other oils, such as cod liver, shark liver (including dogfish), salmon, tuna, sardine, porpoise blubber and jaw oils, seal, and walrus. Imports entered for consumption for the fiscal year ended June 30, 1918, amounted to 4,881,982 gallons, valued at \$3,638,749, and exports in that year were 455,629 gallons, valued at \$446,589.

Realizing the importance of determining more definitely the special properties of those oils for which such information was lacking, to indicate the uses to which they are best suited, the Bureau has made analyses of the body and liver oils of species of sharks, of skate-liver oil, tuna and yellowtail oil, and has furnished the educational bureau of the Paint Manufacturers' Association of the United States various samples of fish oils for analysis and trial as to suitability for use in the manufacture of paints and varnishes.

Albacore or tuna (*Germa alalunga*) oil is particularly interesting because of its excellent drying qualities. It possesses very little unsaponifiable matter and little odor and is pale in color. Drying tests made by the director of the educational bureau of the Paint Manufacturers' Association of the United States showed that it dries even more rapidly than linseed oil. The 1919 production of albacore (*Germa alalunga*), yellowfin tuna (*G. macropterus*), and bluefin tuna (*Thunnus thynnus*) oil in southern California is estimated to exceed 100,000 gallons. An analysis of the albacore oil gave the following results: Specific gravity at 15.5° C., 0.9298; acid value, 0.24; saponification value, 195.9; iodine value (Hanus), 184; refractive index (40° C.), 1.4755; titer test of fatty acids in degrees centigrade, 20.8°; neutralization value of fatty acids, 182.5; mean molecular weight of fatty acids, 307; total unsaponifiable matter 0.80 per cent. Tests with the oil of the yellowtail (*Seriola dorsalis*) indicated that it was fully as satisfactory for the manufacture of paints as menhaden oil, but not as good as the albacore oil. Its color was light and its odor not strong.

There is need for more exhaustive investigations of fish oils, for determining definitely the qualities of the oils of various species of sharks, skates, and other fishes serving as sources of supply of fish oils; for determining more definitely the possibilities of hydrogenating fish oils for use for edible purposes, their nutritive values based on investigations by experts in vitamins, etc. On the subject of hydrogenation, Bulletin No. 769 of the United States Department of Agriculture, February 10, 1919, page 39, states:

Recently a refining process in which hydrogen instead of steam is used to blow the oil has been developed. It appears that it is now possible to remove the disagreeable

odor and flavor from some kinds of fish oils and render them suitable for food. For several years whale and possibly some fish oils have been hardened by hydrogenation in Norway and Germany, and within the last six months a lard substitute made in this way from Pacific coast herring has appeared on the American market.

Before the war whale oil was being hydrogenated in Norway, the Netherlands, and Germany, and a plant is now in operation in England capable of caring for all whale oil likely to arrive. The hardened fat is white, odorless, and tasteless. It is used as a substitute for tallow and the best quality for margarine.

#### FISH SCRAP.

The annual production of scrap for fertilizer will approximate 60,000 tons. In 1918, on the basis of available data, the production of menhaden scrap amounted to nearly 50,000 tons, that of sardine, salmon, tuna, etc., on the west coast, including Alaska, to more than 2,300 tons (exclusive of fish meal), and that of the Alaska whale fishery to 850 tons. Additional material is produced in New England, especially in connection with the fishery for sardines and herring; in the States bordering on the Gulf of Mexico, principally from shrimp waste; on the Great Lakes, etc. The use of sardines for conversion into oil and scrap or meal on the coast of southern California appears to be on the increase, over 33 million pounds having been reported so used in 1919. It is reported that a ton of sardines will yield up to 25 gallons of oil and 500 pounds of meal or scrap.

Persons in the fisheries have been encouraged to save their fish waste and have been furnished information regarding methods and machinery. To care for the comparatively small quantities of waste, there appears to be need for an efficient and inexpensive plant—one that is capable of reducing the oil content of the scrap to a low percentage.

#### FISH MEAL.

To meet the increasing demand for protein feeds for hogs, cattle, and poultry, the Bureau has continued to urge upon the manufacturers employing fish waste the importance of using such of their products as are suitable for manufacture into fish meal. As the menhaden industry affords the greatest prospective source of supply, particular attention has been given to this field. The shrimp fishery of the south Atlantic and Gulf States is another promising field, in which until recently not more than 50 per cent of the waste has been used. One of the Bureau's assistants who visited this field during the year estimates that this industry is capable of yielding from 7,500 to 10,000 tons of raw waste, equivalent to from 1,500 to 2,000 tons of scrap or meal per annum. At the time of his visit, this waste was not being utilized in the Apalachicola and Fernandina (Fla.) districts, nor in the St. Marys and Brunswick (Ga.) section, districts which should supply about three-eighths of available material. The bulk of that now saved is in the Baratavia Bay district, the center of the shrimp-drying industry, in which the shrimp are sun-dried on large wooden platforms. The heads and shells are a by-product. It is believed that the successful solution of the problem will require the use of rotary driers, and at least three companies made provision during the year for the saving of this material.

Samples of shrimp meal analyzed contain from 43 to 56 per cent protein. Following is an analysis of one sample:

	Per cent.
Moisture.....	5.03
Ash.....	29.89
Fat (ether extract).....	3.62
Protein.....	47.44
Undetermined.....	15.02

The Bureau of Animal Industry of the United States Department of Agriculture has cooperated very effectively with the Bureau in this field in the conduct of feeding experiments with fish and shrimp meals to hogs and in directing the attention of hog growers to the value of these products as feeds, thus rendering material aid in assuring those in the fisheries of a market for their product. In an experiment of the Bureau of Animal Industry, conducted at the Government Experiment Station, Beltsville, Md., in which two lots of 15 pigs were fed fish meal and shrimp meal for a period of 91 days, the results indicated that shrimp meal was fully the equal of fish meal. It is believed that elements other than the proteins, such as the mineral elements, vitamins, etc., tend to enhance the value of this material.

Grayfish meal has been furnished the Bureau of Animal Industry for a feeding test, the results of which were comparable to those obtained by feeding with menhaden meal. Although the grayfish meal contained a high percentage of oil, no flavor of fish could be detected in the flesh of the hogs killed at the end of the feeding experiment. Arrangements are being made for additional feeding tests to ascertain more definitely the safety with which meals containing a high oil content or made from decomposed materials may be used.

The American consul at Odense reports that in Denmark a shellfish meal made from the blue mussels which are found in large numbers along the Danish coast is now on the market in that country as a poultry feed and has proved very satisfactory for increasing egg production. An analysis of the dried meal made at an agricultural experiment station quoted from Commerce Report No. 32, February 7, 1919, follows:

Lime (in the form of ashes), 71.41 per cent; sugar, starch, and other organic matter, 13.21 per cent; nitrogenous matter, 11.64 per cent; fats, 1.68 per cent; and water, 2.06 per cent.

Comparatively little fish meal was produced in this country prior to 1914. Beginning with that year the production on the west coast has steadily increased, the 1918 production of the coastal States and Alaska being about 8,684 tons. An assistant who visited the principal centers of production in southern California during the year reports no differences in character of material or process of manufacture of meal or scrap except in a few instances in which the ground scrap is called meal. Until more detailed information is available regarding the results of feeding fish meal it is believed that only fresh waste should be used in its manufacture and badly decomposed waste made into scrap for fertilizer. Some kinds of meal do not require grinding. This is stated to be the case for meal made from sardines in which the steam, or so-called batch, drier is used. If a hot-air drier is employed, grinding may be necessary to reduce the material

to the proper degree of fineness and to break up any small, sharp-pointed bones or spines. This was found necessary for menhaden meal. The most practical type of grinder for breaking up such bones appears to be the swing-hammer type, in which swinging hammers revolving at about from 2,500 to 3,000 revolutions per minute knock the material against a screen.

As evidence of the results of the Bureau's efforts, it may be added that in the menhaden and shrimp industries about 2,500 tons of meal were produced in 1919 and no difficulties in marketing it at reasonable prices reported. It is believed that the present annual production of meal from fishery products approximating 10,000 tons may be doubled without difficulty and with improvements which will keep menhaden fresh until they reach the factory at least trebled. It may be noted that a classification for fish meal is in effect in the three classification territories of the railway companies, and class rates on this commodity between given points are obtainable by application to the proper railroad officials.

#### FISH LEATHER.

The work of the Bureau in encouraging the development of a fish-leather industry has resulted in important progress in this field. The tanning of the hides of sharks and rays into leather which is soft and pliable and of ample strength for many uses is now an established fact, and keen interest is being shown in the development of fisheries for these forms to make available regular supplies of basic materials in quantity production. The use of the hides of porpoises, whales, sea lions, and other unutilized aquatic animals is also increasing. One tannery is now devoted to the production of fish leather, a second is in course of construction, and others are preparing to engage in the industry.

#### SHARK FINS.

The Bureau has been instrumental in the saving and drying of shark fins, which are a delicacy highly prized by orientals. In one city in this country the demand now exceeds the supply, the best grades commanding from 65 to 75 cents per pound.

The trade is furnished with descriptive matter for the preparation of the various by-products, oils, scrap, meal, hides for the tanner, and fins, and with information as to where the various commodities may be marketed.

#### TECHNOLOGICAL INVESTIGATIONS.

In the 1918 report attention was called to the construction and equipment of a Fishery Products Laboratory in Washington for the conduct of technological investigations in the fisheries. Although its activities have been greatly restricted by the limited personnel and provision for the work, the results achieved in the investigations regarding the salting of fish, the studies of fish oils, recovery of used brine and salt, preliminary studies of the production of essence d'Orient from fish scales, and the different methods of refrigeration, the direction of the investigations in the canning of fish in southern California, and provision for the proper handling of minor problems, have emphasized the need for the conduct of such work on a larger

scale. The sundry civil appropriation act of July 19, 1919, contains provision for an additional assistant for the Fishery Products Laboratory, but in the examination held before the end of the calendar year no applicant qualified.

#### DETERMINATION OF PRINCIPLES OF PRESERVATION OF FISH WITH SALT.

Recent reports have contained reference to the technological investigations on the preservation of fish with salt, initiated for the purpose of determining the basic principles governing this method of preservation, to effect improvements in present practices, and to develop satisfactory methods of salting fish at higher temperatures and therefore in warm climates. The preliminary investigation has been completed and the results published in Bureau of Fisheries Document No. 884, "Some Considerations Concerning the Salting of Fish," by D. K. Tressler. A brief summary of some of the results follows:

On the assumption that the more rapidly salt penetrates the flesh of fish the sooner will decomposition be stopped, the first work aimed to determine the rate of penetration of salts of different qualities into the flesh, the squeteague being used. Small amounts of calcium chloride or magnesium chloride retarded the rate of penetration of pure salt (sodium chloride), but produced a firmer, whiter fish than the pure sodium chloride. Other impurities, such as the sulphates, had a similar though less noticeable effect. In this connection it may be of interest to note that analyses of commercial salts reveal the fact that they vary greatly in purity. Solar salts are of lesser purity than salts prepared by evaporation in open or vacuum pans, and most domestic salts are of greater purity than foreign salts available in large quantities. The purest brands obtainable at reasonable cost contain between 99.5 and 99.75 per cent of sodium chloride.

As the rate of penetration in itself was an insufficient index of the keeping qualities, it was considered essential to provide some means of measuring the amount and rate of decomposition of protein in order to determine the amount of decomposition taking place in the course of salting any lot of fish, and thus test the value of the various methods. Having salted fish with prepared salts containing different amounts of the common impurities (calcium, magnesium, and sulphates), the rate of protein decomposition was estimated by determining the amounts of amino-acid nitrogen formed. In this manner the preservative action of the various salts on the protein of the fish was estimated. Calcium and magnesium salts and sulphates cause an increase in decomposition and therefore produce a less perfect preservation of the fish during salting. This reveals the importance of selecting brands of salt low in these impurities for salting fish in warm climates. For salting at temperatures below 50° F. it is possible to exercise a measure of control in producing fish of the desired quality by the use of salts having a high percentage of calcium and magnesium if a hard, white fish is desired and pure salts if a soft, pliable fish is wanted. The degree of fineness of the salt is considered of little importance save in a physical way.

A comparison was made as to the relative efficiency of the two general methods of salting fish, viz. by the use of dry salt or brine and salt, by determining the rate of penetration of salt into the flesh of fish salted by each method and the rate of protein decomposition. These experiments showed that the salt penetrates more rapidly in the dry-salted fish than in the fish in pickle and that more amino acid was formed by the brine method. The dry-salt method is apparently the more economical of both salt and labor.

In addition, experiments were made to determine the effects of a more thorough cleaning of the fish before salting, the rate of formation of amino-acid nitrogen being used to indicate the rate of protein decomposition. River herring cleaned by various methods were salted at high temperatures. All except those from which all roe or milt and blood had been removed spoiled, the thoroughly cleaned fish being successfully salted at 88° F. From these experiments it was concluded that the chief cause of spoilage during salting is due to the decomposition of the blood remaining in the flesh.

The rate of penetration of salt into skinned fish was found to be about double that in the unskinned fish, thus revealing the importance of splitting fish before salting.

Experiments made in salting fish of various degrees of staleness showed that the length of time a fish may be kept before salting depends upon the temperature to which the fish are subjected before and during the salting period, and that at some temperature between 50 and 60° F., or higher, fish spoil very quickly.

The following are important considerations in the salting of fish in warm climates: All viscera and blood should be removed in cleaning, large fish should be split, the fish salted should be in a fresh condition, no brine should be added, and salts low in calcium should be selected.

At the close of the year plans were being perfected for the practical application on a somewhat larger scale of the results obtained in these small-scale laboratory experiments to determine more definitely the manner in which these results may be applied with profit to the industry. These plans include the salting of river herring at points in Florida where usual practices have previously proved a failure. In addition to the work outlined above, some attention has been given to the chemical changes in the fat content of fish.

#### FREEZING FISH IN BRINE.

Refrigeration as a means of preserving fish promises to play an increasingly more important rôle in the fishing industry. In this connection there exists a feeling that more of our energies hitherto expended in perfecting refrigeration machinery and methods should be applied to effecting improvements in the quality of the product and in educating the consumer to its merits, its care, and preparation. In Europe the process of freezing fish in brine has of late been receiving considerable attention, and the use of the method is increasing. Brief mention of the subject may therefore be of interest to those engaged in the industry in this country.

Fundamentally the process consists of immersing the article to be frozen in a strong brine which has previously been cooled to, or nearly to, the point where mush ice begins to form in the solution. That the freezing temperature of brine is lower than that of water and that the freezing temperature of the brine is lowered as its saturation point is approached is well known. At present there are at least two processes employing the brine method, one known as the Dahl method, originated by Nekolai Dahl at Trondhjem, Norway, and the other the Ottesen method, by A. Ottesen, Thisted, Denmark.

By the Dahl process, the fresh fish are packed in the shipping boxes before being frozen. Cold brine, which has had its temperature lowered, by contact with crushed ice, to a point approaching its freezing point is pumped through the boxes of fish, flowing back through the ice for recooling. By this means the fish are frozen quickly and the boxes may be headed and put in transit at once. The plant consists of (1) a chamber for cracked ice, with compartments so arranged that the brine passes through ice always in a downward direction into a brine compartment; (2) a centrifugal pump which receives the cold brine and discharges it through a delivery hose into the boxes of fish; (3) a freezing platform on which the boxes rest, provided with troughs for conducting the brine back to the ice chambers for recooling.

In the Ottesen plant the fish are placed in perforated, galvanized-iron baskets, which are submerged in the brine, or, if the fish are of large size, they may be suspended in the brine chamber until frozen. In its simplest form the equipment consists of an insulated iron

freezing tank holding the brine and provided with a propeller (or agitator) and guide plates with sluices for circulating the brine, also a carbon-dioxide refrigerating unit; metal baskets for holding the fish in the brine and galvanized-iron ice cans and wash tank complete the equipment.

Among the advantages claimed for the brine-freezing method, mention may be made of the following: (1) Fish can be frozen much more quickly—in one-tenth of the time or less—than in air freezing; (2) brine-frozen fish retain the flavor, appearance, and other qualities of fresh fish; (3) in slow air freezing the tissues are partially broken down through the formation of large ice crystals, while in rapid freezing the ice crystals formed are so small as not to disrupt the muscle fibers; (4) there is no loss of weight in freezing through evaporation; (5) the equipment takes up little space, without the necessity for a special freezing room, and is adaptable for use on fishing vessels; and (6) there is no tendency for the brine to penetrate the fish or for its juices to enter and weaken the brine.

As the Bureau has not conducted exhaustive experiments in the brine freezing of fish it is not prepared to express an opinion with regard to the value of the method or as to its probable place in the industry. The Bureau's Fishery Products Laboratory in Washington is equipped for conducting proper investigations in air and brine freezing to determine the relative merits and defects of the two methods. It is desirous of doing this investigative work as soon as adequate provision can be made therefor.

#### INVESTIGATIONS IN CANNING FISHERY PRODUCTS IN SOUTHERN CALIFORNIA.

For years the Bureau has been impressed with the need for rendering those engaged in the preservation of fish by canning a larger measure of service, work which promised to make larger supplies of wholesome protein food available to the consumer and to reduce the cost of that which was being produced. In the summer of 1918 it concluded to initiate such investigations on the coast of southern California and to equip a small plant for the purpose. The immediate object of the work was to develop suitable methods for canning some of the neglected or little-used fishes occurring in abundance in that region and to aid the packers in solving their problems and difficulties. After a study of the principal fishing centers it was decided to start the work at San Pedro, where suitable quarters for housing the equipment were obtained, the necessary equipment provided, and the work begun about May 1, 1919.

A study of canning methods in commercial practice revealed wide differences in the processes used. For example, it was found that the time period and temperature of retorting varied in the different plants. Some used compressed air in the retort when cooling; others did not. Some employed superheated steam exhaust boxes; others no exhaust at all. In some instances large driers of considerable length, equipped with traveling chain-belt conveyors, high-power fans, and an elaborate air-distribution system, were in operation; in others short driers, making use of high temperatures, were employed. One canner holds his pack for a period for ageing; another ships the goods as soon as they are put up. The practices

have been developed in many cases at heavy cost without a definite understanding of the underlying principles and adequate control of the results. These factors do not make for uniformity of pack and have added materially to the cost of production and therefore to the price of the product to the ultimate consumer. In addition, some species of fishes which were abundant were not being canned for the lack of development of suitable methods. The two major functions of the work were, therefore, to develop new methods and to establish standard methods which will yield standard products.

The Pacific coast mackerel (*Scomber japonicus*) is present in large numbers on the southern California coast, being particularly abundant from June to December, inclusive. The principal fishing centers are Monterey, San Pedro, and San Diego. Because of the lack of demand, little attention has been given to the development of the fishery, considerable quantities of that brought in going to the reduction works. In 1918 the Bureau conducted experiments in salting this fish, which indicated that in color and flavor it was hardly the equal of the usual run of salt mackerel on the market. Because of its abundance, favorable food qualities, and lack of demand for it for food purposes, the laboratory has given more attention to perfecting methods of canning this fish than to any other. More than 80 different packs have been put up for examination and several methods of promise developed. The packers have been interested in the results achieved to such an extent as to urge the release of the better methods. This has been granted with the understanding that final tests have not been completed. The California pack of mackerel in 1919 exceeded 9,000 cases, and the increasing interest and tendency of the packers to handle this fish indicate a much larger pack in the future.

In addition to the experiments with mackerel, bonito, barracuda, pilchard, sea bass, smelt, the tunas, and yellowtail have received attention, and several hundred packs of the various species are being held in storage for examination at fixed intervals. Among the problems needing solution are the development of means for overcoming the unpleasant odor and taste encountered in packs of bonito and the detinning of the cans in packs of such fishes as the barracuda. The work done and the interest shown by the trade seem but to accentuate the need for a continuation of investigations in this field.

#### NEW ENGLAND VESSEL FISHERIES.

The vessel fisheries centering at Boston and Gloucester, Mass., and Portland, Me., were in a prosperous condition during the past year, although the total number of trips and the catch were not so large as in the previous year. The decrease in the number of trips was largest at Gloucester. The products landed at Boston fell off 5.55 per cent in quantity and 28.45 per cent in value, at Gloucester 3.78 per cent in quantity and 29.94 per cent in value, and at Portland less than 1 per cent in quantity and 21.76 per cent in value. The fisheries were affected to some extent, no doubt, by the economic changes following the war period and also by unsettled labor conditions. A strike of the fishermen in July and August resulted in a large falling off in the catch landed by the fishing fleet in those months as com-

pared with that usually landed at that time of year. Statistics of these fisheries have been collected by the local agents and published in monthly bulletins, showing, by species and fishing grounds, the quantities and values of fishery products landed by American and Canadian fishing vessels during the year at these ports. Two annual bulletins have been issued, one showing the catch by months and the other by fishing grounds.

The fishing fleet which landed fish at these ports during the calendar year 1919 numbered 523 sail, steam, and gasoline screw vessels, including 25 American and 2 Canadian steam trawlers. These vessels landed at Boston 2,754 trips, aggregating 103,391,370 pounds of fish, valued at \$4,713,350; at Gloucester, 2,965 trips, aggregating 71,370,957 pounds, valued at \$2,145,592; and at Portland, 2,550 trips, aggregating 21,718,943 pounds, valued at \$689,441. The total for the three ports amounted to 8,269 trips, aggregating 196,481,270 pounds of fresh and salted fish, having a value to the fishermen of \$7,548,383. This total includes 39 trips, 26 at Boston and 13 at Portland, landed by 9 Canadian fishing vessels, amounting to 3,296,147 pounds of fresh fish, valued at \$106,261. Of this quantity 1,191,845 pounds, valued at \$53,653, were landed at Boston, and 2,104,302 pounds, valued at \$52,608, at Portland. There was a decrease of 12 vessels, 21 trips, and 2,306,602 pounds in the quantity and \$112,364 in the value of the products as compared with the previous year. These fish were landed in accordance with an arrangement with the Canadian Government as an emergency war measure granting reciprocal privileges to fishing vessels, by which Canadian fishing vessels were permitted to land their fares at American ports direct from the fishing grounds. Canadian fishing vessels began to utilize this privilege in April, 1918, and the arrangement is still in operation.

During the year 1919, 24 American fishing vessels landed 29 trips, amounting to 434,486 pounds of fish, at Canadian ports on the Atlantic coast, of which 8 trips by 8 vessels, amounting to 312,036 pounds, were landed at Halifax, Nova Scotia; and 173 American fishing vessels landed 915 trips, amounting to 12,258,522 pounds at Canadian ports on the Pacific coast, of which 889 trips by 154 vessels, amounting to 10,804,522 pounds, were landed at Prince Rupert, British Columbia.

Compared with the previous year, there was a decrease of 481 trips, or 5.49 per cent, in the total number landed by the fishing fleet at Boston, Gloucester, and Portland, and of 9,019,883 pounds, or 4.38 per cent, in the quantity, and \$2,983,165, or 28.32 per cent, in the value of the fish landed. The only important species showing an increase in catch over that of the previous year were haddock and halibut. The catch of haddock increased 16,044,644 pounds, or 24.06 per cent, in quantity, but decreased \$405,338, or 12.66 per cent, in value, while the catch of halibut increased 333,657 pounds, or 18.73 per cent, in quantity and \$84,911, or 28.09 per cent, in value. The cod catch decreased 6,450,007 pounds, or 8.98 per cent, in quantity and \$1,034,024, or 28.58 per cent, in value; hake, 941,353 pounds, or 17.82 per cent, in quantity and \$92,032, or 33.70 per cent, in value; pollock, 7,808,653 pounds, or 29.39 per cent, in quantity and \$581,570, or 60.44 per cent, in value; cusk, 595,062 pounds, or 22.38 per cent, in quantity and \$40,862, or 39.65 per cent, in value; mackerel, 4,445,271 pounds, or 43.75 per cent, in quantity and \$641,682, or

53.97 per cent, in value; herring, 4,637,077 pounds, or 30.92 per cent, in quantity and \$220,894, or 47.94 per cent, in value; swordfish, 151,664 pounds, or 14.66 per cent, in quantity and \$10,890, or 4.87 per cent, in value; tilefish, 265,910 pounds, or 88.80 per cent, in quantity and \$18,772, or 92.71 per cent, in value; and the various other species combined, 103,187 pounds, or 2.43 per cent, in quantity and \$22,012, or 12.12 per cent, in value. The catch of Newfoundland herring decreased 2,885,047 pounds, or 45.17 per cent, in quantity and \$142,090, or 42.81 per cent, in value. The quantity of tilefish landed at Boston was very small, amounting to only 33,510 pounds, valued at \$1,474, as compared with 299,420 pounds, valued at \$20,246, the previous year.

The following graphs present the quantities and values and average price per pound of fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by fishing vessels, and also the number of trips and the average quantity and value of fishery products per trip for the years 1916 to 1919, inclusive.

The following tables present in detail, by fishing grounds and by months, the products landed at Boston and Gloucester, Mass., and Portland, Me., by American and Canadian fishing vessels, for the calendar year 1919. The weights of fresh and salted fish given in these statistics represent the fish as landed from the vessels, and the values are those received by the fishermen. The grades, or sizes, given for certain species are those recognized in the trade.

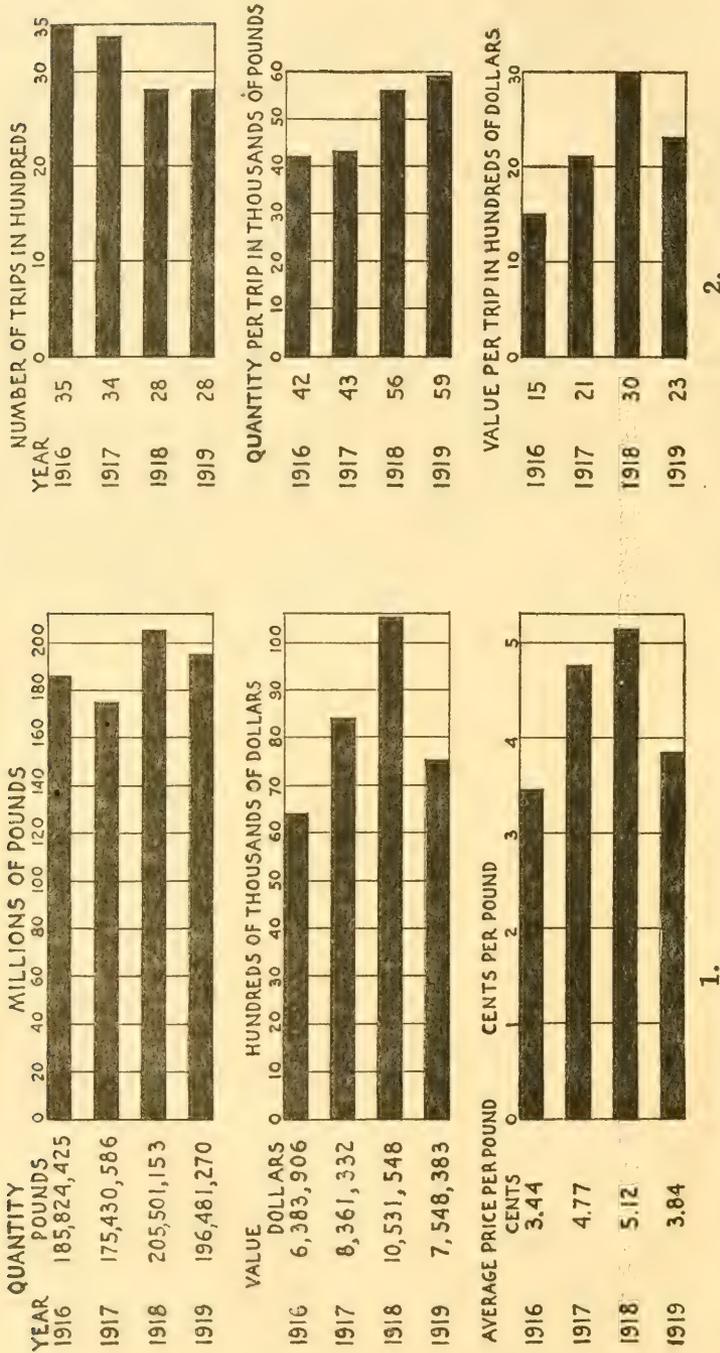


Fig. 1.—Quantities, values, and average price per pound of fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by fishing vessels for the years 1916 to 1919 inclusive.

Fig. 2.—Number of trips, average quantity and value per trip of fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by fishing vessels from fishing grounds, exclusive of "Shore general," for the years 1916 to 1919 inclusive.

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1919, BY FISHING GROUNDS.

Fishing grounds.	Number of trips.	Cod.							
		Large (10 pounds and over).			Market (under 10 and over 2½ pounds).				
		Fresh.	Salted.	Fresh.	Salted.	Fresh.	Salted.		
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	
LANDED AT BOSTON.									
<i>East of 66° W. longitude.</i>									
By American vessels:									
La Have Bank.....	39	655,500	\$10,548	368,948	\$13,594	8,435	\$217		
Western Bank.....	154	3,523,120	180,958	601,715	20,089	1,570	24		
Quebec Bank.....	4	62,900	2,491	11,865	356				
Grand Bank.....	4	34,600	4,852						
Off Newfoundland.....	1								
Cape Shore.....	61	203,850	11,953	138,803	5,707	22,949	530		
St. Ann's Bank.....	2	56,000	4,480	95,000	4,750				
By Canadian vessels: Western Bank	2	33,305	2,025	31,200	1,218	250	4		
<i>West of 66° W. longitude.</i>									
By American vessels:									
Browns Bank.....	89	1,377,935	\$3,822	771,831	30,444	25,190	605		
Georges Bank.....	628	11,314,231	528,419	4,170,126	139,646	66,160	1,399		
Cashes Bank.....	3	9,559	718	4,000	144				
Fipples Bank.....	1	9,500	294	9,500	228	200	2		
Middle Bank.....	138	99,070	6,677	46,930	3,059	11,711	329		
Jeffreys Ledge.....	80	34,902	3,289	28,905	1,733	5,080	156		
South Channel.....	395	1,035,811	64,330	1,309,269	46,952	69,374	1,302		
Nantucket Shoals.....	31	55,703	3,046	180,550	4,806	2,215	41		
Off Highland Light.....	6	22,000	990			1,000	10		
Off Chatham.....	335	1,017,710	66,348	938,236	36,906	193,095	2,911		
Shore, general.....	748	427,762	24,918	123,694	5,650	6,020	153		
By Canadian vessels: Georges Bank.....	24	161,128	9,062	206,090	5,984	6,895	105		
Total.....	2,754	20,134,589	1,039,220	9,038,012	321,434	383,344	7,788		

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHERY VESSELS, CALENDAR YEAR 1919, BY FISHING GROUNDS—Continued.

Fishing grounds.	Number of trips.	Cod.													
		Large (10 pounds and over).						Market (under 10 and over 2½ pounds).						Serod (1 to 2½ pounds).	
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.		Fresh.	Salted.
Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT GLOUCESTER.															
<i>East of 66° W. longitude.</i>															
By American vessels:															
La Have Bank.....	6	39,390	\$1,260		\$109,532	32,890	\$871								
Western Bank.....	192	9,730,135	283,839	2,011,225	4,875,219	128,328	128,328	969,528	\$48,710	1,860	\$28	50,725	\$2,198		
Quereau Bank.....	35	2,226,441	63,241	463,281	25,138	30,569	30,569	312,688	11,886	8,900	134	27,948	1,156		
Green Bank.....	2	21,820	698	10,800	702	870	23	470	28	180	3				
Grand Bank.....	15	610,350	18,081	180,688	10,188	84,045	2,182	77,464	2,105	970	15	5,844	261		
St. Peters Bank.....	2		284	382,235	25,205			195,910	11,755						
Burgeo Bank.....	2	9,630		370	19		48	525	24						
Off Newfoundland.....	14				51										
Cape Shore.....	37	209,094	6,249	1,035	89,057	2,358	2,358	105	5	5,305	84				
Gulf of St. Lawrence.....	2														
<i>West of 66° W. longitude.</i>															
By American vessels:															
Browns Bank.....	4	59,500	1,831		12,720	333	333								
Georges Bank.....	162	3,971,037	129,515	13,785	1,850,918	54,326	54,326	2,290	126	600	12	30,266	594		
South Channel.....	30	302,570	9,230	2,360	304,185	8,178	8,178	3,790	172	3,685	50				
Nantucket Shoals.....	104	16,890	508		91,295	2,257	2,257								
Seal Island.....	1	39,360	1,086												
Shore, general.....	2,357	1,272,295	51,486	1,900		53	53			280	4				
Total.....	2,965	18,508,512	567,307	3,065,779	171,873	8,616,805	229,526	1,562,770	74,811	137,901	2,202	94,502	4,077		

LANDED AT PORTLAND.										
<i>East of 66° W. longitude.</i>										
By American vessels:										
La Have Bank.....	9	72,385	2,527	30,450	785			3,300	34	
Western Bank.....	11	469,720	10,855	136,030	3,196			475	12	
Quereau Bank.....	1		135	1,775	53					
Grand Bank.....	3	3,000								
St. Peters Bank.....	2	6,000	200							
Cape Shore.....	3	4,475	106	4,175	115			345	7	
St. Ann's Bank.....	3									
By Canadian vessels:										
La Have Bank.....	3	44,915	1,142	18,500	489			1,335	17	
Western Bank.....	7	431,175	9,946	82,000	1,713			1,379	21	
Cape Shore.....	1	2,210	133	7,450	234			685	10	
<i>West of 66° W. longitude.</i>										
By American vessels:										
Brown's Bank.....	1	2,000	90							
Georges Bank.....	29	143,627	3,646	44,030	998			60	1	
Cashes Bank.....	34	89,885	3,862	35,639	1,248			6,653	83	
Platts Bank.....	25	28,830	1,043	13,330	380			1,200	19	
Jellreys Ledge.....	49	33,963	2,153	27,335	1,150			5,400	97	
South Channel.....	12	134,639	2,913	15,900	427					
Shore, general.....	2,355	1,334,923	89,729	455,101	20,876		208	77,226	1,790	
By Canadian vessels:										
Brown's Bank.....	1									
Georges Bank.....	1									
Total.....	2,550	2,856,747	131,202	874,835	31,644		208	98,416	2,091	
Grand total.....	8,269	41,499,848	1,737,729	18,529,752	582,604		1,562,978	621,561	12,081	4,077

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1919, BY FISHING GROUNDS—Continued.

Fishing grounds.	Haddock.				Hake.			
	Large (over 2½ pounds).		Scrod (1 to 2½ pounds).		Large (6 pounds and over).		Small (under 6 pounds).	
	Fresh.	Salted.	Fresh.	Fresh.	Fresh.	Salted.	Fresh.	Salted.
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.								
<i>East of 66° W. longitude.</i>								
By American vessels:								
La Have Bank	809,530	\$35,324	1,650	\$83	59,170	\$3,536	62,550	\$2,245
Western Bank	2,230,200	84,479	15,500	346	15,030	913	67,055	2,937
Quebec Bank					24,585	963		
Cape Shore	571,723	33,181	3,400	118	12,540	730	17,285	704
St. Arns Bank	59,000	4,130						
By Canadian vessels: Western Bank.	115,600	4,418	19,500	536				
<i>West of 66° W. longitude.</i>								
By American vessels:								
Browns Bank	1,564,245	70,530	6,640	299	11,340	454	37,840	1,461
Georges Bank	17,481,210	611,385	1,010,778	31,657	37,780	1,567	62,380	2,469
Cashes Bank		6			800	58	5,420	232
Fippennes Bank	7,925	315						
Middle Bank	859,345	54,585	19,430	956	65,008	5,333	232,705	14,498
Jeffrey's Ledge	235,520	18,600	6,745	319	21,110	1,939	152,035	8,150
South Channel	23,656,183	875,841	1,080,091	29,920	334,963	13,666	502,372	16,177
Nantucket Shoals.	6,538,140	13,421	1,215	13	4,080	163	4,995	134
Off Chatham	6,813,869	290,716	47,225	1,471	209,695	9,879	309,468	13,860
South							2,105	113
Shore, general	149,112	7,926	2,965	103	12,278	505	41,718	1,650
By Canadian vessels: Georges Bank.	465,028	23,294	76,115	3,065				
Total.....	55,556,950	2,128,151	2,291,254	59,886	808,379	39,706	1,497,928	64,720

LANDED AT GLOUCESTER.

East of 66° W. longitude.

By American vessels:

La Have Bank.....	82,685	1,447	133,125	\$5,449	245,391	2,871	18,635	358	16,570	\$562	500	8	.....
Western Bank.....	4,548,244	88,349	15,823	566	.....	.....	237,069	5,373	13,800	414	.....	.....	.....
Quebec Bank.....	812,013	16,416	5,694	206	36,085	541	25,500	513	8,000	261	.....	.....	.....
Grand Bank.....	108,640	1,901	70	3	.....	.....	47,405	1,026	.....	.....	.....	.....	.....
St. Peters Bank.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cape Shore.....	131,655	2,696	.....	.....	.....	.....	17,520	347	.....	.....	.....	.....	.....

West of 66° W. longitude.

By American vessels:

Browns Bank.....	115,105	1,850	.....	.....	128,535	1,544	136,410	3,035	700	32	.....	.....	.....
Georges Bank.....	6,373,318	129,025	.....	.....	5,225	226	5,225	131	.....	.....	.....	.....	.....
South Channel.....	1,658,785	35,606	450	16	105,780	1,536	3,165	55	.....	.....	.....	.....	.....
Nantucket Shoals.....	688,845	11,423	.....	.....	.....	.....	10,550	185	.....	.....	.....	.....	.....
Seal Island.....	.....	.....	.....	.....	.....	.....	224,528	13,107	.....	.....	.....	.....	.....
Shore, general.....	2,631,087	107,436	.....	.....	.....	.....	746,097	24,130	39,070	1,269	500	8	.....
Total.....	17,150,377	396,149	155,162	6,240	538,421	6,718	.....	.....	.....	.....	.....	.....	.....

LANDED AT PORTLAND.

East of 66° W. longitude.

By American vessels:

La Have Bank.....	144,320	4,087	.....	.....	5,775	63	1,265	37	.....	.....	4,130	159	.....
Western Bank.....	1,972,624	44,485	.....	.....	15,875	159	1,675	50	.....	.....	7,930	172	.....
Grand Bank.....	.....	.....	.....	.....	.....	.....	1,165	34	.....	.....	.....	.....	.....
St. Peters Bank.....	.....	.....	.....	.....	.....	.....	1,530	21	.....	.....	2,800	71	.....
Cape Shore.....	540	16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Canadian vessels:	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
La Have Bank.....	105,830	2,697	.....	.....	280	4	800	43	.....	.....	2,320	46	.....
Western Bank.....	1,285,585	28,390	.....	.....	1,265	19	210	4	.....	.....	1,250	38	.....
Cape Shore.....	27,475	893	.....	.....	330	6	.....	.....	.....	.....	975	20	.....

West of 66° W. longitude.

By American vessels:

Georges Bank.....	1,052,442	22,238	.....	.....	1,060	22	16,057	33	.....	.....	7,755	345	.....
Cashes Bank.....	8,672	578	.....	.....	.....	.....	12,413	743	.....	.....	60,530	2,425	.....
Platts Bank.....	2,849	178	.....	.....	.....	.....	10,675	722	.....	.....	113,746	3,851	.....
Jeffrey's Ledge.....	321,829	11,866	.....	.....	13,613	321	3,120	125	.....	.....	113,230	4,459	.....
South Channel.....	1,281,829	26,315	.....	.....	.....	.....	140,522	9,107	.....	.....	3,800	95	.....
Shore, general.....	751,272	50,440	.....	.....	31,009	1,017	.....	.....	.....	.....	739,699	27,587	\$15
Total.....	6,954,764	195,183	.....	.....	69,257	1,611	188,887	11,984	.....	.....	1,058,165	39,271	450

Grand total.....

.....	79,662,091	2,719,483	155,162	6,240	2,898,932	68,215	1,743,363	75,770	39,070	1,269	2,556,593	103,999	450
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QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1919, BY FISHING GROUNDS—Continued.

Fishing grounds.	Pollock.				Cusk.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.												
<i>East of 66° W. longitude.</i>												
By American vessels:												
La Have Bank.....	29,770	\$1,359	131,927	\$3,944	63,676	\$14,838	139,021	28,031	321,852	56,825	7,973	6,983
Western Bank.....	305,348	7,916	65,098	1,818	497,023	90,833	1,803	277	33,181	7,973	8,104	
Quebec Bank.....	2,100	66	25,940	818	1,253	470	2,353	746	105,000	21,100	6,000	
Grand Bank.....									6,000	6,000		
Off Newfoundland.....	6,760	310	19,425	544	6,987	1,474	1,474	13	6,987	1,474		
Cape Shore.....	4,530	214			52							
By Canadian vessels: Western Bank.....												
<i>West of 66° W. longitude.</i>												
By American vessels:												
Brown's Bank.....	88,165	3,633	278,521	7,680	497,023	90,833	28,031	4,611	497,023	90,833	2,000	
Georges Bank.....	628,986	22,488	47,660	1,494	1,803	277	1,803	277	2,270	1,180	8320	
Cashes Bank.....	1,120	40	9,800	241	1,253	470	2,353	746	1,253	470		
Fippenes Bank.....	230	3	4,940	9	2,353	746	2,353	746	2,353	746		
Middle Bank.....	25,882	1,713	54,535	2,231	1,833	470	1,833	470	63,255	12,426		
Jeffrey's Ledger.....	286,145	9,978	58,800	2,046	686	10	1,452	279	63,255	12,426		
South Channel.....	312,001	9,777	22,605	686	400	10	1,452	279	63,255	12,426		
Narracket Shoals.....	112,268	2,810	400	10								
Off Highland Light.....	900	36	19,663	728	19,663	728	19,663	728	20,308	4,611		
Off Chatham.....	358,860	16,755	11,222	479	11,222	479	11,222	479	23,159	2,270		
Shore, general.....	788,126	29,202	1,225	25	1,225	25	1,225	25	6,079	1,180		
By Canadian vessels: Georges Bank.....	49,453	1,736										
Total.....	3,000,781	105,036	736,654	22,983			1,329,384	270,112		2,000	320	
LANDED AT GLOUCESTER.												
<i>East of 66° W. longitude.</i>												
By American vessels:												
La Have Bank.....	3,085	49	87,500	1,844	33,115	\$1,475	168,620	22,256	6,983	950		
Western Bank.....	496,122	8,817	252,965	5,566	33,115	6	50,506	7,064	8,104	41		
Quebec Bank.....	58,423	952	11,630	286	685	31	79,373	13,672	8,104	41		
Grand Bank.....												
Off Piers Bank.....	3,124	59	10,952	251	4,022	146	49,234	8,990	218	39		
Cape Shore.....	5,055	68	68,630	1,351					2,205	353		



QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1919, BY FISHING GROUNDS—Continued.

Fishing grounds.	Mackerel.												
	Large (over 2½ pounds).				Medium (1½ to 2¼ pounds).				Small (under 1½ pounds).				
	Fresh.	Salted.		Fresh.	Salted.		Fresh.	Salted.		Fresh.	Salted.		
Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.													
<i>East of 66° W. longitude.</i>													
By American vessels: Cape Shore.	1,831,977	\$118,300	106,000	\$13,556	60,285	\$3,617							
<i>West of 66° W. longitude.</i>													
By American vessels:													
Georges Bank.....	8,350	1,678	14,450	1,301			500	\$85					
Middle Bank.....	7,123	1,407					395,565	34,626					
South Channel.....	24,835	3,407											
Nantucket Shoals.....	30,851	6,496					181	18					
Off Highland Light.....	59,801	10,523	16,360	1,616			120,832	11,949					
Off Chatham.....	69,380	10,073	19,200	808			150	2					
South.....	498,203	91,991	68,490	6,557			546,550	61,389				3,200	\$442
Shore, general.....													
Total.....	2,621,081	237,742	166,000	13,556	179,125	13,899	1,063,778	108,019				3,200	442
LANDED AT GLOUCESTER.													
<i>East of 66° W. longitude.</i>													
By American vessels:													
Cape Shore.....	65,381	5,639	1,094,763	89,784									
Gulf of St. Lawrence.....			34,000	6,246									
<i>West of 66° W. longitude.</i>													
By American vessels:													
Nantucket Shoals.....	1,232	98	46,996	5,037								3,218	129
Shore, general.....	154,516	28,474	8,200	1,156	1,035	98	6,400	\$950				18,680	709
Total.....	221,129	34,211	1,183,959	102,223	1,035	98	6,400	950				21,898	838
Total.....												25,000	1,698
												9,288	840
												34,288	2,538









LANDED AT PORTLAND.

January.....	182	103,379	6,429	69,171	4,829	17,653	583	
February.....	183	100,843	4,703	64,507	2,741	9,944	224	
March.....	293	223,820	8,370	74,907	3,170	8,992	773	
April.....	285	223,820	10,084	333,963	8,645	13,019	236	
May.....	286	577,808	14,199	377,459	10,030	5,037	96	
June.....	275	807,219	23,831	687,227	1,690	3,638	54	
July.....	273	308,959	23,600	287,427	1,933	5,703	49	
August.....	262	206,494	19,062	177,469	2,715	2,432	55	
September.....	115	80,034	5,134	17,264	6	2,437	39	
October.....	202	68,023	3,819	49,208	1,332	4,037	57	
November.....	97	38,156	2,246	20,738	1,107	6,330	87	
December.....	99	54,994	4,568	59,316	2,871	19,532	423	
Total.....	2,550	2,856,747	131,202	874,935	31,644	98,416	2,091	
Grand total.....	8,289	41,499,848	1,737,729	18,529,752	582,604	1,562,978	12,081	94,502
Grounds E. of 66° W. long.....	617	18,470,015	646,122	7,883,697	216,678	1,556,690	2,373	94,502
Grounds W. of 66° W. long.....	7,652	23,029,833	1,091,607	10,646,055	363,926	6,288	9,708	4,077
Landed at Boston in 1918.....	2,830	21,819,066	1,453,212	19,674,977	633,575	35,000	31,055	
Landed at Gloucester in 1918.....	3,414	17,039,268	701,261	10,806,556	311,717	1,386,633	7,586	115,235
Landed at Portland in 1918.....	2,506	2,745,637	143,071	1,242,403	57,550	1,712	5,786	1,115

<sup>1</sup> These statistics for 1919 include 39 trips landed by Canadian fishing vessels, 26 at Boston and 13 at Portland, amounting to 3,296,147 pounds of fish, value \$105,261.

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS DURING 1919, BY MONTHS—Continued.

Fishing grounds.	Haddock.				Hake.				
	Large (over 2½ pounds).		Scrod (1 to 2½ pounds).		Large (6 pounds and over).		Small (under 6 pounds).		
	Fresh.	Salted.	Fresh.	Salted.	Fresh.	Salted.	Fresh.	Salted.	
<b>LANDED AT BOSTON.</b>									
January.....	Pounds. 4,362,153	Value. \$273,283	Pounds. 353,035	Value. \$16,722	Pounds. 35,628	Value. \$4,411	Pounds. 243,170	Value. \$16,386	
February.....	5,127,677	207,402	169,513	5,497	8,580	922	65,010	4,480	
March.....	8,032,356	244,703	353,810	8,374	10,835	645	67,265	2,779	
April.....	6,019,243	161,535	589,560	13,130	8,120	436	74,580	2,830	
May.....	3,594,553	108,012	269,986	3,417	18,780	837	82,935	2,403	
June.....	3,370,891	95,818	185,485	2,646	19,965	569	95,335	2,797	
July.....	919,570	23,905	22,525	322	54,255	1,759	20,820	561	
August.....	1,830,845	85,735	26,190	1,114	48,375	2,677	70,850	3,496	
September.....	5,368,750	177,110	69,710	1,718	103,633	4,228	117,483	4,434	
October.....	7,385,364	229,089	170,095	4,294	290,185	10,318	296,637	7,830	
November.....	4,581,570	249,716	71,175	1,948	144,963	8,710	257,415	9,988	
December.....	4,963,978	271,843	19,200	704	65,120	4,164	146,428	6,726	
Total.....	55,556,950	2,128,151	2,291,254	59,886	808,379	39,706	1,497,928	64,720	
<b>LANDED AT GLOUCESTER.</b>									
January.....	104,423	4,066			700	21			
February.....	450,022	21,243			215	28			
March.....	2,500,942	74,133	48,335	611	1,384	86	1,200	36	
April.....	2,635,398	62,106	18,115	181	4,290	375	2,620	79	
May.....	1,710,289	31,073	184,560	2,642	73,305	1,375	500	8	
June.....	1,960,125	34,694	255,356	2,964	32,665	967			
July.....	827,785	14,470	32,025	320	87,185	1,526	2,140	69	
August.....	64,480	1,451			1,265	32			
September.....	3,479,268	78,069			122,785	3,021	3,800	133	
October.....	3,064,825	64,015			185,105	4,116	25,980	45	
November.....	286,535	5,731			187,863	10,597	839	29	
December.....	66,285	3,121			49,335	2,757	1,000	30	
Total.....	17,150,377	396,149	538,421	6,718	746,097	24,130	39,070	1,269	

LANDED AT PORTLAND.

January.....	170, 011	16, 614	7, 850	390	11, 510	1, 278	67, 661	3, 981	450	15
February.....	261, 223	12, 712	9, 496	272	18, 626	1, 834	147, 580	7, 517	450	15
March.....	1, 105, 627	29, 889	18, 220	335	16, 518	1, 268	130, 377	4, 018	450	15
April.....	1, 430, 030	33, 321	3, 516	77	24, 283	1, 629	169, 186	6, 087	450	15
May.....	1, 961, 603	45, 483	1, 777	31	18, 423	771	94, 984	2, 044	450	15
June.....	1, 308, 603	30, 236	1, 803	40	11, 833	323	55, 827	974	450	15
July.....	1, 426, 512	10, 635	17, 220	211	22, 343	1, 171	56, 832	1, 939	450	15
August.....	17, 548	1, 458	1, 261	40	14, 987	944	84, 727	3, 228	450	15
September.....	32, 008	1, 729	1, 885	28	11, 152	627	51, 359	1, 712	450	15
October.....	103, 180	3, 389	1, 695	26	22, 990	1, 052	109, 902	2, 788	450	15
November.....	49, 562	2, 768	1, 170	36	7, 852	516	69, 033	2, 653	450	15
December.....	88, 857	6, 949	3, 364	125	8, 670	521	38, 697	1, 430	450	15
Total.....	6, 954, 764	195, 183	69, 257	1, 611	188, 887	11, 934	1, 058, 165	39, 271	450	15
Grand total.....	79, 662, 091	2, 719, 483	2, 898, 932	68, 215	1, 743, 363	75, 770	2, 556, 593	103, 999	450	15
Grounds E. of 66° W. long.....	13, 005, 665	352, 909	345, 101	4, 746	483, 249	13, 948	166, 795	6, 490	450	15
Grounds W. of 66° W. long.....	66, 656, 426	2, 366, 574	2, 553, 831	63, 469	1, 260, 114	61, 822	2, 389, 798	97, 509	450	15
Landed at Boston in 1918.....	46, 140, 828	2, 449, 932	6, 044, 978	225, 335	986, 743	67, 897	2, 015, 507	103, 706	450	15
Landed at Gloucester in 1918.....	7, 924, 068	249, 512	461, 590	14, 808	533, 499	17, 319	150	3	460	25
Landed at Portland in 1918.....	5, 959, 531	253, 142	72, 054	3, 046	314, 036	22, 463	1, 395, 867	60, 254	450	15

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS DURING 1919, BY MONTHS—Continued.

Fishing grounds.	Pollock.				Cusk.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.												
January.....	98,480	\$7,441	.....	.....	149,978	\$6,200	.....	.....	28,063	\$9,903	.....	.....
February.....	69,202	4,450	.....	.....	23,848	1,098	.....	.....	74,619	17,753	.....	.....
March.....	32,226	1,890	.....	.....	23,100	939	.....	.....	59,672	13,753	.....	.....
April.....	80,729	3,555	.....	.....	134,660	3,067	.....	.....	290,115	42,662	.....	.....
May.....	348,181	8,875	.....	.....	61,445	1,424	.....	.....	246,976	35,409	.....	.....
June.....	263,587	9,556	.....	.....	14,780	351	.....	.....	154,391	25,500	.....	.....
July.....	30,213	917	.....	.....	28,890	899	.....	.....	114,594	17,422	.....	.....
August.....	75,642	5,897	.....	.....	3,550	147	.....	.....	7,222	1,337	.....	.....
September.....	496,620	18,886	.....	.....	39,250	1,458	.....	.....	108,649	20,385	.....	.....
October.....	571,492	14,619	.....	.....	50,907	1,645	.....	.....	216,570	49,946	.....	.....
November.....	791,784	25,028	.....	.....	62,960	1,794	.....	.....	31,556	7,861	.....	.....
December.....	129,625	3,982	.....	.....	143,286	3,964	.....	.....	26,927	7,961	.....	.....
Total.....	3,000,781	105,035	.....	.....	736,654	22,986	.....	.....	1,329,384	250,112	.....	.....
LANDED AT GLOUCESTER.												
January.....	475,445	29,886	.....	.....	3,187	98	.....	.....	35,889	6,747	.....	.....
February.....	29,390	1,842	.....	.....	4,305	109	.....	.....	56,789	8,358	.....	.....
March.....	71,273	3,773	.....	.....	920	19	.....	.....	12,780	2,055	.....	.....
April.....	155,815	5,024	.....	.....	1,135	400	.....	.....	12,751	11,743	.....	.....
May.....	2,992,329	41,346	.....	\$26	92,100	1,785	.....	.....	56,447	6,599	.....	.....
June.....	96,605	1,284	.....	45	144,865	2,212	.....	.....	9,808	1,093	.....	.....
July.....	198,710	2,389	.....	1	10,265	212	.....	.....	58,611	8,087	.....	.....
August.....	3,356	113	.....	.....	119,375	2,568	.....	.....	22	2	.....	.....
September.....	179,520	4,324	.....	.....	.....	.....	.....	.....	58,611	8,087	.....	.....
October.....	5,015,795	76,620	.....	.....	94,430	2,330	.....	.....	8,508	1,640	.....	.....
November.....	4,157,215	61,314	.....	.....	89,340	2,226	.....	.....	320	37	.....	.....
December.....	1,223,333	20,290	.....	.....	39,465	874	.....	.....	21,441	4,490	.....	.....
Total.....	14,999,786	248,205	.....	.....	608,957	13,373	.....	.....	357,460	54,820	.....	.....
			55,101	1,400			37,962	1,658			12,600	1,770



QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS DURING 1919, BY MONTHS—Continued.

Fishing grounds.		Mackerel.											
		Large (over 24 pounds).				Medium (14 to 24 pounds).				Small (under 14 pounds).			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.		
LANDED AT BOSTON.													
January.....													
February.....													
March.....													
April.....													
May.....													
June.....	2,087,895	\$132,131	166,000	\$13,556	26,300	\$1,841							
July.....	14,473	2,735			95,870	5,668				24,650	\$1,703		
August.....	99,990	20,608			6,000	240				135,480	6,469		
September.....	43,397	7,043			50,955	6,150				11,351	1,279		
October.....	203,839	38,996								863,014	91,894	3,200	\$442
November.....	171,487	36,229								28,083	6,604		
December.....													
Total.....	2,621,081	237,742	166,000	13,556	179,125	13,899				1,063,778	108,019	3,200	442
LANDED AT GLOUCESTER.													
January.....													
February.....													
March.....													
April.....													
May.....													
June.....	65,381	5,639	1,094,763	89,784	835	75						5,700	338
July.....	1,252	98	46,996	5,037						21,898	838	25,000	1,698
August.....													
September.....	1,500	210											
October.....	68,976	12,727	7,400	1,036									
November.....	84,040	15,537	34,000	6,246	200	23						388	54
December.....													
Total.....	221,129	34,211	1,183,959	102,223	1,035	98				6,400	950	34,288	2,538



QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS DURING 1919, BY MONTHS—Continued.

Fishing grounds.	Miscellaneous. 1						Total.					
	Fresh.			Salted.			Fresh.			Salted.		
	Pounds.	Value.		Pounds.	Value.		Pounds.	Value.		Pounds.	Value.	
LANDED AT BOSTON.												
January.....	486, 293	\$23, 356		7, 811, 443	\$492, 372		7, 811, 443		7, 811, 443		\$492, 372	
February.....	410, 197	15, 458		9, 079, 107	391, 842		9, 079, 107		9, 079, 107		391, 842	
March.....	440, 095	15, 010		14, 123, 107	484, 621		14, 123, 107		14, 134, 421		484, 706	
April.....	443, 524	14, 611		10, 447, 500	\$285	11, 400	11, 400	\$285	10, 447, 500		380, 795	
May.....	443, 524	9, 755		7, 746, 204					7, 746, 204		265, 520	
June.....	214, 195	11, 387		9, 473, 402	405, 360	166, 000	166, 000	13, 556	9, 639, 402		418, 916	
July.....	382, 086	84, 407		2, 563, 366	171, 249				2, 563, 366		171, 249	
August.....	205, 624	24, 179		2, 808, 733	150, 540	2, 000	2, 000	320	2, 810, 733		180, 860	
September.....	450, 844	50, 380		10, 322, 133	509, 558	3, 200	3, 200	442	10, 335, 333		510, 000	
October.....	398, 952	15, 929		12, 569, 770	518, 856				12, 569, 770		518, 856	
November.....	268, 046	11, 381		8, 831, 257	482, 902				8, 831, 257		482, 902	
December.....	376, 894	23, 165		7, 422, 774	415, 132				7, 422, 774		415, 132	
Total.....	4, 565, 511	300, 048		103, 298, 770	4, 698, 747	182, 600	182, 600	14, 603	103, 391, 370		4, 713, 350	
LANDED AT GLOUCESTER.												
January.....	23, 475	851		778, 025	47, 934		3, 024, 607	167, 231	3, 802, 632		215, 165	
February.....	17, 886	802		1, 065, 529	49, 413		10, 470	85	1, 065, 406		49, 416	
March.....				4, 810, 630	150, 483		22, 600	489	4, 821, 100		150, 922	
April.....				4, 845, 615	137, 479		32, 215	1, 116	4, 868, 215		138, 595	
May.....	17, 800	178	29	11, 765, 028	266, 974		2, 523, 518	1, 357	11, 797, 243		268, 331	
June.....				8, 011, 664	195, 024		133, 257	164, 391	10, 535, 182		359, 415	
July.....				4, 981, 372	133, 257		1, 277, 009	42, 054	5, 756, 487		175, 311	
August.....	36, 292	6, 918		1, 900, 551	5, 097		1, 467, 560	52, 302	1, 467, 560		57, 390	
September.....				6, 474, 519	171, 871		818, 428	50, 556	7, 292, 947		222, 427	
October.....				11, 530, 821	265, 902		716, 953	48, 030	12, 247, 774		313, 932	
November.....				5, 629, 037	126, 826		46, 785	7, 039	5, 675, 822		133, 865	
December.....	11, 765	637		1, 539, 004	36, 740		501, 585	24, 074	2, 040, 589		60, 814	
Total.....	113, 809	9, 415		61, 621, 587	1, 587, 000	9, 749, 370	9, 749, 370	538, 592	71, 370, 957		2, 145, 592	

LANDED AT PORTLAND.

January.....	784	540,580	39,458	540,580	39,458
February.....	788	706,272	36,635	766,272	36,635
March.....	1,514	1,740,897	54,676	1,740,897	54,676
April.....	1,432	2,837,021	75,277	2,837,021	75,277
May.....	10,233	4,025,466	77,671	4,025,466	77,671
June.....	18,086	6,175,984	100,495	6,180,373	100,901
July.....	40,895	2,137,047	95,835	2,137,047	95,835
August.....	20,486	769,285	67,064	769,285	67,064
September.....	12,679	895,371	50,887	896,094	50,908
October.....	4,856	1,236,108	49,662	1,236,838	49,700
November.....	1,084	312,084	13,106	312,084	13,106
December.....	1,826	347,076	28,210	347,076	28,210
Total.....	113,563	21,713,191	688,976	21,718,943	689,441
Grand total.....	422,026	186,543,548	6,974,723	196,481,270	7,548,383
Grounds E. of 66° W. long. ....	26,727	45,605,309	1,653,348	45,494,420	2,214,761
Grounds W. of 66° W. long. ....	396,299	140,848,239	5,321,375	140,986,820	5,333,622
Landed at Boston in 1918.....	404,529	109,227,021	6,556,383	109,476,041	6,587,754
Landed at Gloucester in 1918.....	45,402	62,012,478	2,196,351	74,175,419	3,062,905
Landed at Portland in 1918.....	114,202	21,704,541	875,799	21,849,613	881,189

<sup>1</sup>Includes herring from Newfoundland, 3,501,777 pounds salted, value \$189,783.

The fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by fishing vessels each year are taken principally from fishing grounds lying off the coast of the United States. In the calendar year 1919, 71.72 per cent of the quantity and 70.64 per cent of the value of the catch landed at these ports by American and Canadian fishing vessels were taken from these grounds; 2.93 per cent of the quantity and 4.61 per cent of the value, consisting largely of herring, from fishing banks off the coast of Newfoundland, and 25.33 per cent of the quantity and 24.74 per cent of the value from fishing grounds off the Canadian Provinces. Newfoundland herring constituted 1.78 per cent of the quantity and 2.51 per cent of the value of the fishery products landed at these ports during the year. The herring were taken on the treaty coast of Newfoundland, and the cod, haddock, hake, halibut, and other species from that region were obtained from fishing banks on the high seas. All fish caught by American fishing vessels off the coast of the Canadian Provinces were from offshore fishing grounds. The catch from each of these regions is given in detail in the following table:

QUANTITY AND VALUE OF FISH LANDED BY AMERICAN AND CANADIAN FISHING VESSELS AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., IN 1919, FROM FISHING GROUNDS OFF THE COAST OF THE UNITED STATES, NEWFOUNDLAND, AND CANADIAN PROVINCES.

Species.	United States.		Newfoundland.		Canadian Provinces.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Cod:								
Fresh.....	34,117,400	\$1,466,155	775,275	\$26,634	25,758,486	\$839,625	60,651,161	\$2,332,414
Salted.....	22,433	1,252	864,291	50,839	3,836,635	198,676	4,723,259	250,767
Haddock:								
Fresh.....	69,210,257	2,430,043	144,725	2,442	13,206,041	355,213	82,561,023	2,787,698
Salted.....	450	16	5,764	209	148,948	6,015	155,162	6,240
Hake:								
Fresh.....	3,639,362	159,146	50,245	1,110	610,349	19,513	4,299,956	179,769
Salted.....	1,150	47	8,000	261	30,370	976	39,520	1,284
Pollock:								
Fresh.....	17,687,259	357,956	3,124	59	1,005,968	21,085	18,696,351	379,100
Salted.....	515	15	2,669	98	52,432	1,302	55,616	1,415
Cusk:								
Fresh.....	1,287,319	42,502	10,952	251	726,965	17,758	2,025,236	60,511
Salted.....			4,707	177	3-3,255	1,481	37,962	1,658
Halibut:								
Fresh.....	909,566	169,430	400,488	76,206	790,007	139,465	2,100,061	385,101
Salted.....	2,000	320	2,453	392	10,147	1,378	14,600	2,090
Mackerel:								
Fresh.....	2,237,342	298,516			2,077,428	128,588	4,314,770	427,104
Salted.....	100,663	10,312			1,297,763	109,826	1,398,426	120,138
Herring:								
Fresh.....	6,858,108	50,005					6,858,108	50,005
Salted.....			3,501,777	189,783			3,501,777	189,783
Swordfish: Fresh.	777,320	188,716	315	110	105,092	23,542	882,727	212,368
Tilfish: Fresh.	33,510	1,474					33,510	1,474
Miscellaneous:								
Fresh.....	4,038,276	156,104			82,369	3,075	4,120,645	159,179
Salted.....	11,400	255					11,400	285
Total.....	140,934,330	5,332,294	5,774,785	348,571	49,772,155	1,867,518	196,481,270	7,548,383

COD.—In 1919 the fishing fleet landing fish at Boston, Gloucester, and Portland was about the same size as in the previous year. There were 9 vessels in the salt-bank fishery and 111 in the market fishery landing their fares of cod and other ground fish at these ports during the year, while large quantities of cod were also landed by vessels fishing on the shore grounds. The total catch of cod landed at these ports during the year amounted to 65,374,420 pounds, valued at

\$2,583,181, of which 4,723,259 pounds, valued at \$250,767, were salted. Cod ranked second in importance among the various species landed.

**HADDOCK.**—The catch of haddock for the year ranked first in both quantity and value, being considerably larger than that of cod. The quantity of haddock landed at these ports by fishing vessels during the year amounted to 82,716,185 pounds, valued at \$2,793,938, all of which was landed fresh except 155,162 pounds, valued at \$6,240. The greater part of the catch was taken on Georges Bank and in South Channel.

**HAKE.**—The catch of hake amounted to 4,339,476 pounds, valued at \$181,053, all landed fresh except 39,520 pounds salted, valued at \$1,284. There was a decline of 941,353 pounds, or 17.82 per cent, in the quantity and \$92,032, or 33.70 per cent, in the value as compared with the previous year. The yield of this species has fallen off very much in the past few years. In 1916 over 13,000,000 pounds of hake were landed at these ports, and in 1910 the receipts at Boston and Gloucester were nearly 20,000,000 pounds.

**POLLOCK.**—The catch of pollock amounted to 18,751,967 pounds, valued at \$380,515, all landed fresh except 55,616 pounds salted, valued at \$1,415. There was a falling off in the catch of this species of 7,808,653 pounds in quantity and \$581,570 in value as compared with the previous year.

**CUSK.**—The quantity of cusk landed was only 2,063,198 pounds, valued at \$62,169, of which 37,962 pounds, valued at \$1,658, were salted. The yield of this species was 595,062 pounds less in quantity and \$40,862 less in value than in the previous year.

**HALIBUT.**—The catch of halibut amounted to 2,114,661 pounds, valued at \$387,191, all landed fresh except 14,600 pounds salted, valued at \$2,090. There was an increase in the catch of halibut of 333,657 pounds in quantity and \$84,911 in value as compared with the previous year.

**MACKEREL.**—The total catch of fresh mackerel taken by the American fishing fleet in 1919 was 53,992 barrels, compared with 69,314 barrels in 1918, a decrease of 15,322 barrels. The total catch of salted mackerel was 7,007 barrels, compared with 13,030 barrels the previous year, a decrease of 6,023 barrels. The quantity of mackerel landed at Boston, Gloucester, and Portland by the fishing fleet during the year was 5,713,196 pounds, valued at \$547,242, of which 4,314,770 pounds, valued at \$427,104, were fresh and 1,398,426 pounds, valued at \$120,138, were salted. These were all landed by American fishing vessels.

Mackerel were reported schooling in southern waters the latter part of April, and prospects for mackerel fishing appeared to be good; but the mackerel seiners were delayed in sailing by a strike of the crews with regard to the pay of engineers. The first seiners arrived at New York with fares of mackerel April 25, one vessel landing 32,000 pounds and another 18,000 pounds. These fish weighed from 1½ to 3 pounds, although most of them did not exceed 2 pounds, and sold for 25 cents per pound. The southern mackerel fleet numbered 30 sail of seiners and 150 sail of netters. Both the seiners and the netters had a comparatively good season. The best stock made by a seiner was \$13,232, the crew sharing \$330 each. The mackerel landed by the southern fleet were mostly large and medium

fish, and sold from 8 to 18 cents per pound, according to market conditions.

The first fare of mackerel from the Cape Shore was landed on June 6, and amounted to 50,000 pounds of large and medium fish, which sold for 6.35 cents per pound. All of the Cape Shore fleet landed good trips of mackerel and stocked from \$4,000 to \$10,000 each. The fleet numbered 32 vessels compared with 38 the previous year. The total catch of mackerel from the Cape Shore was 2,119,000 pounds fresh, and 6,275 barrels salted, compared with 1,689,000 pounds fresh, and 7,558 barrels salted in 1918. The fresh mackerel sold from 5¼ to 7 cents per pound, the salted from \$16 to \$18.50 per barrel.

Tinker mackerel were present in small schools along the shore from Cape Ann to Chatham during the latter part of June.

The total catch of mackerel up to July 1 was 38,787 barrels fresh, and 6,452 barrels salted, compared with 29,259 barrels fresh and 8,079 barrels salted the previous year.

**SWORDFISH.**—The quantity of swordfish landed during the year was 882,447 pounds, valued at \$212,302. The number of vessels engaged in this fishery was 56, or 19 more than in the previous year, but there was a considerable falling off in the catch.

**FLOUNDERS.**—The catch of flounders in the vessel fisheries amounted to 2,451,856 pounds, valued at \$103,050, an increase of 182,049 pounds in quantity and \$9,250 in value over the previous year. The catch taken by boats under 5 tons net tonnage is not included in these statistics.

**HERRING.**—The catch of herring amounted to 10,359,885 pounds, valued at \$239,788. Of this quantity, 6,858,108 pounds, valued at \$50,005, were taken off the coast of the United States and landed fresh, and 3,501,777 pounds, valued at \$189,783, were salted Newfoundland herring.

#### VESSEL FISHERIES AT SEATTLE, WASH.

In the vessel fisheries at Seattle, Wash., there has been considerable decrease in both the quantity and value of products landed by the fishing fleet, but an increase in the products landed by collecting vessels as compared with the previous year. Statistics of the vessel fisheries at Seattle have been collected by the local agent and published as monthly and annual statistical bulletins, giving the quantity and value of fishery products landed by American fishing and collecting vessels at that port.

In 1919 the fishing fleet at Seattle landed 670 trips, aggregating 13,651,020 pounds of fish, having a value to the fishermen of \$1,530,284. This catch was taken from the fishing grounds along the coast from Oregon to Albatross Bank, Alaska. The fishing areas from which the greater part of the products was obtained were Grays Harbor Grounds, Flattery Banks, West Coast of Vancouver Island, Hecate Strait, and Yakutat Grounds. The products included halibut, 11,110,720 pounds, valued at \$1,422,519; sablefish, 1,553,600 pounds, valued at \$74,290; "lingcod," 723,000 pounds, valued at \$24,433; and rockfishes, 263,700 pounds, valued at \$9,042. Compared with the previous year, there was a decrease of 164 trips by fishing vessels, and of 3,440,675 pounds, or 20.13 per cent, in quantity, and \$357,369, or 18.93 per cent, in the value of the products landed. The catch of

halibut increased 866,520 pounds, or 8.46 per cent, in quantity, but decreased \$106,327, or 6.95 per cent, in value. Sablefish decreased 2,801,350 pounds, or 64.32 per cent, in quantity, and \$196,877, or 72.60 per cent, in value; "lingcod," 1,061,600 pounds, or 59.48 per cent, in quantity, and \$37,859, or 60.77 per cent, in value; and rockfishes, 357,070 pounds, or 57.52 per cent, in quantity, and \$13,857, or 60.51 per cent, in value. The falling off in the catch of these species may be attributed largely to a smaller demand than in the previous year.

The fishery products taken in Puget Sound and landed at Seattle by collecting vessels during the year amounted to 11,809,450 pounds, valued at \$983,819. These products included salmon, 10,387,703 pounds, valued at \$902,717; pilchard, 150,000 pounds, valued at \$2,250; steelhead trout, 173,630 pounds, valued at \$21,034; smelt, 296,041 pounds, valued at \$14,723; rockfishes, 120,490 pounds, valued at \$7,632; cod, 104,500 pounds, valued at \$2,305; flounders, 99,940 pounds, valued at \$2,613; sole, 104,200 pounds, valued at \$3,972; crabs, 239,758 pounds, valued at \$21,866; and other species amounting to 133,188 pounds, valued at \$4,707. There was an increase in the products landed by collecting vessels over the previous year of 1,204,127 pounds, or 11.35 per cent, in quantity, and \$71,221, or 7.80 per cent, in value. The quantity and value of fishery products landed at Seattle by fishing and collecting vessels in 1919 are given in detail in the following table:

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS (FRESH) LANDED AT SEATTLE, WASH., BY AMERICAN FISHING VESSELS, CALENDAR YEAR 1919.

	Number of trips.	Halibut.		Sablefish.	
		Pounds.	Value.	Pounds.	Value.
BY FISHING GROUNDS.					
Oregon coast .....	21	852,000	\$93,446	41,000	\$1,890
Columbia River grounds.....	6	275,000	31,493	.....	.....
Grays Harbor grounds .....	48	813,300	110,444	337,000	16,255
Plattery Banks.....	292	1,951,700	268,624	482,200	21,829
West coast, Vancouver Island.....	108	1,075,200	152,679	200,900	9,537
Queen Charlotte Islands grounds.....	3	55,000	9,040	.....	.....
Hecate Strait.....	157	4,040,500	514,116	391,800	19,547
Coronation Island.....	2	39,000	5,305	.....	.....
Cape Ommaney.....	1	65,000	8,043	.....	.....
Yakutat grounds.....	28	1,622,300	195,799	81,200	4,310
Portlock Bank.....	3	224,120	21,100	3,500	107
Albatross Bank.....	1	97,600	12,430	16,000	815
Total.....	670	11,110,720	1,422,519	1,553,600	74,290
BY MONTHS.					
January.....	7	124,900	22,000	31,500	2,450
February.....	14	97,800	16,532	7,000	350
March.....	41	360,300	51,995	51,000	2,631
April.....	70	871,000	112,300	14,000	745
May.....	102	977,200	113,648	42,000	1,530
June.....	120	2,186,200	257,938	16,000	640
July.....	99	2,033,220	219,707	64,000	3,117
August.....	72	1,511,800	187,900	385,500	19,475
September.....	51	860,400	126,994	633,000	30,185
October.....	54	647,400	125,216	220,400	8,957
November.....	14	283,000	49,959	46,700	2,280
December.....	26	1,157,500	138,330	42,500	1,930
Total.....	670	11,110,720	1,422,519	1,553,600	74,290

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS (FRESH) LANDED AT SEATTLE, WASH., BY AMERICAN FISHING VESSELS, CALENDAR YEAR 1919—Contd.

	"Lingcod."		Rockfishes.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
BY FISHING GROUNDS.						
Oregon coast.....	14,000	\$105	8,000	\$205	915,000	\$95,646
Columbia River grounds.....					275,000	31,493
Grays Harbor grounds.....	61,000	1,750	21,000	600	1,232,300	129,049
Flattery Banks.....	344,200	10,673	83,500	2,702	2,861,600	303,828
West coast, Vancouver Island.....	211,000	8,620	84,700	3,300	1,571,800	174,136
Queen Charlotte Islands grounds.....	15,000	900			70,000	9,940
Hecate Strait.....	68,000	2,165	64,500	2,155	4,564,800	537,983
Coronation Island.....	1,500	60			40,500	5,365
Cape Ommaney.....			2,000	80	67,000	8,123
Yakutat grounds.....	7,000	105			1,710,500	200,214
Portlock Bank.....					227,620	21,207
Albatross Bank.....	1,300	55			114,900	13,300
Total.....	723,000	24,433	263,700	9,042	13,651,020	1,530,284
BY MONTHS.						
January.....	15,500	1,225	9,000	810	180,900	26,485
February.....	97,000	5,155	22,200	1,250	224,000	23,287
March.....	76,000	2,355	36,000	1,180	523,300	58,161
April.....	146,700	3,934	86,000	2,332	1,117,700	119,311
May.....	155,500	2,619	39,500	680	1,214,200	118,477
June.....	50,000	2,060	9,000	360	2,261,200	260,998
July.....	21,000	875	1,000	40	2,119,220	223,739
August.....	42,000	1,550	29,000	1,080	1,968,300	210,005
September.....	46,800	1,875	14,000	560	1,554,200	159,614
October.....	22,000	980	10,000	430	899,800	135,583
November.....	10,000	400			339,700	52,639
December.....	40,500	1,405	8,000	320	1,248,500	141,985
Total.....	723,000	24,433	263,700	9,042	13,651,020	1,530,284

FISHERY PRODUCTS TAKEN IN PUGET SOUND AND LANDED AT SEATTLE, WASH., BY COLLECTING VESSELS DURING 1919, BY MONTHS.

Species.	January.		February.		March.		April.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Herring.....	12,000	\$260			34,000	\$340		
Pilchard.....	150,000	2,250						
Salmon:								
Chum or keta.....	140,000	13,800						
King or spring.....	8,000	1,200					31,500	\$3,150
Miscellaneous.....	8,000	1,200					62,000	7,220
Trout: Steelhead.....	60,000	9,000	8,500	\$1,275			6,200	620
Smelt.....	18,400	1,200						
Rockfishes.....	12,000	720	8,000	320	8,500	595	3,000	210
"Lingcod".....					22,000	1,320	16,000	800
Cod.....			86,000	1,720	18,500	585		
Flounders.....	6,000	120	14,200	426	11,000	280	7,000	175
Sole.....	14,600	468	12,500	500	18,600	744	8,600	344
Crabs.....	30,800	2,100	24,000	1,680			39,710	2,918
Total.....	459,800	32,318	153,200	5,921	112,600	3,864	174,010	15,437

## FISHERY PRODUCTS TAKEN IN PUGET SOUND AND LANDED AT SEATTLE, WASH., BY COLLECTING VESSELS DURING 1919, BY MONTHS—Continued.

Species.	May.		June.		July.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sturgeon.....			1,480	\$84	1,588	\$75
Salmon:						
King or spring.....	312,800	\$31,280	1,412,100	155,331	889,000	92,600
Coho or silver.....			83,910	8,390	21,480	2,960
Sockeye or red.....			42,780	4,705	5,500	585
Miscellaneous.....	63,660	6,366				
Trout: Steelhead.....	28,000	2,800	34,260	3,426	12,300	1,476
Rockfishes.....	8,000	560	4,250	130	7,600	532
“Lingcod”.....			4,600	92		
Flounders.....	8,870	176	12,420	248	4,520	90
Sole.....	2,200	88			1,500	60
Other fish.....					10,210	102
Crabs.....	13,612	928	10,340	1,240		
Total.....	437,142	42,198	1,606,140	173,652	953,698	98,480

Species.	August.		September.		October.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sturgeon.....	2,850	\$256	3,600	\$216	3,600	\$288
Salmon:						
Humpback or pink.....	592,400	35,544	516,800	31,008		
Chum or keta.....	485,948	24,297	457,040	27,420	662,389	33,119
King or spring.....	406,312	40,631	608,000	60,800	90,470	9,047
Coho or silver.....	163,880	9,932	1,233,600	123,360	244,424	24,424
Sockeye or red.....	34,930	3,493	6,300	63		
Trout: Steelhead.....	3,510	351			8,690	869
Smelt.....	116,461	5,823	135,080	6,400		
Perch.....					8,000	480
Rockfishes.....	6,000	420	14,300	1,001	12,840	898
“Lingcod”.....	2,130	42	7,000	210		
Flounders.....	9,530	336			4,000	80
Sole.....	11,600	464	4,000	160	12,000	480
Crabs.....					21,020	1,060
Total.....	1,835,551	121,589	2,985,720	250,638	1,067,433	70,745

Species.	November.		December.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sturgeon.....					13,118	\$919
Herring.....					46,000	600
Pilchard.....					150,000	2,250
Salmon:						
Humpback or pink.....					1,109,200	66,552
Chum or keta.....	957,750	\$47,887	709,000	\$88,625	3,412,127	235,148
King or spring.....	23,100	2,310	20,770	2,590	3,802,052	398,939
Coho or silver.....	93,860	9,380			1,841,154	178,446
Sockeye or red.....					89,510	8,846
Miscellaneous.....					133,660	14,786
Trout: Steelhead.....	12,170	1,217			173,630	21,034
Smelt.....	26,100	1,300			296,041	14,723
Perch.....					8,000	480
Rockfishes.....	20,000	1,400	16,000	840	120,490	7,632
“Lingcod”.....			4,130	142	53,860	2,606
Cod.....					104,500	2,305
Flounders.....	9,800	246	12,600	436	93,940	2,613
Sole.....			18,600	664	104,200	3,972
Other fish.....					10,210	102
Crabs.....	74,976	10,215	25,300	1,725	1,239,758	21,866
Total.....	1,217,756	73,955	806,400	95,022	11,809,450	983,819

<sup>1</sup> 11,005 dozen.

## FISHERY PRODUCTS RECEIVED AT MUNICIPAL FISH WHARF AND MARKET, WASHINGTON, D. C.

Through the courtesy of the health department of the District of Columbia the Bureau has continued to receive daily reports of the quantity of fishery products received at the Municipal Fish Wharf and Market, Washington, D. C. These products, which are sold to the

retail markets of the city and also to some extent at retail at this market, it is estimated, represent about 60 per cent of the receipts for the city of Washington. In the following table, in which the statistics are given by months, it will be noted that the five most important products in terms of quantity are: Oysters, 2,146,107 pounds; squeteagues or "sea trout," 2,097,569 pounds; shad, 1,227,459 pounds; river herring, fresh and salted, 1,163,847 pounds; and croaker, 824,047 pounds; a total of 7,459,029 pounds, or 69.49 per cent of the entire receipts for the year, which amounted to 10,733,086 pounds. Such well-known forms as butterfish, carp, catfish, cod, croaker, eels, flounders, haddock, halibut, mullet, perch, pollock, squeteagues or "sea trout," striped bass, clams, oysters, and crabs, including crab meat, were received during each of the 12 months. March, April, and May were the months of the largest receipts; July and August, of the smallest.

FISHERY PRODUCTS RECEIVED AT MUNICIPAL FISH WHARF AND MARKET, WASHINGTON, D. C., IN 1919.

Species.	January.	February.	March.	April.	May.	June.	July.
	<i>Pounds.</i>						
Bass, black and sea.....	24,677	11,403	8,331	400	15,544	11,402	4,995
Bluefish.....	75			500	3,714	2,360	1,685
Bowfin.....	100						
Butterfish.....	16,912	3,375	8,990	4,775	39,750	49,860	73,395
Carp.....	8,996	6,743	8,984	19,354	21,903	6,645	4,464
Catfish.....	8,547	10,619	42,166	31,551	15,369	14,412	9,248
Cisco.....	500						
Cod.....	8,950	14,200	11,800	5,600	4,351	6,300	4,835
Crappie.....	5,097	800					
Crevalle.....	200						
Croaker.....	21,547	15,740	19,708	361,785	144,147	48,973	89,730
Drum, red.....		80					
Eels.....	83	553	3,355	2,569	1,878	500	446
Flounders.....	21,965	9,670	10,777	18,786	18,028	10,372	6,369
Gizzard shad.....	10,291	2,503		350	50	30	395
Haddock.....	19,700	24,275	23,150	11,950	10,350	9,400	8,585
Hake.....					100		
Halibut.....	2,168	10,857	3,850	4,800	3,625	3,125	5,775
Herring:							
River, fresh.....	31,133	79,278	281,011	491,501	116,389	285	-----
River, salted.....				6,750	98,750	28,750	-----
Hickory shad or "jacks".....	2,335	5,487	4,076	2,184	169	-----	-----
Kingfish.....				1,860	200	-----	-----
Mackerel.....	88,000	48,100	5,300	7,000	14,846	57,160	7,116
Mullet.....	1,874	5,369	366	200	110	55	128
Perch.....	20,542	29,558	62,500	35,073	12,518	5,327	4,775
Pigfish.....					300	-----	-----
Pike or pickerel.....	3,003	3,409	1,643	511			
Pollock.....	10,725	3,725	350	4,550	3,150	4,050	4,885
Salmon.....	450					187	150
Scup or porgy.....						500	600
Shad.....	14,509	38,422	254,349	751,846	149,423	6,232	-----
Sheepshead.....	600	860	200	200			-----
Smelt.....	3,175	875	125				-----
Snappers.....							328
Spot.....	2,400	200		2,200	4,980	1,926	23,543
Squeteagues or "sea trout".....	108,346	38,064	23,547	81,749	569,236	353,521	91,650
Striped bass.....	2,692	5,275	65,638	37,479	8,078	17,542	14,470
Sturgeon.....	66		50	400	307	162	-----
Tilefish.....	2,275	1,500	2,550	3,025	1,975	450	-----
Whitefish.....	200						-----
Whiting.....	43,093	66,389	30,569		600	4,200	16,000
Clams, hard.....	5,664	5,376	7,360	11,552	17,792	13,184	14,816
Oysters:							
In the shell.....	193,907	130,319	143,297	51,086	8,239	1,722	420
Opened.....	133,403	84,909	81,584	43,246	4,233	-----	-----
Squid.....					100		
Crabs.....		75	180	6,015	21,450	48,935	94,500
Crab meat.....	3,925	4,205	6,175	9,400	16,545	20,555	15,820
Lobster.....						50	75
Shrimp.....	1,690	1,650	650	450	1,550	1,218	-----
Terrapin.....	240						-----
Turtles.....	560				4,361	786	150
Total.....	824,515	663,863	1,112,631	2,011,597	1,334,335	730,504	499,020

## FISHERY PRODUCTS RECEIVED AT MUNICIPAL FISH WHARF AND MARKET, WASHINGTON, D. C., IN 1919—Continued.

Species.	August.	September.	October.	November.	December.	Total.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Bass, black and sea.....	356	914	10,905	14,355	27,323	130,610
Bluefish.....	8,634	8,310	12,350	3,500	2,600	43,728
Bowfin.....						100
Butterfish.....	50,525	31,664	23,000	6,900	350	309,496
Carp.....	4,814	8,497	11,496	9,073	5,974	116,933
Catfish.....	7,880	18,654	35,930	21,277	10,687	226,340
Cisco.....						500
Cod.....	1,000	3,025	8,400	10,400	10,220	89,081
Crappie.....						5,807
Crevaille.....						200
Croaker.....	40,157	13,700	42,700	24,510	1,350	824,047
Drum, red.....	400		1,200		300	1,980
Eels.....	208	805	3,029	1,629	556	15,611
Flounders.....	3,558	9,068	9,147	16,015	11,172	144,927
Gizzard shad.....	1,094	5,465	5,972	10,334	13,156	49,640
Haddock.....	4,025	17,725	12,350	11,800	13,600	166,910
Hake.....			1,600	36,400	14,300	52,400
Halibut.....	3,528	2,400	1,200	4,320	4,775	50,423
Herring:						
River, fresh.....						999,597
River, salted.....			30,000			164,250
Sea.....			1,400		42,400	42,800
Hickory shad or "jacks"						14,251
Kingfish.....		200		200		2,460
Mackerel.....	6,935	7,415	9,800	20,100	37,113	308,885
Mullet.....	287	858	1,233	4,769	953	16,202
Perch.....	4,512	3,184	7,714	16,451	12,560	214,714
Pigfish.....				1,600		1,900
Pike or pickerel.....	15	357	5,969	2,348	3,810	21,065
Pollock.....	1,010	2,800	5,600	16,400	18,000	75,245
Salmon.....	152		3,000	5,150	800	9,889
Scup or porgy.....	195	400				1,920
Shad.....	1,094	3,440	4,120	3,774	250	1,227,459
Sheepshead.....						1,860
Smelt.....					641	4,816
Snappers.....						328
Spot.....	5,392	28,377	37,300	6,200	600	113,118
Squeteagues or "sea trout"	195,446	243,108	239,287	104,700	48,915	2,097,569
Striped bass.....	7,984	25,833	37,788	28,676	12,056	263,511
Sturgeon.....	112					1,097
Tilefish.....			725	700	275	14,375
Tuna.....			460			460
Whitefish.....				400	200	800
Whiting.....	1,000	2,800	100	49,000	51,147	264,898
Clams, hard.....	11,904	7,328	9,888	6,656	6,496	118,016
Oysters:						
In the shell.....	700	34,293	168,945	280,518	170,772	<sup>2</sup> 1,184,218
Opened.....	2,568	34,716	121,789	235,245	220,196	<sup>3</sup> 961,889
Scallops.....			240	648	160	1,048
Squid.....						100
Crabs.....	47,640	20,985	4,170	75		244,025
Crab meat.....	12,595	1,190	6,660	8,035	4,555	109,660
Lobster.....			200		900	1,225
Shrimp.....	326		2,980	900	200	11,614
Terrapin.....						240
Turtles.....	237		1,835	100	820	8,849
Total.....	426,283	537,511	879,482	963,158	750,187	10,733,086

<sup>1</sup> Smoked.<sup>2</sup> 169,174 bushels. The oysters have been reduced to pounds on the basis of 7 pounds of meat to a bushel, and 8½ pounds to a gallon.<sup>3</sup> 116,592 gallons.

## SHAD FISHERY OF THE HUDSON RIVER.

The Bureau has collected the statistics of the shad fishery of the Hudson River without interruption for the five-year period 1915 to 1919, inclusive. In 1919 there were 299 men engaged in this fishery, using 158 boats valued at \$6,700, 373 gill nets valued at \$15,269, 12 seines valued at \$1,700, and shore and accessory property valued at \$7,920, a total investment of \$31,589. The catch numbered 90,301 fish, or 374,974 pounds, valued at \$83,724. Of this quantity

76,501 shad, or 301,306 pounds, valued at \$60,690, were taken on the New York side of the river and 13,800 fish, or 73,668 pounds, valued at \$23,034, on the New Jersey side.

From the table of comparative statistics it will be noted that this fishery reached its lowest level in 1916, not only in the size and value of the catch but in number of men engaged and boats and gear used. Compared with 1916 there was an increase in 1919 of 180 fishermen, or 151.26 per cent; of 88 boats, or 125.71 per cent; of 294 gill nets, or 372.15 per cent; of 9 haul seines, or 300 per cent; of 81,014 shad, or \$72.33 per cent; and of \$78,259 in the value of the product, or 1,432 per cent.

The principal apparatus of capture is the gill net. Of the total number of fish taken in 1915, 98 per cent were caught with gill nets; in 1916, 97 per cent; in 1917, 91 per cent; in 1918, 97 per cent; and in 1919, 98 per cent. The average number of fish taken per gill net for the various years follows: In 1915, 181; in 1916, 114; in 1917, 56; in 1918, 247; and 1919, 242. The value of the factor—that is, the average catch per gill net—as an index to the relative size of the runs of shad in the river is difficult to estimate. If this may be considered a reliable index, then the number of fish entering the river in 1917 was smaller than in 1916 and the runs for 1918 and 1919 were markedly larger than for the other years.

The results of the yearly canvasses are of considerable interest to those interested in the reestablishment of an extensive shad fishery in the Hudson River and in other rivers in which the supply has been seriously depleted as a source of possible light on the effects of protective measures which have been promulgated to afford better protection and to allow more fish to reach the spawning grounds.

## SHAD FISHERY OF THE HUDSON RIVER, 1919.

Items.	New York.			New Jersey.			Total.		
	Number.	Pounds.	Value.	Number.	Pounds.	Value.	Number.	Pounds.	Value.
Fishermen.....	290			9			299		
Rowboats.....	154		\$6,205	3		\$375	157		\$6,580
Gasoline.....	1		120				1		120
Gill nets.....	359		13,469	14		1,800	373		15,269
Seines.....	12		1,700				12		1,700
Shore and accessory property.....			3,920			4,000			7,920
Total.....			25,414			6,175			31,589
Shad caught:									
With gill nets.....	75,060	296,259	59,544	13,800	73,668	23,034	88,860	369,927	82,578
With seines.....	1,441	5,047	1,146				1,441	5,047	1,146
Total.....	76,501	301,306	60,690	13,800	73,668	23,034	90,301	374,974	83,724

## COMPARATIVE STATISTICS OF SHAD FISHERY OF THE HUDSON RIVER, 1915 to 1919.

Year.	Personnel and investment.						Catch.		
	Fisher-men.	Row-boats.	Gas boats.	Gill nets.	Haul seines.	Invest-ment.	Number.	Pounds.	Value.
1915.....	160	88	4	86	2	\$11,197	15,855	68,668	\$8,643
1916.....	119	67	3	79	3	7,845	9,287	40,173	5,465
1917.....	149	74	2	215	13	14,595	12,015	43,384	6,540
1918.....	227	123	2	273	15	20,107	67,403	234,602	48,184
1919.....	299	157	1	373	12	31,589	90,301	374,974	83,724

## SHAD AND ALEWIFE FISHERY OF THE POTOMAC RIVER.

The results of a yearly canvass of the shad fishery of the Hudson River where no shad-cultural operations are being practiced is given above. Believing that data of value might result from annual canvasses for a river on which extensive shad-cultural operations are being conducted, a canvass of the shad and alewife fisheries of the Potomac River for 1919 has been made, and it is planned to continue this canvass.

In 1919 there were 789 persons engaged in this fishery, using 514 boats valued at \$80,685; 306 pound nets valued at \$159,810; 267 gill nets and one haul seine, the latter being operated in Maryland, valued at \$26,761; and shore and accessory property valued at \$610; a total investment of \$267,866. The catch of shad numbered 544,469, or 2,040,473 pounds, valued at \$332,397. Of this quantity 94,512 shad, or 342,988 pounds, valued at \$56,833, were taken by Maryland fishermen, and 449,957 shad, or 1,697,485 pounds, valued at \$275,564, by Virginia fishermen. The catch of alewives numbered 8,867,902, or 3,676,921 pounds, valued at \$61,016. Of this quantity, 1,488,583 alewives, or 772,867 pounds, valued at \$15,508, were taken by Maryland fishermen and 7,379,319 alewives, or 2,904,054 pounds, valued at \$45,508, by Virginia fishermen.

As shown by the table of comparative statistics, the catch of shad in 1919 was much larger than in any of the years since 1901 for which statistical canvasses have been made. Compared with 1915, there was an increase of 198.5 per cent in the number of fish taken and 360.8 per cent in value. Whereas some years ago the river channel was in places practically closed by pound nets and the continued existence of a commercial fishery threatened through the inability of sufficient fish to reach the spawning ground, at present such nets may be set out from shore at a distance not greater than one-third the width of the river.

## SHAD AND ALEWIFE FISHERY OF THE POTOMAC RIVER, 1919.

Items.	Maryland.			Virginia.			Total.		
	Number.	Pounds.	Value.	Number.	Pounds.	Value.	Number.	Pounds.	Value.
Fishermen.....	227			562			789		
Rowboats.....	82		\$3,300	220		\$6,972	302		\$10,272
Gasoline.....	33		7,255	179		63,158	212		70,413
Pound nets.....	101		12,400	205		147,410	306		159,810
Gill nets and seines <sup>1</sup> .....	65		9,253	203		17,508	268		26,761
Shore and accessory property.....			25			585			610
<b>Total.....</b>			<b>32,233</b>			<b>235,633</b>			<b>267,866</b>
<b>Shad caught:</b>									
With pound nets.....	8,941	36,061	5,498	251,986	951,954	166,694	260,927	988,015	172,192
With gill nets and seines <sup>1</sup> .....	85,571	306,927	51,335	197,971	745,531	108,870	283,542	1,052,458	160,205
<b>Total.....</b>	<b>94,512</b>	<b>342,988</b>	<b>56,833</b>	<b>449,957</b>	<b>1,697,485</b>	<b>275,564</b>	<b>544,469</b>	<b>2,040,473</b>	<b>332,397</b>
<b>Alewives caught:</b>									
With pound nets.....	1,258,083	691,500	13,158	6,486,719	2,606,520	34,550	7,744,802	3,298,020	47,708
With gill nets and seines <sup>1</sup> .....	230,500	81,367	2,350	892,600	297,534	10,958	1,123,100	378,901	13,308
<b>Total.....</b>	<b>1,488,583</b>	<b>772,867</b>	<b>15,508</b>	<b>7,379,319</b>	<b>2,904,054</b>	<b>45,508</b>	<b>8,867,902</b>	<b>3,676,921</b>	<b>61,016</b>

<sup>1</sup> Includes one haul seine, with the catch, operated in Maryland.

## COMPARATIVE STATISTICS OF PRODUCTS OF SHAD AND ALEWIFE FISHERY OF THE POTOMAC RIVER FOR VARIOUS YEARS FROM 1896 TO 1919.

Year.	Maryland.		Virginia.		Total.	
	<i>Number.</i>	<i>Value.</i>	<i>Number.</i>	<i>Value.</i>	<i>Number.</i>	<i>Value.</i>
Shad:						
1896.....	233,238	\$20,524	450,825	\$43,081	684,063	\$63,608
1901.....	146,000	14,800	648,422	104,566	794,462	119,366
1904.....	83,147	16,343	289,500	51,709	372,647	68,052
1909.....	31,158	9,232	172,813	44,500	203,971	53,732
1915.....	17,196	6,827	165,206	65,300	182,402	72,127
1919.....	94,512	56,833	449,957	275,564	544,469	332,397
Alewives:						
1909.....	4,883,000	10,369	24,601,040	42,854	29,484,040	53,223
1915.....	335,000	1,420	7,276,428	30,741	7,611,428	32,161
1919.....	1,488,583	15,508	7,379,319	45,508	8,867,902	61,016

## FISHERIES OF THE GREAT LAKES, LAKE OF THE WOODS, AND RAINY LAKE IN 1917.

The statistics of the fisheries of the Great Lakes, and Lake of the Woods, Rainy Lake, and Lakes Kabetogama and Ia Croix, Minn., presented in this report are for the calendar year 1917. The canvass of these fisheries was made by Winthrop A. Roberts and Rob Leon Greer, agents of this Bureau, and the statistics obtained have already been published in condensed form in Statistical Bulletin No. 436, and in "Fishery Industries of the United States. Report of the Division of Statistics and Methods of the Fisheries for 1918," Appendix X, Report, U. S. Commissioner of Fisheries, 1918, pages 42 to 47. The detailed statistics are published for the first time in the present report.

## EARLIER PUBLICATIONS.

Earlier publications relating to the fisheries of the Great Lakes and published in Washington, D. C., are the following:

- The Fisheries of the Great Lakes. Elaborated from notes gathered by Mr. Ludwig Kumlien, by Frederick W. True. The Fishery Industries of the United States, 1887, Section II, A Geographical Review of the Fisheries Industries and Fishing Communities for the year 1880, pp. 631-673.
- The Fisheries of the Great Lakes, by Ludwig Kumlien. The Fishery Industries of the United States, 1887, Section V, vol. 1, pp. 755-769.
- Report on an Investigation of the Fisheries of Lake Ontario, by Hugh M. Smith. Bulletin, U. S. Fish Commission, Vol. X, 1890, pp. 177-215.
- Review of the Fisheries of the Great Lakes in 1885, compiled by Hugh M. Smith and Merwin-Marie Snell, with Introduction and Description of Fishing Vessels by J. W. Collins. Appendix. Report of Commissioner, U. S. Commission of Fish and Fisheries, 1887, pp. 1-333.
- Report on the Fisheries of the Great Lakes, by Hugh M. Smith. Appendix, Report of Commissioner, U. S. Commission of Fish and Fisheries, 1892, pp. 361-462.
- Report of the Division of Statistics and Methods of the Fisheries, by Hugh M. Smith. Report of Commissioner, U. S. Commission of Fish and Fisheries, 1895, pp. 93-103.
- Report of the Joint Commission relative to the Preservation of the Fisheries in Waters Contiguous to Canada and the United States, by Richard Rathbun and William Wakeham. House Executive Document No. 315, Fifty-fourth Congress, second session, 1897, pp. 1-178.
- Fisheries of Lake Ontario. Report of Commissioner, U. S. Commission of Fish and Fisheries, 1898, pp. CLII-CLVI.
- Statistics of Certain Fisheries of the New England and Middle Atlantic States and the Great Lakes. Report, U. S. Fish Commission, 1898, pp. CLXVI-CLXXV. (In this report the figures presented relate to the fiscal year 1897.)

Statistics of the Fisheries of the Great Lakes. Appendix, Report of Commissioner, U. S. Commission of Fish and Fisheries, 1901, pp. 575-657.  
 Statistics of the Fisheries of the Great Lakes in 1903. Appendix, Report, U. S. Bureau of Fisheries, 1904, pp. 643-731.  
 Fisheries of the United States, 1908. Special Report, Bureau of the Census, 1911.

## COMMON AND SCIENTIFIC NAMES OF FISHES OF THE GREAT LAKES.

For the sake of clarity as to the species referred to in the tables and discussions of the fisheries of the Great Lakes, the following list of common and scientific names of fishes is appended, the common name being the first given in every instance.

Bowfin.....	<i>Ameiurus calvus.</i>
Burbot.....	<i>Lota maculosa.</i>
Carp, Asiatic.....	<i>Cyprinus carpio.</i>
Catfish.....	{ <i>Ameiurus</i> (species). <i>Ictalurus punctatus.</i>
Ciscoes <sup>1</sup> .....	<i>Leucichthys</i> (species). <sup>1</sup>
Eel.....	<i>Anguilla chryssa.</i>
Gold-eye.....	<i>Amphiodon alosoides.</i>
Muskellunge.....	<i>Esox masquinongy.</i>
Pike.....	{ <i>Esox lucius.</i> <i>Esox vermiculatus.</i>
Pike perch (blue pike).....	<i>Stizostedion vitreum.</i>
Pike perch (wall-eyed or yellow pike).....	<i>Stizostedion vitreum.</i>
Rock bass.....	<i>Ambloplites rupestris.</i>
Sauger.....	<i>Stizostedion canadense griseum.</i>
Sheepshead or drum.....	<i>Aplodinotus grunniens.</i>
Sturgeon.....	<i>Acipenser rubicundus.</i>
Suckers.....	<i>Catostomidæ</i> (species).
Sunfishes.....	<i>Centrarchidæ</i> (species).
Trout, lake.....	<i>Crystallomer namaycush.</i>
Trout, steelhead.....	<i>Salmo gairdneri.</i>
White bass.....	<i>Roccus chrysops.</i>
Whitefish, common.....	{ <i>Coregonus clupeiformis.</i> <i>Coregonus albus.</i>
Whitefish, menominee.....	<i>Coregonus quadrilateralis.</i>
Yellow perch.....	<i>Perca flavescens.</i>

## GENERAL STATISTICS.

In presenting the detailed statistics of the fisheries of the Great Lakes it has been necessary to make some revisions of the preliminary statistics previously published, and the statistics of the fisheries of Lake of the Woods, Rainy Lake, and Lakes Kabetogama and La Croix are shown in separate tables.

The number of persons engaged in the fisheries of this entire region in 1917 was 9,416; the investment was \$10,732,879; and the products amounted to 106,436,392 pounds, valued at \$6,413,527.

In the fisheries of the Great Lakes in 1917 the number of persons engaged was 9,221, of whom 2,141 were on vessels fishing and transporting fishery products, 5,076 in the shore or boat fisheries, and 2,004 employed as shormen in the fisheries and wholesale fishery trade. In the fisheries of the various lakes the number of persons engaged was as follows: Superior, 1,348; Michigan, 3,313; Huron, 1,348; St. Clair and the St. Clair River, 64; Erie, 2,770; and Ontario, including the St. Lawrence and Niagara Rivers, 378. Compared with the returns for 1903, the year for which the last previous canvass was made by

<sup>1</sup> Includes lake herring, chub, longjaw, bluefin or blackfin, and tullibee.

the Bureau, there was an increase of 430 persons in Lake Superior, 72 in Lake Michigan, and 43 in Lake Erie, but a decrease of 356 in Lake Huron, 291 in Lake St. Clair and St. Clair River, and 10 in Lake Ontario, a total decrease of 112.

The investment in the fisheries and related industries amounted to \$10,555,669, apportioned among the lakes as follows: Superior, \$841,006; Michigan, \$4,038,927; Huron, \$1,188,705; St. Clair and St. Clair River, \$15,955; Erie, \$4,332,767; and Ontario, \$138,309.

The investment included 585 steam and gasoline vessels engaged in fishing and transporting fishery products, of 7,844 net tons, valued at \$1,512,983, with outfits valued at \$372,106; 3,354 sail, row, and power boats valued at \$536,763; fishing apparatus used on vessels and boats to the value of \$2,630,388; shore and accessory property valued at \$4,478,143; and cash capital amounting to \$1,025,286. The apparatus of capture consisted principally of 8,333 pound nets and trap nets valued at \$1,179,256 and 153,277 gill nets valued at \$1,237,702. The investment, as compared with the returns for 1903, has increased in all the lakes except Lake St. Clair, the total increase being \$3,081,247.

The products of the fisheries amounted to 104,269,223 pounds, having a value to the fishermen of \$6,695,019. The yield of the various lakes was as follows: Superior, 15,547,432 pounds, valued at \$726,674; Michigan, 35,460,628 pounds, valued at \$2,270,859; Huron, 13,363,207 pounds, valued at \$857,478; St. Clair and the St. Clair River, 133,330 pounds, valued at \$11,852; Erie, 38,710,238 pounds, valued at \$2,327,299; and Ontario and the St. Lawrence and Niagara Rivers, 1,054,388 pounds, valued at \$100,857.

The principal species taken, including fresh, salted, and smoked fish, were carp, 7,563,347 pounds, valued at \$331,938; ciscoes, which include lake herring, chub, longjaw, bluefin or blackfin, and tullibee, 53,529,325 pounds, valued at \$2,609,917; pike perch, which include blue pike and wall-eyed or yellow pike, 4,599,524 pounds, valued at \$438,299; sauger, 3,929,172 pounds, valued at \$240,035; sheepshead or drum, 2,901,994 pounds, valued at \$70,936; suckers, 5,362,428 pounds, valued at \$204,881; lake trout, 13,344,139 pounds, valued at \$1,286,704; whitefish, common, including caviar, 6,192,123 pounds, valued at \$723,424; and yellow perch, 4,206,011 pounds, valued at \$245,223. Various other species were also taken in considerable quantities. Compared with the returns for 1903, there has been an increase in the products of the fisheries of the Great Lakes of 18,074,-406 pounds in quantity and of \$3,549,518 in value. There has been considerable increase in both the quantity and value of the products in Lake Superior, Lake Michigan, Lake Huron, and Lake Erie, but a decrease in both quantity and value in Lake St. Clair, and a decrease in quantity with a large increase in value in Lake Ontario.

Compared with the returns for 1908, published by the Bureau of the Census, there was an increase of 8.06 per cent in the number of persons engaged, and of 119.27 per cent in the amount of capital invested, but there was a decrease of 2.21 per cent in the quantity, with an increase of 67.10 per cent in the value of the products. There was a large increase in the catch of burbot, cisco or lake herring, sheepshead or drum, and lake trout, but a decrease in carp, pike, pike perch, whitefish, and a number of other species. Compared with the statistics for 1903, published by the Bureau, there was a decrease of

1.20 per cent in the number of persons engaged, but an increase of 41.22 per cent in the amount of capital invested, and of 20.96 per cent in the quantity, and 129.28 per cent in the value of the products. There was considerable increase in nearly all of the more important species except pike perch, lake trout, and yellow perch. The increase in burbot, and possibly some of the other species, is, no doubt, due to the work of the Bureau in encouraging the more extensive use as food of species heretofore little used for that purpose.

The following tables present by lakes the number of persons engaged, the amount of capital invested, and the quantity and value of the products of the fisheries of the Great Lakes in 1917, and also comparative statistics of the extent of these fisheries in various years from 1880 to 1917:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF THE GREAT LAKES IN 1917.

Items.	Lake Superior.		Lake Michigan.		Lake Huron.		Lake St. Clair. <sup>1</sup>	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>								
On vessels fishing.....	166		1,096		149			
On vessels transporting.....	51		81		29			
Inshore fisheries.....	854		1,285		1,023		64	
Shoreshmen.....	277		851		147			
<b>Total.....</b>	<b>1,348</b>		<b>3,313</b>		<b>1,348</b>		<b>64</b>	
<b>INVESTMENT.</b>								
Vessels fishing, steam.....	12	\$52,800	92	\$397,650	13	\$57,500		
Tonnage.....	302		1,795		266			
Outfit.....		11,080		122,885		22,450		
Vessels, fishing, gasoline.....	4	20,500	240	234,310	13	19,000		
Tonnage.....	104		2,113		113			
Outfit.....		5,550		56,636		5,540		
Vessels, transporting, steam.....	4	56,000			2	7,000		
Tonnage.....	194				24			
Outfit.....		17,880				500		
Vessels, transporting, gasoline.....	7	19,500	60	38,225	19	33,500		
Tonnage.....	68		495		169			
Outfit.....		3,915		4,515		4,750		
Sail and row boats.....	417	10,220	428	9,943	310	8,020	60	\$1,640
Power boats.....	280	82,405	311	91,595	260	103,960	4	900
Apparatus, vessel fisheries:								
Gill nets.....	1,806	31,995	57,453	535,616	6,613	69,575		
Lines.....		960		25,733		3,844		
Apparatus, shore fisheries:								
Pound nets and trap nets.....	204	26,262	1,134	242,570	1,731	207,904		
Gill nets.....	9,311	112,991	26,354	109,458	3,997	33,260		
Fyke nets.....			3,343	39,795	77	12,135		
Seine.....	5	325	61	18,120	77	7,960	6	1,365
Lines.....		4,813		2,135		2,095		50
Crawfish pots.....			6,400	1,600				
Other apparatus.....						1,520		
Shore and accessory property.....	341	310	1,758	341		432,092		12,000
Cash capital.....		42,500		349,800		156,100		
<b>Total.....</b>	<b>841,006</b>		<b>4,038,927</b>		<b>1,188,705</b>		<b>15,955</b>	
<b>PRODUCTS.</b>								
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bowfin.....	2,675	170			200	4		
Burbot.....			166,785	1,436	2,174	51		
Carp, Asiatic.....			246,503	7,500	1,145,250	43,474	85,330	4,652
Catfish and bullheads.....			164,466	6,627	33,329	3,295		
Ciscoes:								
Fresh.....	5,692,498	169,048	15,341,588	706,638	3,277,573	120,705		
Frozen.....	3,302,357	150,810						
Salted.....	3,258,227	139,959	2,917,766	139,344	2,100,792	94,957		
Smoked.....	5,400	432				3,000		120
Muskellunge.....						145		15
Pike.....	5,700	555	40,597	3,375	12,354	1,175		

<sup>1</sup> Includes St. Clair River.

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF THE GREAT LAKES IN 1917—Continued.

Items.	Lake Superior.		Lake Michigan.		Lake Huron.		Lake St. Clair.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
PRODUCTS—continued.								
Pike perch:								
Wall-eyed or yellow pike, fresh.....	27,979	\$3,774	132,024	\$18,445	994,642	\$119,231	48,000	\$7,200
Wall-eyed or yellow pike, salted.....						30		
Rock bass.....			1,714	137	4,283	208		
Sheepshead or drum.....			28,412	796	17,731	615		
Sturgeon.....			10,805	2,517	4,886	1,063		
Sturgeon caviar.....			346	904	227	495		
Suckers:								
Fresh.....	326,203	13,184	2,104,453	74,859	1,775,767	72,883		
Salted.....	15,850	560	14,110	625	1,000	50		
Sunfishes.....					1,650	68		
Trout, lake:								
Fresh.....	2,537,081	209,597	8,647,895	852,879	2,070,797	213,790		
Frozen.....	44,000	5,800						
Salted.....	7,272	576	2,820	259	8,658	784		
Trout, steelhead.....			21,950	3,349				
White bass.....			1,275	77				
Whitefish:								
Common, fresh.....	302,210	30,943	3,045,448	323,162	993,501	124,050		
Common, salted.....			1,945	201	3,350	330		
Common, caviar.....					1,375	257		
Menominee, fresh.....	12,080	682	100,332	4,829	46,457	2,191		
Menominee, salted.....	2,900	228	26,103	1,973	20,017	1,200		
Yellow perch:								
Fresh.....	5,000	356	2,361,071	116,419	844,019	56,464		
Salted.....			1,725	81				
Crawfish.....			80,498	4,427				
Total.....	15,547,432	726,674	35,460,628	2,270,859	13,363,207	857,478	133,330	11,852

Items.	Lake Erie. <sup>1</sup>		Lake Ontario. <sup>2</sup>		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
PERSONS ENGAGED.						
On vessels fishing.....	517		2		1,930	
On vessels transporting.....	48		2		211	
Inshore fisheries.....	1,487		363		5,076	
Shoresmen.....	718		11		2,004	
Total.....	2,770		378		9,221	
INVESTMENT.						
Vessels, fishing, steam.....	73	\$469,398			190	\$977,348
Tonnage.....	1,700				4,063	
Outfit.....		93,679	1			249,494
Vessels, fishing, gasoline.....	20	39,000	1	\$1,200	278	314,010
Tonnage.....	183		8		2,521	
Outfit.....		7,986		20		76,332
Vessels, transporting, steam.....	5	24,500			11	87,500
Tonnage.....	111				329	
Outfit.....		5,200				23,580
Vessels, transporting, gasoline.....	19	41,600	1	1,300	106	134,125
Tonnage.....	193		10		935	
Outfit.....		9,455		65		22,700
Sail and row boats.....	602	27,370	189	4,765	2,006	61,958
Power boats.....	414	178,815	79	17,130	1,348	474,805
Apparatus, vessel fisheries:						
Gill nets.....	38,007	272,577	3	40	103,882	909,803
Lines.....						30,537
Apparatus, shore fisheries:						
Pound nets and trap nets.....	5,011	681,060	353	21,460	8,433	1,179,256
Gill nets.....	9,571	57,055	162	15,135	49,395	327,899
Fyke nets.....	801	44,403	334	4,374	4,938	100,707
Seines.....	285	38,867	12	610	446	67,247
Lines.....		741		1,174		11,008
Crawfish pots.....					6,400	1,600
Fishing machines.....				7	795	795
Other apparatus.....		10		6		1,536
Shore and accessory property.....		1,884,165		50,235		4,478,143
Cash capital.....		456,886		20,000		1,025,286
Total.....		4,332,767		138,309		10,555,669

<sup>1</sup> Includes men and investment in the wholesale fish trade of Detroit.<sup>2</sup> Includes St. Lawrence and Niagara Rivers.

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF THE GREAT LAKES IN 1917—Continued.

Items.	Lake Erie.		Lake Ontario.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>PRODUCTS.</b>						
Bowfin.....	5,165	\$69	7,046	\$350	15,086	\$593
Burbot.....	652,870	8,027	61,760	2,388	883,589	11,902
Carp, Asiatic.....	6,044,792	274,139	41,472	2,173	7,563,347	331,938
Catfish and bullheads.....	628,532	39,232	47,934	5,935	874,261	55,089
Ciscoes:						
Fresh.....	17,160,852	1,046,862	460,303	39,991	41,932,874	2,083,244
Frozen.....					3,302,357	150,810
Salted.....			8,909	1,051	8,285,694	375,311
Smoked.....					8,400	552
Eel.....			43,007	3,402	43,007	2,402
Gold-eye.....	10,335	104			10,335	104
Muskellunge.....					145	15
Pike.....	5,666	550	16,191	2,149	80,508	7,804
Pike perch:						
Blue pike.....	2,057,073	135,241	45,730	4,784	2,102,803	140,025
Wall-eyed or yellow pike, fresh.....	1,291,456	149,163	2,590	458	2,496,691	298,271
Wall-eyed or yellow pike, salted.....					30	3
Rock bass.....	100	5	7,525	463	13,622	813
Sauger.....	3,929,172	240,035			3,929,172	240,035
Sheepshead or drum.....	2,855,551	69,502	300	23	2,901,994	70,93
Sturgeon.....	28,384	6,064	51,141	12,057	95,216	21,701
Sturgeon, caviar.....	1,018	2,045	544	1,232	2,135	4,676
Suckers:						
Fresh.....	1,035,934	36,403	89,111	6,317	5,331,468	203,646
Salted.....					30,960	1,235
Sunfishes.....			23,885	1,327	25,535	1,395
Trout, lake:						
Fresh.....	1,922	201	23,694	2,818	13,281,389	1,279,285
Frozen.....					44,000	5,800
Salted.....					18,750	1,619
Trout, steelhead.....					21,950	3,349
White bass.....	286,112	17,212			287,387	17,289
Whitefish:						
Common, fresh.....	1,755,947	232,761	88,347	11,720	6,185,453	722,636
Common, salted.....					5,295	531
Common, caviar.....					1,375	257
Menominee, fresh.....					158,869	7,702
Menominee, salted.....					49,020	3,401
Yellow perch:						
Fresh.....	959,357	69,684	34,839	2,219	4,204,286	245,142
Salted.....					1,725	81
Crawfish.....					80,495	4,427
<b>Total.....</b>	<b>38,710,238</b>	<b>2,327,299</b>	<b>1,054,388</b>	<b>100,857</b>	<b>104,269,223</b>	<b>6,295,019</b>

## COMPARATIVE STATISTICS OF THE FISHERIES OF THE GREAT LAKES FOR VARIOUS YEARS FROM 1880 TO 1917.

## PERSONS ENGAGED.

Lake.	1880	1885	1890	1893	1899	1903	1908	1917
Superior.....	414	914	653	916	613	918	792	1,348
Michigan.....	1,578	3,379	2,877	3,928	3,255	3,241	2,706	3,313
Huron.....	470	892	726	944	1,241	1,704	1,382	1,348
St. Clair <sup>1</sup> .....	356	272	611	529	442	355	221	64
Erie <sup>2</sup> .....	1,620	4,298	4,482	3,622	3,728	2,727	3,142	2,770
Ontario <sup>3</sup> .....	612	600	389	241	391	388	296	378
<b>Total.....</b>	<b>5,050</b>	<b>10,355</b>	<b>9,738</b>	<b>10,180</b>	<b>9,670</b>	<b>9,333</b>	<b>8,539</b>	<b>9,221</b>

<sup>1</sup> Includes St. Clair and Detroit Rivers. There was no fishing in Detroit River in 1917.<sup>2</sup> Includes persons in wholesale trade of Detroit, Mich.<sup>3</sup> Includes St. Lawrence and Niagara Rivers.

## COMPARATIVE STATISTICS OF THE FISHERIES OF THE GREAT LAKES FOR VARIOUS YEARS FROM 1880 TO 1917—Continued.

## APPARATUS AND CAPITAL EMPLOYED.

Lake and year.	Vessels and boats. <sup>1</sup>		Pound nets and trap nets.		Gill nets.		Seines.		Value of other apparatus. <sup>2</sup>		Shore property and cash capital.	Total.
	Num-ber.	Value.	Num-ber.	Value.	Num-ber.	Value.	Num-ber.	Value.	Value.	Value.		
<b>Superior:</b>												
1880.....	161	\$26,240	43	\$14,950	4,630	\$25,280	32	\$2,010	\$200	\$12,700	\$81,380	\$81,380
1885.....	519	100,735	230	67,520	7,557	78,082	43	2,920	1,155	177,521	427,933	427,933
1890.....	328	85,275	140	34,435	5,974	63,476	19	955	2,763	179,778	366,682	366,682
1893.....	447	139,035	276	63,415	8,899	87,680	14	500	1,565	209,512	529,024	529,024
1899.....	315	69,045	162	25,820	7,229	99,283	1	50	1,058	167,023	372,083	372,083
1903.....	378	141,109	218	27,793	10,169	127,238	8	335	815	299,032	596,322	596,322
1908.....	.....	149,000	.....	.....	.....	.....	.....	.....	159,009	83,000	391,000	391,000
1917.....	724	241,425	204	26,262	11,117	144,986	5	325	5,773	383,810	802,581	802,581
<b>Michigan:</b>												
1880.....	836	133,375	476	185,425	24,599	124,740	19	2,040	1,455	104,100	551,135	551,135
1885.....	1,402	368,326	715	253,840	58,516	326,902	87	6,950	13,457	788,356	1,757,831	1,757,831
1890.....	1,102	266,331	844	244,880	49,896	215,914	30	3,480	13,460	693,169	1,437,224	1,437,224
1893.....	1,549	357,987	785	181,385	54,232	352,084	28	2,529	27,863	1,092,219	2,063,497	2,063,497
1899.....	1,178	281,968	805	186,349	49,857	288,395	11	510	29,285	2,087,829	2,915,241	2,915,241
1903.....	1,363	386,396	980	198,960	48,645	269,754	44	2,384	37,743	2,593,950	3,489,187	3,489,187
1908.....	.....	692,000	.....	.....	.....	.....	.....	.....	753,000	519,000	1,964,000	1,964,000
1917.....	1,131	771,723	1,133	242,570	83,807	645,074	61	18,129	69,263	2,108,141	3,854,891	3,854,891
<b>Huron:</b>												
1880.....	111	20,905	189	49,425	3,360	20,609	28	5,600	3,500	3,700	103,730	103,730
1885.....	561	72,946	586	113,350	3,444	35,333	.....	.....	23,100	140,620	385,349	385,349
1890.....	417	36,898	551	85,515	2,206	21,665	6	600	7,155	254,025	408,858	408,858
1893.....	520	87,645	731	108,508	4,923	53,071	1	75	3,807	236,285	503,700	503,700
1899.....	539	87,585	996	111,839	5,676	54,384	9	673	8,188	203,989	474,953	474,953
1903.....	643	126,418	1,685	176,495	6,129	51,526	18	608	13,977	482,615	851,637	851,637
1908.....	.....	185,000	.....	.....	.....	.....	.....	.....	281,000	267,000	733,000	733,000
1917.....	617	228,980	1,731	207,904	10,610	102,835	77	7,960	19,594	588,192	1,155,465	1,155,465
<b>St. Clair:<sup>3</sup></b>												
1880.....	52	8,000	.....	.....	180	1,080	42	6,000	1,500	24,000	40,580	40,580
1885.....	215	7,457	57	12,550	23	1,600	34	8,225	3,819	218,270	251,081	251,081
1890.....	166	28,773	34	9,450	814	9,418	28	6,240	5,589	150,682	210,145	210,145
1893.....	211	13,728	91	7,400	380	4,260	20	3,025	2,346	206,672	240,076	240,076
1899.....	188	3,770	5	1,050	60	600	13	1,255	915	46,945	54,535	54,535
1903.....	150	3,150	.....	.....	.....	.....	6	899	961	234,884	239,885	239,885
1908.....	.....	10,000	.....	.....	.....	.....	.....	.....	8,000	28,000	46,000	46,000
1917.....	64	2,540	.....	.....	.....	.....	6	1,365	50	12,000	15,955	15,955
<b>Erie:</b>												
1880.....	692	\$3,880	758	233,600	5,775	22,500	18	2,800	8,645	163,675	515,100	515,100
1885.....	1,536	298,757	1,028	259,785	22,644	75,507	71	8,320	72,203	847,564	1,562,138	1,562,138
1890.....	1,449	524,033	1,893	548,100	49,320	169,513	44	5,305	70,601	1,592,750	2,816,392	2,816,392
1893.....	1,146	424,227	1,783	439,069	35,369	164,683	47	4,440	23,339	1,423,017	2,506,842	2,506,842
1899.....	980	435,566	1,724	329,500	41,678	224,182	104	8,399	19,362	1,614,677	2,720,554	2,720,554
1903.....	608	490,236	1,469	172,805	35,150	180,581	110	8,049	18,350	1,326,385	2,196,397	2,196,397
1908.....	.....	603,000	.....	.....	.....	.....	.....	.....	615,000	426,000	1,644,000	1,644,000
1917.....	1,133	780,683	5,011	681,060	47,578	329,632	285	38,867	45,154	2,341,051	4,216,447	4,216,447
<b>Ontario:<sup>4</sup></b>												
1880.....	167	13,100	34	14,000	6,000	20,000	9	1,950	.....	5,000	54,050	54,050
1885.....	467	20,448	350	19,445	4,722	23,952	69	3,177	12,627	56,100	135,749	135,749
1890.....	376	31,162	288	24,577	2,345	18,110	27	656	10,361	38,667	123,533	123,533
1893.....	177	9,619	77	2,310	1,185	8,794	7	175	2,240	32,250	56,131	56,131
1899.....	289	9,482	145	5,850	1,187	18,674	24	420	7,194	38,640	80,350	80,350
1903.....	234	15,457	176	9,945	1,796	13,862	8	205	9,303	52,220	100,992	100,992
1908.....	.....	11,000	.....	.....	.....	.....	.....	.....	16,000	7,900	34,900	34,900
1917.....	270	24,395	353	21,460	165	15,175	12	610	6,349	70,235	138,224	138,224
<b>All lakes:</b>												
1880.....	1,929	285,500	1,500	497,400	44,544	214,200	148	20,400	15,300	313,175	1,345,975	1,345,975
1885.....	4,700	868,669	2,966	726,490	96,906	539,956	304	30,192	126,363	2,228,431	4,520,081	4,520,081
1890.....	3,838	968,474	3,750	949,957	101,555	498,096	154	17,236	109,920	2,819,061	5,362,774	5,362,774
1893.....	4,030	1,032,241	3,743	892,078	104,988	670,572	117	10,735	61,160	3,199,955	5,893,270	5,893,270
1899.....	3,489	887,416	3,837	660,408	105,687	690,518	162	11,298	66,002	4,169,103	6,617,716	6,617,716
1903.....	3,376	1,162,766	4,528	585,998	101,889	642,961	194	12,462	81,149	4,989,086	7,474,422	7,474,422
1908.....	.....	1,651,000	.....	.....	.....	.....	.....	.....	1,831,000	1,332,000	4,814,000	4,814,000
1917.....	3,939	2,049,746	8,433	1,179,256	153,277	1,237,702	446	67,247	115,586	5,503,429	10,183,563	10,183,563

<sup>1</sup> In 1908 the outfit of the vessels is included in the value.<sup>2</sup> Includes all forms of apparatus in 1908.<sup>3</sup> Includes St. Clair and Detroit Rivers. There was no fishing in Detroit River in 1917.<sup>4</sup> Includes St. Lawrence and Niagara Rivers.

## COMPARATIVE STATISTICS OF THE FISHERIES OF THE GREAT LAKES FOR VARIOUS YEARS FROM 1880 TO 1917—Continued.

PRODUCTS.<sup>1</sup>

Lake and year.	Whitefish.	Trout.	Ciscoes.	Sturgeon.	All other.	Total.	
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Value.</i>
Superior:							
1880.....	2,257,000	1,464,750	34,000		60,875	3,816,625	\$118,370
1885.....	4,571,947	3,488,177	324,680	182,760	258,416	8,825,980	291,523
1890.....	3,213,176	2,613,378	199,121	47,482	42,835	6,115,992	220,968
1893.....	2,732,270	4,342,122	660,272	62,052	300,211	8,096,927	252,107
1899.....	693,191	3,118,169	1,125,478	4,415	488,401	5,429,654	150,862
1903.....	794,022	4,954,830	4,742,805	13,137	2,700,219	13,205,013	343,671
1908.....	910,100	2,752,200	5,587,600	67,600	878,000	10,195,500	342,000
1917.....	302,210	2,588,353	12,258,482		398,387	15,547,432	726,674
Michigan:							
1880.....	12,030,400	2,659,450	3,050,400	3,839,600	1,562,025	23,141,875	668,400
1885.....	8,682,986	6,431,298	3,312,493	1,406,678	3,684,693	23,518,148	878,788
1890.....	5,455,079	8,364,167	6,082,082	946,897	5,586,041	26,434,266	830,465
1893.....	2,330,060	8,216,920	11,580,895	311,780	8,308,100	30,747,755	828,611
1899.....	1,510,364	5,488,947	21,573,716	108,279	5,818,690	34,499,996	876,743
1903.....	1,972,594	9,049,299	13,863,617	56,420	8,637,568	33,579,498	1,090,550
1908.....	2,490,900	7,892,000	21,842,000	70,500	7,521,900	39,817,300	1,554,000
1917.....	3,047,393	8,650,715	18,289,354	10,805	5,492,561	35,160,628	2,270,859
Huron:							
1880.....	2,700,778	2,084,500	246,800	204,000	1,969,195	7,205,273	195,277
1885.....	1,425,380	2,539,780	1,265,650	215,500	6,010,860	11,457,170	276,397
1890.....	1,004,094	1,505,619	2,514,551	365,718	4,606,399	10,056,381	221,067
1893.....	1,178,271	3,439,575	2,758,628	79,553	4,608,311	12,064,338	306,381
1899.....	592,308	1,887,101	3,699,807	30,497	6,208,614	12,418,327	308,078
1903.....	692,863	2,108,632	4,640,967	34,343	6,978,404	14,455,209	450,318
1908.....	719,000	1,358,800	4,791,000	9,900	6,053,300	12,932,000	486,000
1917.....	990,851	2,079,455	5,381,365	4,886	4,900,650	13,363,207	857,478
St. Clair: <sup>2</sup>							
1880.....	77,922		250,700	998,500	523,805	1,850,927	36,273
1885.....	41,125		1,208,150	227,780	708,740	2,185,795	40,193
1890.....	238,764	244,817	490,334	309,003	1,711,623	2,994,571	73,577
1893.....	50,950	72,000	140,112	54,106	1,497,143	1,814,311	46,030
1899.....	69,902	69,915		7,600	451,650	579,067	23,864
1903.....	25,591			8,500	487,550	521,941	21,594
1908.....				13,000	724,700	737,700	32,000
1917.....					133,330	133,330	11,852
Erie:							
1880.....	3,333,500	26,200	11,774,400	1,970,000	11,982,900	29,087,300	474,880
1885.....	3,531,857	106,900	19,354,900	4,727,950	23,734,912	51,456,517	1,109,006
1890.....	2,941,451	121,420	38,808,283	2,078,907	21,430,812	64,850,873	1,000,905
1893.....	1,292,410	203,132	20,931,076	793,800	19,747,907	42,968,325	805,979
1899.....	2,063,314	32,024	33,427,797	789,402	22,078,327	58,393,864	1,150,895
1903.....	302,805	15,127	8,788,625	300,103	13,781,896	23,188,556	780,015
1908.....	1,503,000	6,900	10,599,100	63,900	29,733,600	41,906,500	1,280,000
1917.....	1,759,947	1,922	17,160,852	28,384	19,703,133	38,710,238	2,327,299
Ontario: <sup>3</sup>							
1880.....	1,064,000	569,700	611,217	545,283	849,800	3,640,000	159,700
1885.....	90,711	20,510	403,585	386,974	1,496,686	2,398,466	95,869
1890.....	128,771	41,010	598,978	541,752	2,115,937	3,446,448	124,786
1893.....	45,380	6,204	164,998	125,293	586,140	928,015	31,510
1899.....	161,935	15,432	86,778	189,155	1,953,032	2,406,332	100,997
1903.....	25,384	4,050	121,315	226,095	867,756	1,244,600	59,353
1908.....	56,000	14,000	35,000	37,000	679,800	821,800	74,000
1917.....	88,347	23,694	469,272	51,141	421,934	1,054,388	100,857
All lakes:							
1880.....	21,463,900	6,804,600	15,967,517	7,557,383	16,948,600	68,742,000	1,652,900
1885.....	18,344,004	12,586,665	25,869,458	7,147,642	35,894,307	99,842,076	2,691,866
1890.....	12,401,335	12,890,441	48,753,349	4,289,759	35,563,647	113,898,531	2,471,768
1893.....	7,629,341	16,279,953	36,235,981	1,426,584	35,047,812	96,619,671	2,270,613
1899.....	5,094,014	10,611,588	59,913,576	1,129,348	36,978,714	113,727,240	2,611,439
1903.....	3,813,259	16,131,938	32,157,319	638,898	33,453,393	86,194,817	2,745,501
1908.....	5,679,000	12,023,900	42,854,700	261,900	45,591,300	106,410,800	3,765,000
1917.....	6,190,748	13,344,139	53,529,325	95,216	31,109,795	104,269,223	6,295,619

<sup>1</sup> In this table caviar and other secondary products are omitted except in 1893, 1899, and 1903. In 1880, 1885, and 1890 bluefin, longjaw, and menominee in Lake Michigan and menominee in Lake Huron are included with whitefish. In 1893 and 1899 bluefin in Lake Superior, bluefin and menominee in Lake Michigan, and menominee in Lake Huron are included with "all other," and longjaw in Lake Michigan with ciscoes. In 1903, bluefin, menominee, longjaw, and steelhead trout are included with "all other." In 1908 and 1917 ciscoes (herring) include longjaw, bluefin or blackfin, and tullibee.

The statistics for 1908 in these tables are from data published by the Bureau of the Census.

<sup>2</sup> Includes St. Clair and Detroit Rivers. There was no fishing in Detroit River in 1917.

<sup>3</sup> Includes St. Lawrence and Niagara Rivers.

## FISHERIES OF LAKE SUPERIOR.

The number of persons engaged in the fisheries of Lake Superior in 1917 was 1,348, of whom 166 were on fishing vessels, 51 on vessels transporting fishery products, 854 in the shore or boat fisheries, and 277 in the wholesale fishery trade and other occupations on shore connected with the fishery industries.

The investment amounted to \$841,006. This included 16 steam and gasoline fishing vessels, valued at \$73,300, with a net tonnage of 406 tons and outfits valued at \$16,630; 11 steam and gasoline transporting vessels, valued at \$75,500, with a net tonnage of 262 tons and outfits valued at \$21,795; 697 power, sail, and row boats, valued at \$92,625; fishing apparatus employed on vessels to a value of \$32,955; fishing apparatus employed on boats to a value of \$144,391; shore and accessory property valued at \$341,310 and cash capital amounting to \$42,500.

The principal forms of fishing apparatus were gill nets, pound nets, and trap nets. The number of gill nets used on vessels was 1,806, valued at \$31,995; and on boats 9,311, valued at \$112,991; a total in both fisheries of 11,117 nets, representing a value of \$144,986. The number of pound nets and trap nets in operation was 204, valued at \$26,262.

The products of the fisheries of Lake Superior amounted to 15,547,-432 pounds, valued at \$726,674. Among the species of special importance were the following: Ciscoes, 12,258,482 pounds, valued at \$460,249, representing 78.85 per cent of total quantity of fish and 63.34 per cent of total value of fish taken in the lake; lake trout, 2,588,353 pounds, valued at \$215,973; suckers, 342,053 pounds, valued at \$13,744; and common whitefish, 302,210 pounds, valued at \$30,943.

Compared with the other lakes, Lake Superior ranked third in quantity of products and fourth in value of products, number of persons engaged, and amount of invested capital. Compared with 1903 there was an increase of 430, or 46.84 per cent, in the number of persons employed; \$244,684, or 41.03 per cent, in the amount of capital invested; and 2,342,419 pounds, or 17.74 per cent, in quantity, and \$383,003 or 111.44 per cent, in the value of the products.

## FISHERIES, BY STATES AND COUNTIES.

The following tables show by States and counties the number of persons employed, investment, and quantity and value of the products of the fisheries in 1917:

STATISTICS OF THE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES AND COUNTIES.

PERSONS ENGAGED.

State and county.	On vessels fishing.	On vessels transporting.	In shore fisheries.	Shoresmen.	Total.
<b>Michigan:</b>					
Alger.....			44	2	46
Baraga.....			30		30
Chippewa.....	20		43	15	78
Gogebie.....			10		10
Houghton.....			78		78
Keweenaw.....		3	53		56
Marquette.....	22		16	15	53
Ontonagon.....			17		17
<b>Total.....</b>	<b>42</b>	<b>3</b>	<b>291</b>	<b>32</b>	<b>368</b>
<b>Wisconsin:</b>					
Ashland.....			6	7	13
Bayfield.....	74		117	154	345
Douglas.....			9	3	12
Iron.....			2		2
<b>Total.....</b>	<b>74</b>		<b>134</b>	<b>164</b>	<b>372</b>
<b>Minnesota:</b>					
Cook.....			185		185
Lake.....		4	168		172
St. Louis.....	50	44	76	81	251
<b>Total.....</b>	<b>50</b>	<b>48</b>	<b>429</b>	<b>81</b>	<b>608</b>
<b>Grand total.....</b>	<b>166</b>	<b>51</b>	<b>854</b>	<b>277</b>	<b>1,348</b>

INVESTMENT.

State and county.	Vessels, fishing.								Vessels, transporting.			
	Steam.				Gasoline.				Steam.			
	Num-ber.	Ton-nage.	Value.	Value of outfit.	Num-ber.	Ton-nage.	Value.	Value of outfit.	Num-ber.	Ton-nage.	Value.	Value of outfit.
<b>Michigan:</b>												
Chippewa.....	1	48	\$5,000	\$2,600	1	66	\$5,000	\$2,600				
Marquette.....	2	78	6,500	5,200								
<b>Total.....</b>	<b>3</b>	<b>126</b>	<b>11,500</b>	<b>7,800</b>	<b>1</b>	<b>66</b>	<b>5,000</b>	<b>2,600</b>				
<b>Wisconsin:</b>												
Bayfield.....	4	96	29,800	1,520	1	12	7,000	225				
<b>Minnesota:</b>												
St. Louis.....	5	80	11,500	1,760	2	26	8,500	2,725	4	194	\$56,000	\$17,880
<b>Grand total..</b>	<b>12</b>	<b>302</b>	<b>52,800</b>	<b>11,080</b>	<b>4</b>	<b>104</b>	<b>20,500</b>	<b>5,550</b>	<b>4</b>	<b>194</b>	<b>56,000</b>	<b>17,880</b>

## STATISTICS OF THE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES AND COUNTIES—Continued.

## INVESTMENT—Continued.

State and county.	Vessels transporting—Contd.				Sail and row boats.		Power boats.		Apparatus of capture, vessel fisheries.		
	Gasoline.								Gill nets.		Value of lines.
	Number.	Tonnage.	Value.	Value of outfit.	Number.	Value.	Number.	Value.			
Michigan:											
Alger.....					9	\$190	18	\$8,625			
Baraga.....					17	290	8	1,850			
Chippewa.....					16	220	13	5,700	214	\$7,470	\$560
Gogebic.....					2	45	4	1,200			
Houghton.....					15	185	33	11,400			
Keweenaw.....	1	10	\$2,000	\$500	12	265	20	6,000			
Marquette.....					1	15	8	3,820	920	11,800	
Ontonagon.....					2	20	5	2,200			
Total.....	1	10	2,000	500	74	1,230	109	40,795	1,134	19,270	560
Wisconsin:											
Ashland.....					2	35	3	675			
Bayfield.....					66	1,110	45	21,075	450	7,550	400
Douglas.....					5	75	2	800			
Iron.....							2	600			
Total.....					73	1,220	52	23,150	450	7,550	400
Minnesota:											
Cook.....					112	4,250	57	5,760			
Lake.....	1	8	4,000	500	81	2,270	32	6,975			
St. Louis.....	5	50	13,500	2,915	47	1,250	30	5,725	222	5,175	
Total.....	6	58	17,500	3,415	270	7,770	119	18,460	222	5,175	
Grand total..	7	68	19,500	3,915	417	10,220	280	82,405	1,806	31,995	960

State and county.	Apparatus of capture, shore fisheries.						Shore and accessory property.	Cash capital.	Total investment.	
	Pound nets and trap nets.		Gill nets.		Seines.					Value of lines.
	Number.	Value.	Number.	Value.	Number.	Value.				
Michigan:										
Alger.....	34	\$4,912	446	\$4,205	3	\$240	\$623	\$10,725	\$29,520	
Baraga.....	22	2,010	124	875				1,010	6,035	
Chippewa.....	80	7,490	546	5,375			325	45,425	92,765	
Gogebic.....			83	539				1,185	2,969	
Houghton.....	2	325	1,000	6,639	2	85	560	20,780	39,974	
Keweenaw.....	8	1,825	840	8,635			30	18,525	37,780	
Marquette.....	1	300	216	2,400			6	12,200	42,241	
Ontonagon.....	4	450	175	1,650				2,200	7,095	
Total.....	151	17,312	3,430	30,318	5	325	2,119	112,050	258,379	
Wisconsin:										
Ashland.....	4	450	65	750			140	7,375	5,000	
Bayfield.....	44	8,000	845	11,285			1,229	38,275	9,000	
Douglas.....			44	650				390	500	
Iron.....			12	175				100	875	
Total.....	48	8,450	966	12,860			1,369	46,140	14,500	
Minnesota:										
Cook.....			2,387	35,503			100	17,870	63,483	
Lake.....			1,536	21,865			125	11,900	47,635	
St. Louis.....	5	500	992	12,445			1,100	153,350	23,000	
Total.....	5	500	4,915	69,813			1,325	183,120	23,000	
Grand total..	204	26,262	9,311	112,991	5	325	4,813	341,310	42,500	

STATISTICS OF THE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES AND COUNTIES—Continued.

YIELD, BY SPECIES.

State and county.	Bowfin.		Ciscoes.									
			Fresh.		Frozen.		Salted.		Smoked.			
			Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.		
<b>Michigan:</b>												
Alger.....			4,100	\$195				500	\$23			
Baraga.....			95,200	4,030								
Chippewa.....			185,062	8,425								
Gogebic.....			17,060	680								
Houghton.....			179,600	7,966								
Keweenaw.....	2,675	\$170	73,825	3,484								
Marquette.....			325,109	12,835								
Ontonagon.....			44,000	1,556								
<b>Total.....</b>	<b>2,675</b>	<b>170</b>	<b>923,986</b>	<b>39,171</b>				<b>500</b>	<b>23</b>			
<b>Wisconsin:</b>												
Ashland.....			11,600	695								
Bayfield.....			1,645,805	30,528				68,000	2,340			
Douglas.....			69,000	2,065								
Iron.....			8,000	200								
<b>Total.....</b>			<b>1,734,405</b>	<b>33,488</b>				<b>68,000</b>	<b>2,340</b>			
<b>Minnesota:</b>												
Cook.....			1,375,239	43,658	1,651,178	\$75,405	1,593,925	67,948				
Lake.....			559,465	19,208	1,100,786	50,270	995,302	43,242				
St. Louis.....			1,099,403	33,523	550,393	25,135	600,500	26,406	5,400	\$432		
<b>Total.....</b>			<b>3,034,107</b>	<b>96,389</b>	<b>3,302,357</b>	<b>150,810</b>	<b>3,189,727</b>	<b>137,596</b>	<b>5,400</b>	<b>432</b>		
<b>Grand total..</b>	<b>2,675</b>	<b>170</b>	<b>5,692,498</b>	<b>169,048</b>	<b>3,302,357</b>	<b>150,810</b>	<b>3,258,227</b>	<b>139,959</b>	<b>5,400</b>	<b>432</b>		

State and county.	Pike.		Pike perch (wall-eyed or yellow pike).		Suckers.							
					Fresh.		Salted.					
					Pounds.	Value.	Pounds.	Value.	Pounds.	Value.		
<b>Michigan:</b>												
Alger.....			243	\$40	23,165	\$980						
Baraga.....			60	6	3,200	133						
Chippewa.....	800	\$80	3,470	525	100,713	4,305						
Gogebic.....			50	5	1,000	25						
Houghton.....			500	20	1,600	76						
Keweenaw.....			231	59	5,464	218						
Marquette.....			325	26	21,271	695						
Ontonagon.....					18,835	681						
<b>Total.....</b>	<b>800</b>	<b>80</b>	<b>4,879</b>	<b>681</b>	<b>175,248</b>	<b>7,116</b>						
<b>Wisconsin:</b>												
Ashland.....	3,300	355	3,300	469	19,000	890						
Bayfield.....	1,600	120	19,800	2,624	104,900	4,100	15,850	\$560				
<b>Total.....</b>	<b>4,900</b>	<b>475</b>	<b>23,100</b>	<b>3,093</b>	<b>123,900</b>	<b>4,990</b>	<b>15,850</b>	<b>560</b>				
<b>Minnesota:</b>												
Cook.....					100	2						
Lake.....					1,000	55						
St. Louis.....					25,955	1,021						
<b>Total.....</b>					<b>27,055</b>	<b>1,078</b>						
<b>Grand total..</b>	<b>5,700</b>	<b>555</b>	<b>27,979</b>	<b>3,774</b>	<b>326,203</b>	<b>13,184</b>	<b>15,850</b>	<b>560</b>				

## STATISTICS OF THE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES AND COUNTIES—Continued.

## YIELD, BY SPECIES—Continued.

State and county.	Lake trout.						Whitefish, common.	
	Fresh.		Frozen.		Salted.			
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Michigan:</b>								
Alger.....	174,557	\$14,399					30,846	\$3,280
Baraga.....	10,500	1,059					2,525	223
Chippewa.....	422,188	30,075					142,044	14,074
Gogebic.....	21,750	1,550					12,000	1,000
Houghton.....	170,325	16,206					19,080	1,711
Keweenaw.....	232,850	21,011					8,933	979
Marquette.....	395,499	34,340					11,635	1,455
Ontonagon.....	109,182	8,734					15,199	1,639
<b>Total.....</b>	<b>1,536,851</b>	<b>127,374</b>					<b>242,262</b>	<b>24,361</b>
<b>Wisconsin:</b>								
Ashland.....	8,875	685					1,200	112
Bayfield.....	573,720	46,459					41,295	4,145
Iron.....	12,500	1,000					360	40
<b>Total.....</b>	<b>595,095</b>	<b>48,144</b>					<b>42,855</b>	<b>4,297</b>
<b>Minnesota:</b>								
Cook.....	83,642	8,710			3,700	\$268	1,047	147
Lake.....	110,646	9,909			1,372	92	3,400	350
St. Louis.....	210,847	15,460	44,000	\$5,800	2,200	216	12,646	1,788
<b>Total.....</b>	<b>405,135</b>	<b>34,079</b>	<b>44,000</b>	<b>5,800</b>	<b>7,272</b>	<b>576</b>	<b>17,093</b>	<b>2,285</b>
<b>Grand total..</b>	<b>2,537,081</b>	<b>209,597</b>	<b>44,000</b>	<b>5,800</b>	<b>7,272</b>	<b>576</b>	<b>302,210</b>	<b>30,943</b>

State and county.	Whitefish, menominee.				Yellow perch.		Total.	
	Fresh.		Salted.					
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Michigan:</b>								
Alger.....							233,411	\$18,917
Baraga.....							111,485	5,451
Chippewa.....					3,000	\$235	857,277	57,719
Gogebic.....							51,800	3,260
Houghton.....	500	\$40					371,605	26,019
Keweenaw.....	430	48					324,408	25,969
Marquette.....	300	22					754,139	49,373
Ontonagon.....							187,306	12,613
<b>Total.....</b>	<b>1,230</b>	<b>110</b>			<b>3,000</b>	<b>235</b>	<b>2,891,431</b>	<b>199,321</b>
<b>Wisconsin:</b>								
Ashland.....							47,275	3,206
Bayfield.....	4,050	178			2,000	121	2,477,020	91,175
Douglas.....							69,000	2,065
Iron.....							20,860	1,240
<b>Total.....</b>	<b>4,050</b>	<b>178</b>			<b>2,000</b>	<b>121</b>	<b>2,614,155</b>	<b>97,686</b>
<b>Minnesota:</b>								
Cook.....	200	20	100	\$4			4,709,131	196,162
Lake.....	2,200	174					2,774,171	123,300
St. Louis.....	4,400	200	2,800	224			2,558,544	110,205
<b>Total.....</b>	<b>6,800</b>	<b>394</b>	<b>2,900</b>	<b>228</b>			<b>10,041,846</b>	<b>429,667</b>
<b>Grand total..</b>	<b>12,080</b>	<b>682</b>	<b>2,900</b>	<b>228</b>	<b>5,000</b>	<b>356</b>	<b>15,547,432</b>	<b>726,674</b>

## FISHERIES, BY APPARATUS.

The catch of the vessel fisheries amounted to 3,259,811 pounds, valued at \$123,169, and of the shore or boat fisheries to 12,287,621 pounds, valued at \$603,505. In the vessel fisheries the catch of ciscoes, suckers, lake trout, and whitefish with gill nets amounted to 3,164,811 pounds, valued at \$116,369, the balance of the catch consisting of lake trout taken with set lines. In the shore fisheries 11,095,696 pounds consisting of bowfin, ciscoes, pike, pike perch, suckers, lake trout, and whitefish, valued at \$523,260, were taken with gill nets; 901,873 pounds, including ciscoes, pike, pike perch, suckers, lake trout, whitefish, and yellow perch, valued at \$63,610, with pound nets and trap nets; 177,300 pounds of lake trout, valued at \$15,708, with lines; and 12,752 pounds of ciscoes, suckers, lake trout, and whitefish, valued at \$927, with seines.

The following tables give the products of the vessel and shore fisheries, by States and counties, in 1917:

YIELD OF VESSEL FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Michigan.					
	Chippewa.		Marquette.		Total.	
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Gill nets:						
Ciscoes.....	33,995	\$1,698	292,609	\$11,444	326,604	\$13,142
Suckers.....			8,471	255	8,471	255
Trout, lake.....	266,625	18,960	318,499	27,006	585,124	45,966
Whitefish—						
Common.....			9,487	1,187	9,487	1,187
Menominee.....			300	22	300	22
Total.....	300,620	20,658	629,366	39,914	929,986	60,572
Set lines: Trout, lake.....	75,000	4,800			75,000	4,800
Grand total.....	375,620	25,458	629,366	39,914	1,004,986	65,372

Apparatus and species.	Wisconsin.		Minnesota.		Grand total.	
	Bayfield.		St. Louis.			
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Gill nets:						
Ciscoes.....	1,273,105	\$21,246	800,000	\$23,712	2,399,709	\$58,100
Suckers.....					8,471	255
Trout, lake.....	13,595	1,359	148,125	9,480	746,844	56,805
Whitefish—						
Common.....					9,487	1,187
Menominee.....					300	22
Total.....	1,286,700	22,605	948,125	33,192	3,164,811	116,369
Set lines: Trout, lake.....	20,000	2,000			95,000	6,800
Grand total.....	1,306,700	24,605	948,125	33,192	3,259,811	123,169

## YIELD OF SHORE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Michigan.									
	Alger.		Baraga.		Chippewa.		Gogebie.		Houghton.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Pound nets and trap nets:										
Ciscoes—										
Fresh			82,800	\$3,410	5,000	\$200			1,000	\$36
Salted	500	\$23								
Pike					800	80				
Pike perch (wall-eyed or yellow pike)	243	40			3,470	525				
Suckers, fresh	4,805	188	2,300	105	90,713	3,805				
Trout, lake	24,102	1,971	5,625	565	13,063	890			3,750	560
Whitefish, common	25,752	2,727	2,255	198	135,444	13,415				
Yellow perch					3,000	235				
Total	55,402	4,949	92,980	4,278	251,490	19,150			4,750	596
Gill nets:										
Ciscoes, fresh	3,600	170	12,400	620	146,067	6,527	17,000	\$680	174,800	7,770
Pike perch (wall-eyed or yellow pike)			60	6			50	5	500	20
Suckers, fresh	16,360	692	900	28	10,000	500	1,000	25	600	26
Trout, lake, fresh	116,012	9,653	4,875	494	35,625	2,875	21,750	1,550	147,825	13,821
Whitefish—										
Common	810	71	270	25	6,600	659	12,000	1,000	18,480	1,646
Menominee, fresh									500	40
Total	136,782	10,586	18,505	1,173	198,292	10,561	51,800	3,260	342,705	23,323
Seines:										
Ciscoes	500	25							3,800	160
Suckers	2,000	100							1,000	50
Trout	508	45								
Whitefish	4,284	482							600	65
Total	7,352	652							5,400	275
Lines: Trout, lake	33,875	2,730			31,875	2,550			18,750	1,825
Grand total	233,411	18,917	111,485	5,451	481,657	32,261	51,800	3,260	371,605	26,019

Apparatus and species.	Michigan—Continued.							
	Keweenaw.		Marquette.		Ontonagon.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Pound nets and trap nets:								
Ciscoes—								
Fresh	5,000	\$250	500	\$21			94,300	\$3,917
Salted							500	23
Pike							800	80
Pike perch (wall-eyed or yellow pike)	166	37					3,879	602
Suckers, fresh	3,302	132	1,500	45			102,620	4,275
Trout, lake	65,725	7,811	3,125	310	7,500	\$600	122,890	12,707
Whitefish—								
Common	2,933	394	600	75	3,600	420	170,584	17,229
Menominee	355	38					355	38
Yellow perch							3,000	235
Total	77,481	8,662	5,725	451	11,100	1,020	498,928	39,106

YIELD OF SHORE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Michigan—Continued.							
	Keweenaw.		Marquette.		Ontonagon.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Gill nets:								
Bowfin.....	2,675	\$170					2,675	\$170
Ciscoes, fresh.....	68,825	3,234	32,000	\$1,370	44,090	\$1,556	498,782	21,927
Pike perch (wall-eyed or yellow pike).....	65	22	325	26			1,000	79
Suckers, fresh.....	2,162	86	11,300	395	18,835	684	61,157	2,436
Trout, lake, fresh.....	164,625	12,970	72,125	6,860	91,682	7,334	654,519	55,557
Whitefish—								
Common.....	6,000	585	1,548	193	11,599	1,219	57,307	5,398
Menominee, fresh.....	75	10					575	50
Total.....	244,427	17,077	117,298	8,844	166,206	10,793	1,276,015	85,617
Seines:								
Ciscoes.....							4,300	185
Suckers.....							3,000	150
Trout.....							568	45
Whitefish.....							4,884	547
Total.....							12,752	927
Lines: Trout, lake.....	2,500	230	1,750	164	10,000	800	98,750	8,299
Grand total.....	324,408	25,969	124,773	9,459	187,306	12,613	1,886,445	133,949

Apparatus and species.	Wisconsin.									
	Ashland.		Bayfield.		Douglas.		Iron.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Pound nets and trap nets:										
Ciscoes—										
Fresh.....	600	\$20	62,500	\$1,637					63,100	\$1,677
Salted.....			23,000	690					23,000	690
Pike.....	800	55	1,600	120					2,400	175
Pike perch (wall-eyed or yellow pike).....	2,800	399	16,300	2,142					19,100	2,541
Suckers—										
Fresh.....	12,000	515	95,500	3,735					107,500	4,250
Salted.....			15,000	523					15,000	525
Trout, lake.....	750	60	120,750	9,095					121,500	9,755
Whitefish—										
Common.....	600	56	26,895	2,745					27,495	2,801
Menominee.....			150	7					150	7
Yellow perch.....			1,700	103					1,700	103
Total.....	17,550	1,105	363,395	21,419					380,945	22,524
Gill nets:										
Ciscoes—										
Fresh.....	11,000	675	310,200	7,625	69,000	\$2,065	8,000	\$200	398,200	10,565
Salted.....			45,000	1,650					45,000	1,650
Pike.....	2,500	300							2,500	300
Pike perch (wall-eyed or yellow pike).....	500	70	3,500	482					4,000	552
Suckers—										
Fresh.....	7,000	375	9,400	365					16,400	740
Salted.....			850	35					850	35
Trout, lake, fresh.....	6,256	475	362,500	27,870			12,500	1,000	381,256	29,345
Whitefish—										
Common.....	600	56	14,400	1,400			360	40	15,360	1,496
Menominee, fresh.....			3,900	171					3,900	171
Yellow perch.....			300	18					300	18
Total.....	27,850	1,951	750,050	39,616	69,000	2,065	20,860	1,240	867,760	44,872
Lines: Trout, lake.....	1,875	150	56,875	5,535					58,750	5,685
Grand total.....	47,275	3,206	1,170,320	66,570	69,000	2,065	20,860	1,240	1,307,455	73,081

## YIELD OF SHORE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Minnesota.								Grand total.	
	Cook.		Lake.		St. Louis.		Total.			
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Pound nets and trap nets:										
Ciscoes—									157,400	\$5,594
Fresh									23,500	713
Salted									3,200	255
Pike										
Pike perch (wall-eyed or yellow pike)									22,979	3,143
Suckers—										
Fresh					12,000	\$480	12,000	\$480	222,120	9,005
Salted									15,000	525
Trout, lake									244,390	22,462
Whitefish—										
Common					10,000	1,500	10,000	1,500	208,079	21,530
Menominee									505	45
Yellow perch									4,700	338
Total					22,000	1,980	22,000	1,980	901,873	63,610
Gill nets:										
Bowfin									2,675	170
Ciscoes—										
Fresh	1,375,239	\$43,658	559,465	\$19,208	299,403	9,811	2,234,107	72,677	3,131,089	105,169
Frozen	1,651,178	75,405	1,100,786	50,270	550,393	25,135	3,302,357	150,810	3,302,357	150,810
Salted	1,593,925	67,948	995,302	43,242	600,500	26,406	3,189,727	137,596	3,134,727	139,246
Smoked					5,400	432	5,400	432	5,400	432
Pike									2,500	300
Pike perch (wall-eyed or yellow pike)									5,000	631
Suckers—										
Fresh	100	2	1,000	55	13,955	541	15,055	598	92,612	3,774
Salted									850	35
Trout, lake—										
Fresh	82,842	8,646	106,646	9,549	47,722	4,680	237,210	22,875	1,272,979	107,777
Frozen					44,000	5,800	44,000	5,800	44,000	5,800
Salted	3,700	268	1,372	92	2,200	216	7,272	576	7,272	576
Whitefish—										
Common	1,047	147	3,400	350	2,646	288	7,093	785	79,760	7,679
Menominee, fresh	200	20	2,200	174	4,400	200	6,800	394	11,275	615
Menominee, salted	100	4			2,800	221	2,900	228	2,900	228
Yellow perch									300	18
Total	4,708,331	196,098	2,770,171	122,940	1,573,419	73,733	9,051,921	392,771	11,095,696	523,260
Seines:										
Ciscoes									4,300	185
Suckers									3,000	150
Trout									568	45
Whitefish									4,884	547
Total									12,752	927
Lines: Trout, lake	800	64	4,000	360	15,000	1,300	19,800	1,724	177,300	15,708
Grand total	4,709,131	196,162	2,774,171	123,300	1,610,419	77,013	9,093,721	396,475	12,287,621	603,505

## WHOLESALE FISHERY TRADE.

The wholesale fishery trade of Lake Superior in 1917 was conducted by 15 establishments, of which 8 were at Duluth, 2 at Bayfield, and 1 at each of the following places: Ashland, Bark Point, Port Wing, Superior, and Sault Ste. Marie. The total number of persons employed in these establishments was 249, to whom \$65,353 were paid in wages during the year; the investment in shore and accessory property amounted to \$210,400 and the cash capital utilized was \$42,500. Compared with 1903, there was a decrease of 1 in the num-

ber of establishments and of \$100,200 in cash capital, and an increase of 150 employees, of \$6,773 in the amount of wages paid, and of \$103,986 in the value of the property.

The following table shows by localities the extent of the wholesale fishery trade of Lake Superior in 1917:

WHOLESALE FISHERY TRADE OF LAKE SUPERIOR IN 1917.

Cities and towns.	State.	Number of firms.	Persons engaged.	Wages paid.	Shore and accessory property.	Cash capital.
Duluth.....	Minnesota.....	8	77	\$35,742	\$146,350	\$23,000
Ashland, Bayfield, and Bark Point.	Wisconsin.....	4	140	19,125	21,325	12,500
Port Wing, Superior, and Sault Ste. Marie.	Wisconsin and Michigan.	3	32	10,486	42,725	7,000
Total.....		15	249	65,353	210,400	42,500

## FISHERIES OF LAKE MICHIGAN.

In 1917 Lake Michigan ranked first among the Great Lakes in the number of persons employed in the fisheries and second in the amount of invested capital and the quantity and value of the products. The total number of persons employed in the fisheries of Lake Michigan was 3,313, of whom 1,096 were on fishing vessels, 81 on vessels transporting fishery products, 1,285 in the shore fisheries, and 851 shoresmen in the wholesale fishery trade, etc. Of the total number of persons engaged 1,537 were credited to Wisconsin, 1,145 to Michigan, 564 to Illinois, and 67 to Indiana.

The total investment in the fisheries of the lake amounted to \$4,038,927. The number of vessels fishing was 332, with a net tonnage of 3,913 tons, valued at \$631,960, and having outfits to the value of \$179,521; and of transporting vessels, 60 with net tonnage of 495 tons, valued at \$38,225, with outfits valued at \$4,515. The number of boats was 739, worth \$101,538. The fishing apparatus used on vessels was valued at \$561,349, and on boats at \$413,678. Shore and accessory property amounted to \$1,758,341 and cash capital to \$349,800. The investment was divided among the different States as follows: Wisconsin, \$1,514,295, or 37.49 per cent; Illinois, \$1,265,664, or 31.34 per cent; Michigan, \$1,179,143, or 29.19 per cent; and Indiana, \$79,825, or 1.98 per cent.

Gill nets were the most important apparatus of capture, 57,453, representing a value of \$535,616, being employed in the vessel fisheries, and 26,354, valued at \$109,458, in the boat fisheries, a total in both fisheries of 83,807, amounting in value to \$645,074. Lines valued at \$27,868 were employed in both the vessel and shore fisheries. Other apparatus used in the shore fisheries included 1,134 pound nets and trap nets, valued at \$242,570; 3,343 fyke nets, valued at \$39,795; 61 seines, valued at \$18,120; and 6,400 crawfish pots, valued at \$1,600.

The fishery products of Lake Michigan amounted to 35,460,628 pounds, valued at \$2,270,859. This total was divided among the different States as follows: Wisconsin, 21,453,679 pounds, valued at \$1,225,084; Michigan, 11,634,480 pounds, valued at \$883,301; Illinois, 1,356,294 pounds, valued at \$87,375; and Indiana, 1,016,175 pounds, valued at \$75,099. The more important species taken in

this lake were ciscoes, 18,259,354 pounds, valued at \$845,982; lake trout, 8,650,715 pounds, valued at \$853,138; common whitefish, 3,047,393 pounds, valued at \$323,363; yellow perch, 2,362,796 pounds, valued at \$116,500; and suckers, 2,118,563 pounds, valued at \$75,484.

As compared with 1903 there was an increase of 72, or 2.22 per cent, in the number of persons employed; \$549,740, or 15.76 per cent, in the investment in the fisheries; and 1,881,130 pounds, or 5.60 per cent, in quantity; and \$1,180,309, or 108.23 per cent, in the value of the products.

## FISHERIES, BY STATES AND COUNTIES.

The following tables show by States and counties the extent of the fisheries of Lake Michigan in 1917:

## STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES.

## PERSONS EMPLOYED.

State and county.	On vessels fishing.	On vessels trans- porting.	In shore or boat fisheries.	Shoresmen.	Total.
<b>Michigan:</b>					
Allegan.....			9		9
Antrim.....			10		10
Benzie.....	49	2	6	19	76
Berrien.....	38		33	2	73
Charlevoix.....	96	2	30	21	149
Delta.....	11		157	6	174
Emmet.....			28		28
Grand Traverse.....	10	2	23		35
Leelanau.....	50		34	7	91
Mackinac.....	16	2	75		93
Manistee.....	16		11	2	29
Mason.....	26	2	15		43
Menominee.....		22	61	36	119
Muskegon.....	8	1	30		39
Oceana.....	6				6
Ottawa.....	50		18	11	79
Schoolcraft.....	47		20	4	71
Van Buren.....	13		8		21
<b>Total.....</b>	<b>436</b>	<b>33</b>	<b>568</b>	<b>108</b>	<b>1,145</b>
<b>Indiana:</b>					
Lake.....			10		10
Laporte.....	21		21	3	45
Porter.....			12		12
<b>Total.....</b>	<b>21</b>		<b>43</b>	<b>3</b>	<b>67</b>
<b>Illinois:</b>					
Cook.....	31		15	482	528
Lake.....	24		12		36
<b>Total.....</b>	<b>55</b>		<b>27</b>	<b>482</b>	<b>564</b>
<b>Wisconsin:</b>					
Brown.....	53	22	200	107	382
Door.....	143	5	174	10	332
Kenosha.....	9		1	4	14
Kewaunee.....	33		6		39
Manitowoc.....	42		22	20	84
Marinette.....	75	10	81	32	198
Milwaukee.....	77		24	26	127
Oconto.....	52	9	95		156
Ozaukee.....	26	2	11	18	57
Racine.....	23		2	10	35
Sheboygan.....	51		31	31	113
<b>Total.....</b>	<b>584</b>	<b>48</b>	<b>647</b>	<b>258</b>	<b>1,537</b>
<b>Grand total.....</b>	<b>1,096</b>	<b>81</b>	<b>1,285</b>	<b>851</b>	<b>3,313</b>

STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

INVESTMENT.

State and county.	Vessels, fishing.							Vessels transporting.				
	Steam.				Gasoline.				Gasoline.			
	No.	Ton-nage.	Value.	Out-fit.	No.	Ton-nage.	Value.	Out-fit.	No.	Ton-nage.	Value.	Out-fit.
Michigan:												
Benzle .....	7	113	\$20,150	\$11,500	5	46	\$4,200	\$2,715	1	6	\$450	\$50
Berrien .....	5	153	32,700	4,890	2	15	1,500	125				
Charlevoix .....	8	114	18,700	9,210	18	141	16,000	6,650	1	7	300	225
Delta .....	2	26	3,000	1,000								
Grand Traverse .....					4	43	3,800	1,200	1	9	1,000	20
Leelanau .....	5	57	9,600	5,925	12	96	11,250	3,350				
Mackinac .....					7	43	3,350	990	2	16	900	240
Manistee .....					7	49	7,000	3,435				
Mason .....	2	21	4,000	415	9	79	6,550	2,115	2	16	850	95
Menominee .....									9	124	10,700	1,285
Muskegon .....					4	27	4,500	800	1	8	600	50
Oceana .....					3	23	2,950	1,000				
Otawa .....	8	143	31,100	9,875								
Schoolcraft .....	4	100	10,500	6,500	6	53	4,250	1,675				
Van Buren .....	2	31	4,700	2,125	1	6	600	150				
Total .....	43	758	134,450	52,040	78	616	65,950	24,205	17	186	14,800	1,965
Indiana: Laporte .....	2	51	11,000	3,610	1	8	1,200	850				
Illinois:												
Cook .....					8	73	17,200	4,095				
Lake .....					5	55	13,500	3,100				
Total .....					13	128	30,700	7,195				
Wisconsin:												
Brown .....	1	9	1,000	200	23	192	14,800	1,300	22	140	10,350	875
Door .....	5	92	17,500	1,950	47	423	43,650	3,881	4	34	2,500	130
Kenosha .....	1	32	5,000	1,650	1	14	1,400	800				
Keweenaw .....	2	27	4,000	1,500	12	112	10,400	1,880				
Manitowoc .....	2	51	5,500	2,785	11	149	15,900	6,550				
Marinette .....	4	46	9,700	2,800	22	173	21,700	3,500	7	74	4,900	950
Milwaukee .....	13	254	83,000	20,000	4	33	3,800	2,450				
Oconto .....					26	201	15,810	1,325	9	51	5,375	395
Ozaukee .....	4	100	30,500	9,500	1	15	2,000	200	1	10	300	200
Racine .....	5	118	31,000	7,250								
Sheboygan .....	10	257	65,000	19,600	1	49	7,000	2,500				
Total .....	47	986	252,200	67,235	148	1,361	136,460	24,386	43	309	23,425	2,550
Grand total .....	92	1,795	397,650	122,885	240	2,118	234,310	56,636	60	495	38,225	4,515

## STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

## INVESTMENT—Continued.

State and county.	Sail and row boats.		Power boats.		Apparatus of capture, vessel fisheries.			Apparatus of capture, shore fisheries.				
	No.	Value.	No.	Value.	Gill nets.		Value of lines.	Pound nets and trap nets.		Gill nets.		
					No.	Value.		No.	Value.	No.	Value.	
<b>Michigan:</b>												
Allegan.....	5	\$115	4	\$750				7	\$1,475	146	\$1,447	
Antrim.....	7	100	3	350				6	725	48	370	
Benzie.....	2	50	3	700	1,875	\$29,074		6	460	55	545	
Berrien.....	15	335	9	4,000	3,757	35,552		11	3,550	671	6,640	
Charlevoix.....	6	85	18	6,625	6,702	61,048	\$1,500	31	6,005	633	6,309	
Delta.....	66	1,053	35	10,115	880	5,300		136	16,090	2,938	19,810	
Emmet.....	14	300	5	1,625				12	5,100	237	2,445	
Grand Traverse.....	17	340	8	2,150	199	1,841		106	7,995	139	1,450	
Leelanau.....	18	390	9	1,825	2,588	20,290		48	5,865	174	1,070	
Mackinac.....	10	145	27	6,580	242	1,786	4	152	20,725	375	3,320	
Manistee.....	9	165	5	550	890	8,600	1,535	13	1,180	156	766	
Mason.....	13	345			1,317	14,496	700	79	6,400	14	150	
Menominee.....	10	320	26	7,850	269	2,748	600	80	24,675	161	954	
Muskegon.....	24	519	2	750				39	5,800	133	1,156	
Oceana.....					350	3,500	750					
Ottawa.....	16	361	3	900	7,275	54,200	1,650	19	2,425	112	1,120	
Schoolcraft.....	5	115	8	2,975	1,677	15,045		42	5,950	253	2,105	
Van Buren.....	4	90	3	550	1,812	14,248				171	1,710	
<b>Total.....</b>	<b>241</b>	<b>4,828</b>	<b>168</b>	<b>48,295</b>	<b>29,833</b>	<b>267,728</b>	<b>6,739</b>	<b>787</b>	<b>114,420</b>	<b>6,416</b>	<b>51,367</b>	
<b>Indiana:</b>												
Lake.....	4	125	6	1,200				5	1,100	210	4,460	
Laporte.....	10	255	6	1,400	1,695	35,940	200	7	3,800	102	1,530	
Porter.....	9	230	2	450				6	2,700	57	1,140	
<b>Total.....</b>	<b>23</b>	<b>610</b>	<b>14</b>	<b>3,050</b>	<b>1,695</b>	<b>35,940</b>	<b>200</b>	<b>18</b>	<b>7,600</b>	<b>369</b>	<b>7,130</b>	
<b>Illinois:</b>												
Cook.....	7	125	1	1,500	705	7,125				80	845	
Lake.....	2	70	3	1,300	1,650	13,100		8	3,000	110	800	
<b>Total.....</b>	<b>9</b>	<b>195</b>	<b>4</b>	<b>2,800</b>	<b>2,355</b>	<b>20,225</b>		<b>8</b>	<b>3,000</b>	<b>190</b>	<b>1,645</b>	
<b>Wisconsin:</b>												
Brown.....	62	1,810	23	6,500	1,506	7,686		24	3,600	1,785	8,925	
Door.....	14	545	43	11,750	8,730	76,330	7,324	97	23,450	14,315	21,065	
Kenosha.....	1	20			597	4,500				4	35	
Kewaunee.....	1	30	3	700	1,080	9,530	6,650	3	900			
Manitowoc.....	6	120	8	2,875	1,507	16,248		29	25,500	31	165	
Marquette.....	9	250	13	3,900	5,365	46,675		43	15,800	2,070	8,560	
Milwaukee.....	13	230	5	2,650	1,868	23,060		2	400	165	1,470	
Oconto.....	34	995	18	5,400	1,373	9,529		93	17,900	954	8,586	
Ozaukee.....			3	1,375	1,051	8,600	425	6	5,000	10	85	
Racine.....	1	20	1	150	58	865	1,000			20	250	
Sheboygan.....	14	290	8	2,150	435	8,700	3,395	24	25,000	25	175	
<b>Total.....</b>	<b>155</b>	<b>4,310</b>	<b>125</b>	<b>37,450</b>	<b>23,570</b>	<b>211,723</b>	<b>18,794</b>	<b>321</b>	<b>117,550</b>	<b>19,379</b>	<b>49,316</b>	
<b>Grand total.....</b>	<b>428</b>	<b>9,943</b>	<b>311</b>	<b>91,595</b>	<b>57,453</b>	<b>535,616</b>	<b>25,733</b>	<b>1,134</b>	<b>242,570</b>	<b>26,354</b>	<b>109,458</b>	

STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

INVESTMENT—Continued.

State and county.	Apparatus of capture, shore fisheries—Continued.						Shore and accessory property.	Cash capital.	Total investment.	
	Fyke nets.		Seines.		Value of lines.	Crawfish pots.				
	No.	Value.	No.	Value.		No.				Value.
Michigan:										
Allegan.....							\$1,275		\$5,062	
Antrim.....					\$70		310		1,925	
Benzie.....							15,145		85,039	
Berrien.....			1	\$150	25		8,705	\$2,000	100,172	
Charlevoix.....							34,540	7,000	174,197	
Delta.....	27	\$5,395					14,040	2,500	78,903	
Emmet.....					250		1,675		11,395	
Grand Traverse.....					120		4,675		24,591	
Leelanau.....					40		21,835		81,440	
Mackinac.....							4,415		42,455	
Manistee.....							4,600		27,831	
Mason.....					70		2,975		39,161	
Menominee.....	30	1,000					97,961	80,000	224,745	
Muskegon.....							3,420		20,943	
Oceana.....									8,200	
Ottawa.....							34,865	32,000	168,496	
Schoolcraft.....							7,000	3,500	59,615	
Van Buren.....							800		24,973	
Total.....	57	6,395	1	150	575		258,236	127,000	1,179,143	
Indiana:										
Lake.....					60		1,250		8,195	
Laporte.....							5,075	1,000	65,860	
Porter.....							1,250		5,770	
Total.....					60		7,575	1,000	79,825	
Illinois:										
Cook.....					35		1,085,769	112,500	1,229,194	
Lake.....							1,600		36,470	
Total.....					35		1,087,369	112,500	1,265,664	
Wisconsin:										
Brown.....	2,771	27,710	48	15,500		6,400	\$1,600	160,169	79,500	341,525
Door.....			5	1,250	800			20,385	6,500	239,010
Kenosha.....							6,000		19,405	
Kewaunee.....					130		650		36,370	
Manitowoc.....			2	200			27,385	1,800	105,028	
Marinette.....	27	810					29,097	9,000	157,642	
Milwaukee.....					20		87,500	10,000	234,580	
Oconto.....	488	4,880	3	900			7,125		78,220	
Ozaukee.....					500		23,500	1,000	83,185	
Racine.....					15		7,400		47,950	
Sheboygan.....			2	120			35,950	1,500	171,380	
Total.....	3,286	33,400	60	17,970	1,465	6,400	1,600	405,161	109,300	1,514,295
Grand total.....	3,343	39,795	61	18,120	2,135	6,400	1,600	1,758,341	349,800	4,038,927

## STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

YIELD, BY SPECIES.

State and county.	Burbot.		Carp, Asiatic.		Catfish and bullheads.		Ciscoes.			
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Fresh.		Salted.	
							Pounds.	Value.	Pounds.	Value.
Michigan:										
Allegan.....			300	\$12			7,633	\$466	2,437	\$142
Antrim.....							14,520	832		
Benzie.....	4,870	\$89					176,920	10,268		
Berrien.....	2,870	66	400	16			475,171	30,384		
Charlevoix.....	8,739	195					244,476	12,312		
Delta.....	565	7					236,098	8,529	114,329	4,510
Emmet.....							3,168	170		
Grand Traverse.....	1,100	20					31,760	1,934		
Leelanau.....							262,617	13,532		
Mackinac.....							10,575	370		
Manistee.....							85,097	4,374		
Mason.....	6,850	204	130	5			187,531	12,239		
Menominee.....	300	3					217,919	8,280	402,960	18,922
Muskegon.....	200	6	410	16			138,707	8,904		
Oceana.....							24,000	1,440		
Ottawa.....	1,572	32	600	23			935,501	53,316		
Schoolcraft.....							26,226	1,071		
Van Buren.....							81,216	5,389		
Total.....	27,066	622	1,840	72			3,159,135	173,810	519,726	23,574
Indiana:										
Lake.....	625	13	400	16			86,500	5,085		
Laporte.....	2,164	107	650	26	120	\$17	641,730	43,353		
Porter.....	350	10	100	4			85,600	4,275		
Total.....	3,139	130	1,150	46	120	17	813,830	52,713		
Illinois:										
Cook.....	58	1					580,098	31,825		
Lake.....							435,720	22,315		
Total.....	58	1					1,015,818	54,140		
Wisconsin:										
Brown.....	86,886	435	213,453	6,404	148,577	5,979	1,078,433	35,049	58,360	2,762
Door.....	46,194	231					1,595,733	51,861	1,788,550	86,388
Kenosha.....							292,874	16,084		
Kewaunee.....							423,016	13,748		
Manitowoc.....			2,760	141			755,762	42,855		
Marquette.....	1,842	9			3,969	159	2,396,248	78,575	317,135	15,318
Milwaukee.....			200	12			1,069,310	61,420		
Oconto.....	1,600	8	26,500	795	11,800	472	1,445,931	46,992	233,995	11,302
Ozaukee.....							342,140	21,793		
Racine.....							20,400	1,150		
Sheboygan.....			600	30			932,958	56,448		
Total.....	136,522	683	243,513	7,382	164,346	6,610	10,352,805	425,975	2,398,040	115,770
Grand total.....	166,785	1,436	246,503	7,500	164,466	6,627	15,341,588	706,638	2,917,766	139,344

State and county.	Pike.		Pike perch (wall-eyed or yellow pike).		Rock bass.		Sheepshead or drum.		Sturgeon.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Michigan:										
Allegan.....			4,755	\$655			1,600	\$64	895	\$205
Berrien.....			1,100	126			300	12	3,520	943
Charlevoix.....									40	5
Delta.....	6,230	\$623	56,231	6,425					763	94
Emmet.....			75	9						
Grand Traverse.....									35	3
Mackinac.....									890	124
Manistee.....	519	27	5,585	818					943	144
Mason.....	900	90	11,775	2,553			200	8	68	16
Menominee.....	71	6	1,065	128					361	72
Muskegon.....	300	30	5,378	804			7,000	280	434	104
Ottawa.....			2,523	365			1,315	48	360	103
Schoolcraft.....			523	104					50	6
Van Buren.....									50	13
Total.....	8,020	776	89,016	11,987			10,415	412	8,409	1,837

STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

YIELD, BY SPECIES—Continued.

State and county.	Pike.		Pike perch (wall-eyed or yellow pike).		Rock bass.		Sheepshead or drum.		Sturgeon.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Indiana:										
Lake.....	175	\$26	1,400	\$240			750	\$30	1,514	\$466
Laporte.....	50	4							482	162
Porter.....									400	112
Total.....	225	30	1,400	240			750	30	2,396	680
Wisconsin:										
Brown.....	3,518	281	18,289	2,743			16,929	338		
Door.....	8,972	717	662	99	1,714	\$137	318	16		
Marnette.....	6,562	505	1,618	221						
Oconto.....	13,100	1,048	21,039	3,155						
Sheboygan.....	200	18								
Total.....	32,352	2,569	41,608	6,218	1,714	137	17,247	354		
Grand total..	40,597	\$3,375	132,024	18,445	1,714	137	28,412	796	10,805	2,517

State and county.	Sturgeon caviar.		Suckers.				Trout, lake.			
			Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Michigan:										
Allegan.....	16	\$32	5,832	\$249			1,016	\$139		
Antrim.....			3,250	208			4,440	470		
Benzie.....			22,261	892			326,945	29,396		
Berrien.....			10,442	711			250,189	26,658		
Charlevoix.....	190	570	8,963	284	100	\$4	1,063,698	68,803		
Delta.....			577,334	24,597			138,664	11,539		
Emmet.....			3,600	149			96,398	7,456		
Grand Traverse.....			187,351	6,496			34,019	2,567		
Leelanau.....			47,639	1,921			434,587	32,213		
Macinac.....			33,926	1,697			85,447	7,261	200	\$22
Manistee.....			29,381	1,178			168,168	16,903		
Mason.....			62,132	3,531			149,563	16,617		
Menominee.....			3,754	150	345	16	10,753	968	345	16
Muskegon.....	50	125	14,408	816			20,903	2,400		
Oceana.....							46,450	7,013		
Ottawa.....	25	62	1,302	51			240,753	29,447		
Schoolcraft.....			23,785	1,415	2,100	74	378,964	30,805		
Van Buren.....			1,442	100			63,271	7,481		
Total.....	281	789	1,036,802	44,445	2,545	94	3,514,258	298,436	545	38
Indiana:										
Lake.....	55	100	740	30			19,100	2,350		
Laporte.....	10	15	2,000	80			103,010	10,746		
Porter.....			450	22			1,300	130		
Total.....	65	115	3,190	132			123,410	13,226		
Illinois:										
Cook.....							515	37		
Lake.....			5,265	200			168,125	18,075		
Total.....			5,265	200			168,640	18,112		
Wisconsin:										
Brown.....			537,770	12,559	2,600	122				
Door.....			64,635	2,323	8,160	371	802,519	81,736	1,830	186
Kenosha.....							180,346	19,616		
Kewaunee.....			3,862	93			461,813	47,952	215	17
Manitowoc.....			18,763	799			452,220	41,546		
Marquette.....			212,899	8,938			134,690	12,465		
Milwaukee.....			2,105	88			1,075,831	110,677		
Oconto.....			209,912	4,897	805	38	15,144	1,575	230	18
Ozaukee.....			2,800	131			302,128	30,700		
Racine.....							527,125	72,800		
Sheboygan.....			6,450	254			889,771	104,038		
Total.....			1,059,196	30,082	11,565	531	4,841,587	523,105	2,275	221
Grand total..	346	904	2,104,453	74,859	14,110	625	8,647,895	852,879	2,820	259

## STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

## YIELD, BY SPECIES—Continued.

State and county.	Trout, steel-head.		White bass.		Whitefish, common.				Whitefish, menominee.	
					Fresh.		Salted.		Fresh.	
	Pounds.	Valuc.	Pounds.	Valuc.	Pounds.	Valuc.	Pounds.	Valuc.	Pounds.	Valuc.
Michigan			250	\$15	11,217	\$1,530				
Allegan					11,156	1,186			240	\$18
Antrim					693,388	73,988			30	1
Benzie					27,636	3,781				
Berrien					492,552	49,615	1,200	\$96	19,568	1,190
Charlevoix					152,428	14,566			1,772	95
Delta					42,587	4,786			3,000	210
Emmet					41,268	5,812				
Grand Traverse					423,877	37,345			1,422	91
Leelanau					529,510	53,476	745	105	23,233	1,265
Mackinac					29,352	3,558				
Manistee					16,317	2,151				
Mason					4,254	468			49	4
Menominee	700	\$117	350	35	7,615	1,114				
Muskegon					1,518	258				
Oceana					6,862	832				
Ottawa					325,941	40,825			27,373	1,002
Schoolcraft					24,300	3,303				
Van Buren										
Total	700	117	600	50	2,839,868	298,594	1,945	201	76,687	3,876
Indiana:										
Lake	19,200	2,880			300	42				
Laporte	900	180			3,550	637				
Porter	1,150	172			300	43				
Total	21,250	3,232			4,150	722				
Illinois, Lake					33,600	4,750				
Wisconsin:										
Brown			675	27	600	67				
Door					48,002	4,950			23,145	926
Kewaunee					1,000	112				
Manitowoc					42,582	4,451				
Marinette					26,672	2,805				
Milwaukee					4,680	571				
Oconto					14,344	1,607				
Ozaukee					5,040	545				
Sheboygan					24,910	3,988			500	27
Total			675	27	167,830	19,096			23,645	953
Grand total..	21,950	3,349	1,275	77	3,045,448	323,162	1,945	201	100,332	4,829

## STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

## YIELD, BY SPECIES—Continued.

State and county.	Whitefish, menominee— Continued.		Yellow perch.				Crawfish.		Total.	
	Salted.		Fresh.		Salted.					
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Michigan:										
Allegan.....			1,148	\$91					37,132	\$3,600
Antrim.....									33,606	2,714
Benzie.....			1,300	112					1,225,714	114,746
Berrien.....			11,964	1,340					783,782	64,607
Charlevoix.....	7,400	\$553	52,088	3,170					1,898,824	136,227
Delta.....			176,204	12,035					1,460,621	83,020
Emmet.....			5,800	460					154,628	13,240
Grand Traverse.....			4,157	362					299,720	17,494
Leelanau.....	698	47	3,391	287					692,406	27,297
Mackinac.....	7,500	557	3,380	19					1,174,231	85,436
Manistee.....			9,815	295					328,806	64,896
Mason.....			5,013	511					440,479	37,925
Menominee.....			4,561	180	1,725	\$81			648,462	29,294
Muskegon.....			8,137	654					204,592	15,405
Oceana.....									71,968	8,711
Ottawa.....			21,818	1,703					1,212,631	85,987
Schoolcraft.....	9,700	776							792,662	76,078
Van Buren.....			3,823	338					174,162	16,624
Total.....	25,298	1,933	309,599	21,557	1,725	81			11,634,480	883,301
Indiana:										
Lake.....			18,300	1,785					146,734	12,707
Laporte.....			18,600	1,611					775,541	57,260
Porter.....			4,200	360					93,900	5,132
Total.....			41,100	3,786					1,016,175	75,099
Illinois:										
Cook.....			80,613	7,157					661,284	39,020
Lake.....			52,300	3,015					695,010	48,355
Total.....			132,913	10,172					1,356,294	87,375
Wisconsin:										
Brown.....			1,122,303	44,892			80,495	\$4,427	3,368,888	116,085
Door.....	805	40	135,232	5,410					4,526,471	235,391
Kenosha.....			6,360	474					479,580	36,174
Kewaunee.....			17,832	713					907,738	62,635
Manitowoc.....			15,968	1,380					1,288,055	91,172
Marinette.....			110,421	4,417					3,212,056	123,412
Milwaukee.....			117,360	8,974					2,269,486	181,742
Oconto.....			338,733	13,549					2,333,133	85,456
Ozaukee.....			2,500	195					654,668	53,364
Racine.....			5,950	445					553,475	74,395
Sheboygan.....			4,800	455					1,860,189	165,258
Total.....	805	40	1,877,459	80,904			80,495	4,427	21,453,679	1,225,084
Grand total..	26,103	1,973	2,361,071	116,419	1,725	81	80,495	4,427	35,460,628	2,270,859

## FISHERIES, BY APPARATUS.

Of the total product, 20,786,387 pounds, valued at \$1,493,914, was credited to the vessel fisheries, and 14,674,241 pounds, valued at \$776,945, to the shore or boat fisheries. In the vessel fisheries, gill nets and lines were employed and in the shore fisheries pound nets and trap nets, gill nets, fyke nets, seines, lines, and crawfish pots. The catch with these forms of apparatus was as follows: Gill nets, 22,346,654 pounds, valued at \$1,458,809; pound nets and trap nets, 8,735,445 pounds, valued at \$491,647; lines, 2,007,204 pounds, valued at \$231,563; fyke nets, 1,906,613 pounds, valued at \$72,875; seines, 384,217 pounds, valued at \$11,538; crawfish pots, 80,495 pounds, valued at \$4,427.

The products of the vessel and shore fisheries by States, counties, apparatus, and species in 1917 are shown in the following tables:

YIELD OF VESSEL FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Indiana.		Illinois.					
	Laporte.		Cook.		Lake.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Gillnets:								
Burbot.....	1,764	\$75	58	\$1			58	\$1
Ciscoes, fresh.....	573,330	39,973	525,258	28,835	309,000	\$15,935	834,258	44,770
Trout, lake.....	95,310	9,951	515	37	151,875	16,325	152,390	16,362
Whitefish, common, fresh.....	100	15						
Yellow perch.....			44,613	3,807	34,200	1,875	78,813	5,682
Total.....	670,504	50,014	570,444	32,680	495,075	34,135	1,065,519	66,815
Lines: Trout, lake, fresh.....	7,000	700						
Grand total.....	677,504	50,714	570,444	32,680	495,075	34,135	1,065,519	66,815

Apparatus and species.	Michigan.							
	Benzie.		Berrien.		Charlevoix.		Delta.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Gillnets:								
Burbot.....	4,870	\$89	2,770	\$63	7,742	\$172		
Ciscoes—								
Fresh.....	176,545	10,253	389,976	25,326	241,184	12,153	3,552	\$125
Salted.....							34,840	1,398
Suckers.....	11,011	412	1,125	90	7,896	244	2,097	79
Trout, lake.....	295,695	26,896	233,164	24,163	876,740	54,663	96,499	7,720
Whitefish—								
Common, fresh.....	678,988	72,668	10,068	1,437	409,354	40,908	26,063	3,193
Common, salted.....					1,200	96		
Menominee, fresh.....	30	1			6,305	381		
Menominee, salted.....					100	7		
Yellow perch.....			1,725	202	14,908	892		
Total.....	1,167,139	110,319	638,828	51,281	1,565,429	109,516	163,051	12,515
Lines: Trout, lake, fresh.....					80,581	6,347		
Grand total.....	1,167,139	110,319	638,828	51,281	1,646,010	115,863	163,051	12,515

Apparatus and species.	Michigan—Continued.							
	Grand Traverse.		Leelanau.		Mackinac.		Manistee.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Gillnets:								
Burbot.....	1,100	\$20						
Ciscoes, fresh.....	7,320	354	230,659	\$11,985			75,405	\$3,889
Suckers.....			250	10	13,309	\$767	11,606	410
Trout, lake.....	12,000	884	378,500	27,722	32,969	3,044	139,542	14,051
Whitefish—								
Common, fresh.....	1,560	241	320,625	28,748	69,048	8,203	18,142	2,266
Common, salted.....					155	22		
Menominee, fresh.....					11,918	535		
Menominee, salted.....			698	47	5,900	442		
Yellow perch.....	987	86	36	3				
Total.....	22,967	1,585	930,768	68,515	133,299	13,013	244,695	20,616
Lines: Trout, lake, fresh.....					1,025	82	25,875	2,580
Grand total.....	22,967	1,585	930,768	68,515	134,324	13,095	270,570	23,196

YIELD OF VESSEL FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Michigan—Continued.							
	Mason.		Muskegon.		Oceana.		Ottawa.	
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Gill nets:								
Burbot.....	5,850	\$169					1,522	\$31
Ciscoes, fresh.....	167,110	11,363	20,555	\$1,234	24,000	\$1,440	863,050	48,878
Pike perch (wall-eyed or yellow pike).....							40	6
Suckers.....	700	36	357	21				
Trout, lake.....	121,401	12,998	2,408	273	9,875	1,337	198,491	24,047
Whitefish, common, fresh.....	3,205	406	2,101	309	1,518	258	3,000	360
Yellow perch.....			4,942	396			1,000	70
Total.....	298,266	24,972	30,363	2,233	35,393	3,035	1,067,103	73,392
Lines: Trout, lake, fresh.....	27,465	3,530	13,466	1,526	36,575	5,676	38,981	5,021
Grand total.....	325,731	28,502	43,829	3,759	71,968	8,711	1,106,084	78,413

Apparatus and species.	Michigan—Continued.						Wisconsin.	
	Schoolcraft.		Van Buren.		Total.		Brown.	
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Gill nets:								
Burbot.....					23,854	\$544	32,230	\$161
Ciscoes—								
Fresh.....	13,891	\$557	80,016	\$5,303	2,293,263	132,860	573,702	18,645
Salted.....					34,840	1,398	43,138	2,027
Pike perch (wall-eyed or yellow pike).....	114	23			154	29		
Suckers.....	5,747	287	542	52	54,640	2,408	1,624	49
Trout, lake.....	347,412	28,328	60,871	7,197	2,805,567	233,333		
Whitefish—								
Common, fresh.....	203,575	28,635	14,360	2,101	1,761,607	189,733		
Common, salted.....					1,355	118		
Menominee, fresh.....	2,875	115			21,128	1,032		
Menominee, salted.....					6,698	496		
Yellow perch.....			623	62	24,221	1,711	70,144	2,806
Total.....	573,614	57,945	156,412	14,715	7,027,327	563,662	720,838	23,688
Lines: Trout, lake, fresh.....					223,968	24,762		
Grand total.....	573,614	57,945	156,412	14,715	7,251,295	588,424	720,838	23,688

Apparatus and species.	Wisconsin—Continued.							
	Door.		Kenosha.		Kewaunee.		Manitowoc.	
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Gill nets:								
Burbot.....	43,664	\$218						
Carp, Asiatic.....							1,300	\$68
Ciscoes—								
Fresh.....	852,095	27,693	292,874	\$16,084	265,573	\$8,631	752,522	42,693
Salted.....	58,918	2,846						
Suckers.....	3,642	85			760	18	5,213	259
Trout, lake.....	285,784	29,722	180,346	19,616	41,723	4,339	152,772	13,800
Whitefish—								
Common, fresh.....	21,383	2,390					108	19
Menominee, fresh.....	23,145	926						
Yellow perch.....	38,851	1,554			15,312	612	10,928	951
Total.....	1,327,440	65,434	473,220	35,700	323,358	13,600	922,843	57,790
Lines:								
Pike.....	5,756	460						
Trout, lake—								
Fresh.....	300,888	31,292			410,525	42,695		
Salted.....					215	17		
Total.....	306,644	31,752			410,740	42,712		
Grand total.....	1,634,084	97,186	473,220	35,700	734,098	56,312	922,843	57,790

## YIELD OF VESSEL FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Wisconsin—Continued.							
	Marinette.		Milwaukee.		Oconto.		Ozaukee.	
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Gill nets:								
Burbot.....	1,842	\$9						
Ciscoes, fresh.....	1,868,107	65,372	965,870	\$56,461	675,458	\$21,952	309,680	\$20,488
Pike.....	2,000	140						
Pike perch (wall-eyed or yellow pike).....	700	84						
Suckers.....	166,218	7,849			6,089	142		
Trout, lake.....	99,528	8,808	1,029,581	105,051			177,128	18,600
Whitefish, common, fresh.....	21,056	2,176						
Yellow perch.....	68,114	2,725	71,360	5,224				
Total.....	2,227,565	87,163	2,066,811	166,736	681,547	22,094	486,808	39,088
Lines: Trout, lake, fresh.....							55,000	6,000
Grand total.....	2,227,565	87,163	2,066,811	166,736	681,547	22,094	541,808	45,088

Apparatus and species.	Wisconsin—Continued.						Grand total.	
	Racine.		Sheboygan.		Total.			
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Gill nets:								
Burbot.....					77,736	\$388	103,412	\$1,008
Carp, Asiatic.....					1,300	68	1,300	68
Ciscoes—								
Fresh.....	17,400	\$1,000	600,430	\$44,474	7,173,714	323,493	10,874,565	541,096
Salted.....					102,056	4,873	136,896	6,271
Pike.....					2,000	140	2,000	140
Pike perch (wall-eyed or yellow pike).....					700	84	854	113
Suckers.....					183,536	8,402	238,176	10,810
Trout, lake.....	64,375	8,500	238,000	29,500	2,269,237	237,936	5,322,504	497,582
Whitefish—								
Common, fresh.....					42,502	4,585	1,804,209	194,333
Common, salted.....							1,355	118
Menominee, fresh.....					23,145	926	44,273	1,958
Menominee, salted.....							6,698	496
Yellow perch.....					274,709	13,872	377,743	21,265
Total.....	81,775	9,500	838,430	73,974	10,150,635	594,767	18,913,985	1,275,258
Lines:								
Pike.....					5,756	400	5,756	400
Trout, lake—								
Fresh.....	462,750	64,300	406,300	48,430	1,635,463	192,717	1,866,431	218,179
Salted.....					215	17	215	17
Total.....	462,750	64,300	406,300	48,430	1,641,434	193,194	1,872,402	218,656
Grand total.....	544,525	73,800	1,244,730	122,404	11,792,069	787,961	20,786,387	1,493,914

## YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Michigan.									
	Allegan.		Antrim.		Benzie.		Berrien.		Charlevoix.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
<b>Pound nets and trap nets:</b>										
Burbot.....							100	\$3	323	\$8
Carp, Asiatic.....	300	\$12					400	16		
Ciscoes, fresh.....	6,933	424	4,800	\$282			63,984	3,616		
Pike perch (wall-eyed or yellow pike).....	4,678	644					1,100	126		
Sheepshead or drum.....	1,600	64					300	12		
Sturgeon.....	795	179					1,720	443	40	5
Sturgeon caviar.....	16	32					190	570		
Suckers, fresh.....	4,249	186	3,250	208	10,000	\$440	1,550	111		
Trout, lake, fresh.....	351	46	625	70			867	104	31,835	2,291
White bass.....	250	15								
Whitefish—										
Common, fresh.....	4,435	576	9,794	1,051	2,400	220	9,775	1,289	62,332	6,543
Menominee, fresh.....									865	49
Yellow perch, fresh.....	574	45			900	76	3,500	335	32,627	1,944
<b>Total.....</b>	<b>24,181</b>	<b>2,223</b>	<b>18,469</b>	<b>1,611</b>	<b>13,300</b>	<b>736</b>	<b>83,486</b>	<b>6,625</b>	<b>128,022</b>	<b>10,840</b>
<b>Gill nets:</b>										
Burbot.....									674	15
Ciscoes—										
Fresh.....	700	42	9,720	550	375	15	21,211	1,442	3,292	159
Salted.....	2,437	142								
Pike perch (wall-eyed or yellow pike).....	80	11								
Sturgeon.....	100	26								
Suckers—										
Fresh.....	1,583	63			1,250	40	7,697	506	1,067	40
Salted.....									100	4
Trout, lake, fresh.....	665	93	2,565	270	31,250	2,500	16,158	2,391	74,542	5,492
Whitefish—										
Common, fresh.....	6,812	954	1,362	135	12,000	1,100	7,793	1,055	20,866	2,164
Menominee, fresh.....			240	18					12,398	760
Menominee, salted.....									7,300	546
Yellow perch.....	574	46			400	36	6,439	779	4,553	334
<b>Total.....</b>	<b>12,951</b>	<b>1,377</b>	<b>13,887</b>	<b>973</b>	<b>45,275</b>	<b>3,691</b>	<b>59,298</b>	<b>6,173</b>	<b>124,792</b>	<b>9,514</b>
<b>Seines:</b>										
Suckers.....							70	4		
Yellow perch.....							300	24		
<b>Total.....</b>							<b>370</b>	<b>28</b>		
<b>Lines:</b>										
Sturgeon.....							1,800	500		
Trout, lake.....			1,250	130						
<b>Total.....</b>			<b>1,250</b>	<b>130</b>			<b>1,800</b>	<b>500</b>		
<b>Grand total.....</b>	<b>37,132</b>	<b>3,600</b>	<b>33,606</b>	<b>2,714</b>	<b>58,575</b>	<b>4,427</b>	<b>144,954</b>	<b>13,326</b>	<b>252,814</b>	<b>20,354</b>

## YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Michigan—Continued.									
	Delta.		Emmet.		Grand Traverse.		Leelanau.		Mackinac.	
	Pounds.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Pounds.	Value.
Pound nets and trap nets:										
Burbot.....	565	\$7								
Ciscoes—										
Fresh.....	161,888	5,445			14,220	\$965	27,038	\$1,303	10,575	\$370
Salted.....	46,341	1,576								
Pike perch (wall-eyed or yellow pike).....	10,039	1,297	75	\$9						
Sturgeon.....	763	94			35	3			890	124
Suckers, fresh.....	297,084	12,027	3,600	149	187,351	6,496	47,389	1,911	9,575	409
Trout, lake, fresh.....	16,985	1,557	11,225	985	7,174	594	35,845	2,743	36,448	2,780
Whitefish—										
Common, fresh.....	40,688	3,327	20,400	2,510	37,588	5,335	97,041	7,973	428,103	41,548
Common, salted.....									531	75
Menominee, fresh.....	823	42	3,000	210			114	9	7,589	478
Menominee, salted.....									1,600	115
Yellow perch, fresh.....	49,520	3,305			200	16	2,489	214		
Total.....	624,696	28,677	38,300	3,863	246,568	13,409	209,916	14,153	495,311	45,899
Gill nets:										
Ciscoes—										
Fresh.....	68,538	2,875	3,168	170	10,220	615	4,920	244		
Salted.....	33,148	1,536								
Pike.....	1,230	123								
Pike perch (wall-eyed or yellow pike).....	17,027	2,003								
Suckers, fresh.....	221,061	9,813							11,042	521
Trout, lake—										
Fresh.....	25,180	2,262	80,173	6,051	8,500	785	15,867	1,348	15,005	1,355
Salted.....									200	22
Whitefish—										
Common, fresh.....	85,677	8,046	22,187	2,276	2,120	236	6,211	624	32,359	3,725
Common, salted.....									59	8
Menominee, fresh.....	949	53					1,308	82	3,726	252
Yellow perch.....	106,883	7,148	5,800	460	2,970	260	866	70	380	19
Total.....	559,693	33,949	111,328	8,957	23,810	1,896	29,172	2,368	62,771	5,902
Fyke nets:										
Ciscoes.....	2,120	\$4								
Pike.....	5,000	500								
Pike perch (wall-eyed or yellow pike).....	29,168	3,035								
Suckers, fresh.....	57,092	2,678								
Yellow perch.....	19,801	1,582								
Total.....	113,181	7,879								
Lines: Trout, lake.....			5,000	420	6,375	604	4,375	400		
Grand total.....	1,297,570	70,505	154,628	13,240	276,753	15,909	243,463	16,921	558,082	51,801

YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Michigan—Continued.									
	Manistee.		Mason.		Menominee.		Muskegon.		Ottawa.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets and trap nets:										
Burbot.....			1,000	\$35	100	\$1	200	\$6	50	\$1
Carp, Asiatic.....			130	5			410	16	600	23
Ciscoes—										
Fresh.....	7,688	\$402	19,121	811	120,406	4,575	109,977	7,172	58,419	3,565
Salted.....					402,900	18,922				
Pike.....	25	1	900	90			300	30		
Pike perch (wall-eyed or yellow pike).....	5,088	748	11,475	2,508	751	90	4,528	677	2,483	359
Sheepshead or drum.....			100	4			7,000	250	1,315	48
Sturgeon.....	158	35	48	10	361	72	434	104	360	108
Sturgeon caviar.....							50	125	25	62
Suckers, fresh.....	4,344	178	60,432	3,445			7,411	404	1,302	51
Trout, lake—										
Fresh.....	2,094	208	597	77	8,063	726	4,229	503	2,865	326
Salted.....					345	16				
Trout, steelhead.....							500	81		
White bass.....							350	35		
Whitefish—										
Common, fresh.....	10,519	1,212	12,612	1,670	4,254	468	4,499	661	3,812	467
Menominee, fresh.....					49	1				
Yellow perch—										
Fresh.....	4,945	191	3,513	391	3,461	136	650	55	4,040	210
Salted.....					1,725	81				
Total.....	34,861	2,975	109,928	9,046	542,475	25,091	140,538	10,149	75,271	5,220
Gill nets:										
Burbot.....					200	2				
Ciscoes, fresh.....	2,004	83	1,300	65	97,513	3,705	8,175	498	14,032	873
Pike.....	494	26								
Pike perch (wall-eyed or yellow pike).....	497	70	300	45			850	127		
Sheepshead or drum.....			100	4						
Sturgeon.....	785	109	20	6						
Suckers—										
Fresh.....	13,431	590	1,000	50	3,754	150	6,640	391		
Salted.....					345	16				
Trout, lake, fresh.....	657	64	100	12	2,690	242	800	98	416	53
Trout, steelhead.....							200	36		
Whitefish, common, fresh.....	691	80	500	75			1,015	144	50	5
Yellow perch.....	4,870	104	800	64			2,545	203	16,778	1,423
Total.....	23,429	1,126	4,120	321	104,502	4,115	20,225	1,497	31,276	2,354
Fyke nets:										
Pike.....					71	6				
Pike perch (wall-eyed or yellow pike).....					314	38				
Yellow perch.....					1,100	44				
Total.....					1,485	88				
Lines: Yellow perch.....			700	56						
Grand total.....	58,290	4,101	114,748	9,423	648,462	29,294	160,763	11,646	106,547	7,574

## YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Michigan—Continued.						Indiana.			
	Schoolcraft.		Van Buren.		Total.		Lake.		Laporte.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets and trap nets:										
Burbot.....					2,338	\$61	125	\$3	400	\$32
Carp, Asiatic.....					1,840	72	409	16	650	26
Catfish and bullheads.....									120	17
Ciscoes—										
Fresh.....					605,049	28,930	65,000	3,800	59,000	2,840
Salted.....					449,301	20,498				
Pike.....					1,225	121			175	26
Pike perch (wall-eyed or yellow pike).....	400	\$80			40,617	6,538			1,400	240
Sheepshead or drum.....					10,315	408			750	30
Sturgeon.....					5,604	1,177	914	256	482	162
Sturgeon caviar.....					281	789	40	70	10	15
Suckers—										
Fresh.....	15,600	1,031			653,137	27,046	540	22	1,500	60
Salted.....	2,100	74			2,100	74				
Trout, lake—										
Fresh.....	16,162	1,274			175,365	14,284	100	10	600	84
Salted.....					345	16				
Trout, steelhead.....					500	\$1	200	30	900	180
White bass.....					600	50				
Whitefish—										
Common, fresh.....	107,427	10,842			855,679	85,692	300	42	3,300	595
Common, salted.....					531	75				
Menominee, fresh.....	15,250	610			27,690	1,402				
Menominee, salted.....	9,700	776			11,300	891				
Yellow perch—										
Fresh.....					106,419	6,918	6,300	565	6,500	605
Salted.....					1,725	81				
<b>Total.....</b>	<b>166,639</b>	<b>14,687</b>			<b>2,951,961</b>	<b>195,204</b>	<b>73,919</b>	<b>4,814</b>	<b>75,787</b>	<b>4,912</b>
Gill nets:										
Burbot.....					874	17	500	10		
Ciscoes—										
Fresh.....	12,335	514	1,200	\$86	258,703	11,936	21,500	1,285	9,400	540
Salted.....					35,585	1,678				
Pike.....					1,724	149				
Pike perch (wall-eyed or yellow pike).....	9	1			18,763	2,347				
Sheepshead or drum.....					100	4				
Sturgeon.....	50	6	50	13	1,005	160				
Suckers—										
Fresh.....	2,438	97	900	48	271,863	12,309	200	8	500	20
Salted.....					415	20				
Trout, lake—										
Fresh.....	15,390	1,203	2,400	284	292,358	24,503	19,000	2,340	100	11
Salted.....					200	22				
Trout, steelhead.....					200	36	19,000	2,850		
Whitefish—										
Common, fresh.....	12,939	1,348	10,000	1,202	222,582	23,169			150	27
Common, salted.....					59	8				
Menominee, fresh.....	9,248	277			27,869	1,442				
Menominee, salted.....					7,300	546				
Yellow perch.....			3,200	276	157,058	11,222	12,000	1,220	12,100	1,036
<b>Total.....</b>	<b>52,409</b>	<b>3,446</b>	<b>17,750</b>	<b>1,909</b>	<b>1,296,688</b>	<b>89,568</b>	<b>72,200</b>	<b>7,713</b>	<b>22,250</b>	<b>1,634</b>
Fyke nets:										
Ciscoes.....					2,120	84				
Pike.....					5,071	506				
Pike perch (wall-eyed or yellow pike).....					29,482	3,073				
Suckers, fresh.....					57,092	2,678				
Yellow perch.....					20,901	1,626				
<b>Total.....</b>					<b>114,666</b>	<b>7,967</b>				

YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Michigan—Continued.						Indiana.			
	Schoolcraft.		Van Buren.		Total.		Lake.		Laporte.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:										
Suckers.....					70	\$4				
Yellow perch.....					300	24				
Total.....					370	28				
Lines:										
Sturgeon.....					1,800	500	600	\$150		
Sturgeon caviar.....							15	30		
Trout, lake.....					17,000	1,554				
Yellow perch.....					700	56				
Total.....					19,500	2,110	615	180		
Grand total.....	219,048	\$18,133	17,750	\$1,909	4,383,185	294,877	146,734	12,707	98,037	\$6,546

Apparatus and species.	Indiana—Continued.				Illinois.					
	Porter.		Total.		Cook.		Lake.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets and trap nets:										
Burbot.....	150	\$6	675	\$41						
Carp, Asiatic.....	100	4	1,150	46						
Catfish and bullheads.....			120	17						
Ciscoes, fresh.....	80,000	4,000	204,000	10,640			9,600	\$555	9,600	\$555
Pike.....	50	4	225	30						
Pike perch (wall-eyed or yellow pike).....			1,400	240						
Sheepshead or drum.....			750	30						
Sturgeon.....	400	112	1,796	530						
Sturgeon caviar.....			50	85						
Suckers, fresh.....	400	20	2,440	102			5,265	200	5,265	200
Trout, lake, fresh.....	1,300	130	2,000	224			16,250	1,750	16,250	1,750
Trout, steelhead.....	1,075	161	2,175	371						
Whitefish, common, fresh.....	250	36	3,850	673			33,600	4,750	33,600	4,750
Yellow perch, fresh.....	1,500	150	14,300	1,320			2,100	125	2,100	125
Total.....	85,225	4,623	234,931	14,349			66,815	7,380	66,815	7,380
Gill nets:										
Burbot.....	200	4	700	14						
Ciscoes, fresh.....	5,600	275	36,500	2,100	54,840	\$2,990	117,120	5,825	171,960	8,815
Suckers, fresh.....	50	2	750	30						
Trout, lake, fresh.....			19,100	2,351						
Trout, steelhead.....	75	11	19,075	2,861						
Whitefish, common, fresh.....	50	7	200	34						
Yellow perch.....	2,700	210	26,800	2,466	20,000	1,350	16,000	1,015	36,000	2,365
Total.....	8,675	509	103,125	9,856	74,840	4,340	133,120	6,840	207,960	11,180
Lines:										
Sturgeon.....			600	150						
Sturgeon caviar.....			15	30						
Yellow perch.....					16,000	2,000			16,000	2,000
Total.....			615	180	16,000	2,000			16,000	2,000
Grand total.....	93,900	5,132	338,671	24,385	90,840	6,340	199,935	14,220	290,775	20,560

## YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Wisconsin.									
	Brown.		Door.		Kenosha.		Kewaunee.		Manitowoc.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets and trap nets:										
Burbot	8,500	\$43	2,530	\$13						
Catfish and bullheads	600	24								
Ciscoes—										
Fresh	123,930	4,028	543,111	17,651			157,443	\$5,117		
Salted			1,717,403	82,951						
Pike	600	48	3,216	237						
Pike perch (wall-eyed or yellow pike)	300	45								
Rock bass			1,714	137						
Sheepshead or drum	1,920	38								
Suckers—										
Fresh	538	13	48,176	1,930			3,112	75		
Salted			8,160	371						
Trout, lake—										
Fresh			121,531	11,667			1,238	119,208,108	\$27,611	
Salted			1,830	186						
Whitefish—										
Common, fresh	600	67	26,664	2,560			1,000	112	41,274	4,302
Menominee, salted			805	40						
Yellow perch, fresh	11,223	449	36,752	1,470			2,520	101	740	69
Total	148,211	4,755	2,511,892	119,233			165,313	5,524	340,212	31,982
Gill nets:										
Burbot	28,237	141								
Carp, Asiatic									500	23
Ciscoes—										
Fresh	380,801	12,376	200,524	6,517					3,210	162
Salted	15,222	735	12,229	591						
Pike perch (wall-eyed or yellow pike)	1,914	287	662	99						
Sheepshead or drum			318	16						
Suckers, fresh	2,142	50	12,817	308					7,300	295
Trout, lake, fresh			70,196	6,739					1,250	135
Yellow perch	210,432	8,417	50,214	2,009	6,360	\$474			4,300	360
Total	638,748	22,006	346,960	16,279	6,360	474			16,590	975
Fyke nets:										
Burbot	17,919	90								
Carp, Asiatic	27,464	824								
Catfish and bullheads	147,977	5,955								
Pike	2,918	233								
Pike perch (wall-eyed or yellow pike)	16,075	2,411								
Sheepshead or drum	15,009	300								
Suckers—										
Fresh	483,993	11,293								
Salted	2,600	122								
White bass	675	27								
Yellow perch	824,904	32,996								
Total	1,539,534	54,251								
Seines:										
Carp, Asiatic	185,989	5,580							960	50
Suckers	49,473	1,154							6,250	245
Whitefish									1,200	130
Yellow perch	5,600	224								
Total	241,062	6,958							8,410	425
Lines:										
Trout, lake			24,120	2,316			8,327	799		
Yellow perch			9,415	377						
Total			33,535	2,693			8,327	799		
Crawfish pots: Crawfish	80,495	4,427								
Grand total	2,648,050	92,397	2,892,387	138,205	6,360	474	173,640	6,323	365,212	33,382

YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Wisconsin—Continued.									
	Marinette.		Milwaukee.		Oconto.		Ozaukee.		Racine.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets and trap nets:										
Carp, Asiatic.....			200	\$12	100	\$3				
Catfish and bullheads.....	3,969	\$159			1,800	72				
Ciscoes—										
Fresh.....	305,732	7,643	4,800	235	428,342	13,921	30,000	\$1,200		
Salted.....	317,135	15,318			233,995	11,302				
Pike.....					4,000	320				
Pike perch (wall-eyed or yellow pike).....	276	41			4,441	666				
Suckers—										
Fresh.....	18,320	427	900	45	32,944	769	900	42		
Salted.....					805	38				
Trout, lake—										
Fresh.....	25,461	2,648	625	76	15,144	1,575	20,000	1,700		
Salted.....					230	18				
Whitefish, common, fresh.....	3,778	423	4,680	571	14,344	1,607	5,010	545		
Yellow perch, fresh.....	24,510	980	8,000	650	201,680	8,067	800	68		
Total.....	699,181	27,639	19,205	1,589	937,825	38,358	56,740	3,555		
Gill nets:										
Burbot.....					1,600	8				
Ciscoes, fresh.....	222,409	5,560	98,640	4,724	342,131	11,119	2,460	105	3,000	\$150
Suckers, fresh.....	19,716	460	1,205	43	4,992	116	1,900	89		
Trout, lake, fresh.....	9,701	1,009	41,250	5,000						
Whitefish, common, fresh.....	1,838	206								
Yellow perch.....	9,896	396	38,000	3,100	2,600	104	1,700	127	3,500	270
Total.....	263,560	7,631	179,095	12,867	351,323	11,347	6,060	321	6,500	420
Fyke nets:										
Carp, Asiatic.....					400	12				
Catfish and bullheads.....					10,000	400				
Pike.....	4,562	365			9,100	728				
Pike perch (wall-eyed or yellow pike).....	642	96			10,823	1,623				
Suckers, fresh.....	8,645	202			65,887	1,537				
Yellow perch.....	7,901	316			134,453	5,378				
Total.....	21,750	979			230,663	9,678				
Seines:										
Carp, Asiatic.....					26,000	780				
Pike perch (wall-eyed or yellow pike).....					5,575	866				
Suckers.....					100,000	2,333				
Total.....					131,575	3,979				
Lines:										
Trout, lake.....			4,375	550			50,000	4,400		
Yellow perch.....									2,450	175
Total.....			4,375	550			50,000	4,400	2,450	175
Grand total.....	984,491	36,249	202,675	15,006	1,651,586	63,362	112,800	8,276	8,950	595

## YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Wisconsin—Continued.				Grand total.	
	Sheboygan.		Total.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
<b>Pound nets and trap nets:</b>						
Burbot.....			11,030	\$56	14,043	\$158
Carp, Asiatic.....			300	15	3,290	133
Catfish and bullheads.....			6,369	255	6,489	272
Ciscoes—						
Fresh.....	332,528	\$11,974	1,925,886	61,769	2,744,535	101,894
Salted.....			2,268,533	109,571	2,717,834	130,069
Pike.....			7,816	625	9,266	776
Pike perch (wall-eyed or yellow pike).....			5,017	752	47,034	7,530
Rock bass.....			1,714	137	1,714	137
Sheepshead or drum.....			1,920	38	12,985	476
Sturgeon.....					7,400	1,707
Sturgeon caviar.....					331	874
Suckers—						
Fresh.....	150	4	105,040	3,305	765,882	30,653
Salted.....			8,965	409	11,065	483
Trout, lake—						
Fresh.....	245,471	26,108	727,668	71,504	921,283	87,762
Salted.....			2,060	204	2,405	220
Trout, steelhead.....					2,675	452
White bass.....					600	50
Whitefish—						
Common, fresh.....	24,910	3,988	122,290	14,175	1,015,419	105,290
Common, salted.....					531	75
Menominee, fresh.....					27,690	1,402
Menominee, salted.....			805	40	12,105	931
Yellow perch—						
Fresh.....	100	5	286,325	11,859	409,144	20,222
Salted.....					1,725	81
<b>Total.....</b>	<b>603,159</b>	<b>42,079</b>	<b>5,481,738</b>	<b>274,714</b>	<b>8,735,445</b>	<b>491,647</b>
<b>Gill nets:</b>						
Burbot.....			29,837	149	31,411	180
Carp, Asiatic.....			500	23	500	23
Ciscoes—						
Fresh.....			1,253,205	40,713	1,720,368	63,564
Salted.....			27,451	1,326	63,036	3,004
Pike.....					1,724	149
Pike perch (wall-eyed or yellow pike).....			2,576	386	21,339	2,733
Sheepshead or drum.....			318	16	418	20
Sturgeon.....					1,005	160
Suckers—						
Fresh.....	4,700	175	54,772	1,536	327,385	13,875
Salted.....					445	20
Trout, lake—						
Fresh.....			122,397	12,883	433,855	39,737
Salted.....					200	22
Trout, steelhead.....					19,275	2,897
Whitefish—						
Common, fresh.....			1,838	206	224,620	23,409
Common, salted.....					59	8
Menominee, fresh.....	500	27	500	27	28,369	1,469
Menominee, salted.....					7,300	546
Yellow perch.....	4,500	425	331,502	15,682	551,360	31,735
<b>Total.....</b>	<b>9,700</b>	<b>627</b>	<b>1,824,896</b>	<b>72,947</b>	<b>3,432,669</b>	<b>183,551</b>
<b>Fyke nets:</b>						
Burbot.....			17,919	90	17,919	90
Carp, Asiatic.....			27,864	836	27,864	836
Catfish and bullheads.....			157,977	6,355	157,977	6,355
Ciscoes.....					2,120	84
Pike.....			16,580	1,326	21,651	1,832
Pike perch (wall-eyed or yellow pike).....			27,540	4,130	57,022	7,203
Sheepshead or drum.....			15,009	300	15,009	300
Suckers—						
Fresh.....			558,525	13,032	615,617	15,710
Salted.....			2,600	122	2,600	122
White bass.....			675	27	675	27
Yellow perch.....			967,258	38,690	988,159	40,316
<b>Total.....</b>			<b>1,791,947</b>	<b>64,908</b>	<b>1,906,613</b>	<b>72,875</b>

## YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Wisconsin—Continued.				Grand total.	
	Sheboygan.		Total.			
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
<b>Seines:</b>						
Carp, Asiatic.....	600	\$30	213,549	\$6,440	213,549	\$6,440
Pike.....	200	18	200	18	200	18
Pike perch (wall-eyed or yellow pike).....			5,775	866	5,775	866
Suckers.....	1,000	75	157,323	3,807	157,393	3,811
Whitefish.....			1,200	130	1,200	130
Yellow perch.....	200	25	5,800	249	6,100	273
<b>Total.....</b>	<b>2,000</b>	<b>148</b>	<b>383,847</b>	<b>11,510</b>	<b>384,217</b>	<b>11,538</b>
<b>Lines:</b>						
Sturgeon.....					2,400	650
Sturgeon caviar.....					15	30
Trout, lake.....					86,822	9,619
Yellow perch.....					11,865	552
<b>Total.....</b>			<b>98,687</b>	<b>8,617</b>	<b>134,802</b>	<b>12,907</b>
<b>Crawfish pots: Crawfish.....</b>			<b>80,495</b>	<b>4,427</b>	<b>80,495</b>	<b>4,427</b>
<b>Grand total.....</b>	<b>615,459</b>	<b>42,854</b>	<b>9,661,340</b>	<b>437,123</b>	<b>14,674,241</b>	<b>776,945</b>

## WHOLESALE FISHERY TRADE.

The wholesale fishery trade of Lake Michigan in 1917 was carried on by 75 establishments, of which 38 were in Chicago, 7 in Green Bay, and the same number in Milwaukee, the principal centers of the wholesale trade, and the remaining 22 distributed in Michigan and Wisconsin towns. The number of persons employed was 752, to whom \$792,927 were paid in wages; the value of the shore and accessory property utilized was \$1,444,826; and the cash capital amounted to \$349,800.

The following table shows the extent of the wholesale fishery trade of Lake Michigan in 1917:

## WHOLESALE FISHERY TRADE OF LAKE MICHIGAN IN 1917.

Cities and towns.	State.	Number of firms.	Persons engaged.	Wages paid.	Shore and accessory property.	Cash capital.
Chicago <sup>1</sup> .....	Illinois.....	39	485	\$624,821	\$1,082,919	\$113,500
Grand Haven, Charlevoix, and St. Joseph.....	Michigan.....	5	24	27,178	40,105	41,000
Escanaba, Fairport, Manistique, and Naubinway.....	.....do.....	4	10	3,460	7,300	6,000
Menominee.....	.....do.....	3	36	18,100	65,961	80,000
Green Bay.....	Wisconsin.....	7	107	82,504	153,694	79,500
Sturgeon Bay, Detroit Harbor, and Two Rivers.....	.....do.....	4	18	6,564	15,710	8,300
Marinette.....	.....do.....	3	32	14,700	16,687	9,000
Milwaukee.....	.....do.....	7	26	10,900	58,000	10,000
Port Washington and Sheboygan.....	.....do.....	3	14	4,700	4,450	2,500
<b>Total.....</b>		<b>75</b>	<b>752</b>	<b>792,927</b>	<b>1,444,826</b>	<b>349,800</b>

<sup>1</sup> Includes one firm at Michigan City, Ind.

## FISHERIES OF LAKE HURON.

The total number of persons employed in the fisheries of Lake Huron in 1917 was 1,348. Of this number, 149 were on fishing vessels, 29 on transporting vessels, 1,023 in the shore or boat fisheries, and 147 shoresmen in the wholesale establishments and other shore activities.

The total investment in the fisheries amounted to \$1,188,705, which included 26 steam and gasoline fishing vessels of 379 net tons, valued at \$76,500, and their outfits valued at \$27,990; 21 transporting vessels of 193 net tons, valued at \$40,500, and outfits valued at \$5,250; 570 boats valued at \$111,980; fishing apparatus used in the vessel fisheries to the value of \$73,419 and in the shore or boat fisheries to the value of \$264,874; shore and accessory property with a value of \$432,092; and cash capital amounting to \$156,100. Gill nets and lines were employed in both vessel and shore fisheries. The number of gill nets used in the vessel fisheries was 6,613, representing a value of \$69,575, and in the boat fisheries 3,997, valued at \$33,260, a total of 10,610 nets with a value of \$102,835. The use of pound nets, trap nets, fyke nets, seines, and spears was confined to the shore fisheries. The number of pound nets and trap nets operated was 1,731, valued at \$207,904.

The products of the fisheries of Lake Huron in 1917 aggregated 13,363,207 pounds, valued at \$857,478. The more important species were ciscoes, 5,381,365 pounds, valued at \$215,782; lake trout, 2,079,455 pounds, valued at \$214,574; suckers, 1,776,767 pounds, valued at \$72,933; carp, 1,145,250 pounds, valued at \$43,474; common whitefish, 998,226 pounds, valued at \$124,637; pike perch, 994,672 pounds, valued at \$119,234; and yellow perch, 844,019 pounds, valued at \$56,464.

In comparison with the other lakes in 1917 Lake Huron ranked third in the number of persons engaged, investment, and value of the products and fourth in the quantity of products taken. Compared with 1903 there has been a decrease of 356, or 20.89 per cent, in the number of persons engaged; an increase of \$337,066, or 39.57 per cent, in the investment and \$407,160, or 90.42 per cent, in the value of the products; and a decrease of 1,092,002 pounds, or 7.55 per cent, in the quantity of the products.

## FISHERIES, BY COUNTIES.

The number of persons engaged, investment, and quantity and value of the products of the fisheries in 1917, by counties, are shown in the following tables:

## STATISTICS OF THE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES.

## PERSONS ENGAGED.

County.	On vessels fishing.	On vessels transporting.	In shore or boat fisheries.	Shoresmen.	Total.
Alcona.....			20		20
Alpena.....	54	1	66	14	135
Arenac.....			91		91
Bay.....		2	220	46	268
Cheboygan.....	19	12	73	8	112
Chippewa.....	5	6	49	4	64
Huron.....	33	2	246	52	338
Iosco.....	9		67	11	87
Mackinac.....		5	89	4	98
Presque Isle.....	24		20	5	49
St. Clair.....		1	18	3	22
Sauk.....			42		42
Tuscola.....			22		22
Total.....	149	29	1,023	147	1,348

## STATISTICS OF THE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES—Continued.

## INVESTMENT.

Items.	Alcona.		Alpena.		Arenac.		Bay.		Cheboygan.	
	Num-ber.	Value.	Num-ber.	Value.	Num-ber.	Value.	Num-ber.	Value.	Num-ber.	Value.
Vessels, fishing:										
Steam.....			6	\$29,500					1	\$2,500
Tonnage.....			154						9	
Outfit.....				12,650						1,400
Gasoline.....			1	3,000					4	5,500
Tonnage.....			8						35	
Outfit.....				250						1,530
Vessels transporting:										
Steam.....									1	5,500
Tonnage.....									13	
Outfit.....										300
Gasoline.....			1	1,000			1	\$2,800	9	15,700
Tonnage.....			10				9		78	
Outfit.....				100				475		2,010
Sail and rowboats.....	8	\$240	32	695	13	\$345	51	1,465	29	840
Power boats.....	5	975	16	2,560	14	3,450	44	16,900	15	4,675
Apparatus, vessel fisheries:										
Gill nets.....			2,758	31,460					1,130	10,215
Lines.....				800						
Apparatus, shore fisheries:										
Pound nets and trap nets.....	39	2,750	108	8,385	81	19,856	240	33,330	276	12,825
Gill nets.....	70	600	223	1,542	6	60	69	700	455	4,490
Fyke nets.....					10	400	122	4,325		
Seines.....					11	1,470	27	3,125		
Lines.....		50								
Spears.....					25	200	90	720		
Shore and accessory property.....		4,000		37,825		17,250		115,672		16,125
Cash capital.....				37,000				41,500		20,000
Total.....		8,615		167,067		43,031		221,012		103,610

Items.	Chippewa.		Huron.		Iosco.		Mackinac.		Presque Isle.	
	Num-ber.	Value.	Num-ber.	Value.	Num-ber.	Value.	Num-ber.	Value.	Num-ber.	Value.
Vessels, fishing:										
Steam.....	1	\$2,000	4	\$22,500	1	\$1,900				
Tonnage.....	9		80		14					
Outfit.....		400		6,200		1,800				
Gasoline.....			2	3,600	1	700			5	\$6,200
Tonnage.....			22		8				40	
Outfit.....				700						3,060
Vessels transporting:										
Steam.....							1	\$1,500		
Tonnage.....							11			
Outfit.....								200		
Gasoline.....	3	6,700	1	1,500			3	3,300		
Tonnage.....	28		7				30			
Outfit.....		935		400				530		
Sail and rowboats.....	20	415	74	2,000	15	385	38	855	13	300
Power boats.....	16	7,700	68	31,625	23	12,900	28	11,925	4	900
Apparatus, vessel fisheries:										
Gill nets.....	100	1,000	1,330	12,800	300	2,600			995	11,500
Lines.....				2,344		300				400
Apparatus, shore fisheries:										
Pound nets and trap nets.....	184	9,150	397	65,383	75	18,850	223	15,395	22	1,480
Gill nets.....	743	5,522	588	4,384	819	7,956	579	4,064	74	702
Fyke nets.....			309	6,830	9	450				
Seines.....			30	2,915	4	180				
Lines.....				1,435	4	165		80		100
Spears.....			75	600						
Shore and accessory property.....		10,750		147,432		28,050		9,630		10,150
Cash capital.....		2,000		25,600		10,000		10,000		5,000
Total.....		42,572		338,248		85,336		57,479		39,792

## STATISTICS OF THE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES—Continued.

## INVESTMENT—Continued.

Items.	St. Clair.		Sanilac.		Tuscola.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number	Value.
Vessels fishing:								
Steam.....							13	\$57,500
Tonnage.....							266	
Outfit.....								22,450
Gasoline.....							13	19,000
Tonnage.....							113	
Outfit.....								5,540
Vessels transporting:								
Steam.....							2	7,000
Tonnage.....							24	
Outfit.....								500
Gasoline.....	1	\$2,500					19	33,500
Tonnage.....	7						169	
Outfit.....		300						4,750
Sail and rowboats.....	3	95	9	\$220	5	\$165	310	8,020
Power boats.....	6	1,200	15	6,900	6	1,950	260	103,960
Apparatus, vessel fisheries:								
Gill nets.....							6,613	69,575
Lines.....								3,844
Apparatus, shore fisheries:								
Pound nets and trap nets.....	13	2,300	42	14,400	31	3,800	1,731	207,904
Gill nets.....	90	265	281	2,975			3,997	33,260
Fyke nets.....					10	130	460	12,135
Seines.....					5	270	77	7,960
Lines.....		100		135		30		2,095
Spears.....							190	1,520
Shore and accessory property.....		11,153		18,555		5,500		432,092
Cash capital.....		5,000						156,100
Total.....		27,913		43,185		11,845		1,188,705

## YIELD, BY SPECIES.

Species.	Alcona.		Alpena.		Arenac.		Bay.		Cheboygan.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Bowfin.....					200	\$4				
Burbot.....							200	\$4	350	\$7
Carp, Asiatic.....					15,008	636	219,105	8,297	850	34
Catfish and bullheads.....			21	\$1	850	62	13,538	1,245	450	22
Ciscoes:										
Fresh.....	182,050	\$5,390	395,366	27,297	168,594	4,695	345,762	5,919	44,499	2,333
Salted.....			2,480	105	174,855	9,242	207,585	9,341		
Smoked.....			3,000	120						
Muskellunge.....			45	5						
Pike.....	300	32	510	47	100	10	1,150	97	925	75
Pike perch (wall-eyed or yellow pike), fresh.....	7,100	855	12,622	2,238	51,059	5,337	283,199	29,903	24,857	2,497
Rock bass.....					300	12	800	48	833	34
Sheepshead or drum.....					300	12	600	18		
Sturgeon.....	193	25	665	133	70	21	200	50	260	59
Sturgeon caviar.....			23	46			12	24		
Suckers, fresh.....	37,825	1,497	118,458	6,202	59,131	1,806	413,447	12,221	377,751	15,686
Sunfish.....					300	12	800	32		
Trout, lake:										
Fresh.....	16,850	1,737	509,995	60,392	140	14	2,400	244	136,515	13,616
Salted.....			4,475	448						
Whitefish:										
Common, fresh.....	2,600	349	188,512	26,620	21,255	2,691	45,877	4,649	162,662	19,940
Common, salted.....			850	130						
Common, caviar.....							300	60		
Menominee, fresh.....	11,200	279	15,691	694					5,605	372
Menominee, salted.....			1,800	90					14,417	787
Yellow perch.....	2,000	150	10,312	1,020	60,182	3,636	444,511	26,384	20,856	1,482
Total.....	260,118	10,314	1,264,825	125,588	552,344	28,190	1,979,486	98,536	790,830	56,945

STATISTICS OF THE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES—Continued.

YIELD, BY SPECIES—Continued.

Species.	Chippewa.		Huron.		Iosco.		Mackinac.		Presque Isle.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Bowfin.....					824	\$24	800	\$16		
Burbot.....					200	8				
Carp, Asiatic.....			861,976	\$32,574	300	30				
Catfish and bullheads.....	1,077	\$178	14,493	1,505						
Ciscoes:										
Fresh.....	101,300	5,065	747,798	26,180	492,389	12,857	10,200	414	275,481	\$15,173
Salted.....			1,243,019	53,355	125,700	7,542	61,000	2,495		
Muskellunge.....	100	10								
Pike.....	6,000	600	2,419	241	200	16	750	56		
Pike perch (wall-eyed or yellow pike):										
Fresh.....	29,998	4,280	374,691	51,908	117,816	11,424	3,092	339	1,050	113
Salted.....									30	3
Rock bass.....	2,000	100								
Sheepshead or drum.....			5,850	176						
Sturgeon.....			930	157	650	160	240	49		
Sturgeon caviar.....					20	40	20	50		
Suckers:										
Fresh.....	241,712	13,609	130,096	3,953	46,322	1,870	291,896	13,782	28,777	1,161
Salted.....							1,000	50		
Sunfish.....	200	10								
Trout, lake:										
Fresh.....	146,667	12,348	582,708	61,891	433,000	38,424	87,933	9,341	97,977	9,831
Salted.....	900	90	2,235	90			1,000	150	48	6
Whitefish:										
Common, fresh.....	17,113	1,883	184,784	21,624	159,011	17,558	141,371	19,030	30,922	3,816
Common, salted.....							2,500	200		
Common, caviar.....			1,075	197						
Menominee, fresh.....	650	52			136	6	9,475	513	3,700	275
Menominee, salted.....							3,800	323		
Yellow perch.....	24,371	2,225	178,184	13,226	8,695	617	55,183	4,348	200	19
<b>Total.....</b>	<b>572,088</b>	<b>40,450</b>	<b>4,330,258</b>	<b>267,107</b>	<b>1,385,263</b>	<b>90,576</b>	<b>670,260</b>	<b>51,156</b>	<b>438,185</b>	<b>30,397</b>

Species.	St. Clair.		Sanilac.		Tuscola.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bowfin.....							200	\$4
Burbot.....							2,174	51
Carp, Asiatic.....			1,800	\$72	46,311	\$1,853	1,145,250	43,474
Catfish and bullheads.....			200	16	2,400	236	33,329	3,295
Ciscoes:								
Fresh.....	45,914	\$1,289	443,257	13,298	24,963	795	3,277,573	120,705
Salted.....			286,053	12,873	100	4	2,100,792	94,957
Smoked.....							3,000	120
Muskellunge.....							145	15
Pike.....							12,354	1,175
Pike perch (wall-eyed or yellow pike):								
Fresh.....	26,320	3,980	19,010	2,594	43,828	3,763	991,642	119,231
Salted.....							30	3
Rock bass.....			50	2	300	12	4,283	208
Sheepshead or drum.....	10,181	382	200	6	600	21	17,731	615
Sturgeon.....	1,218	287	460	92			4,886	1,063
Sturgeon caviar.....	122	268	30	67			227	495
Suckers:								
Fresh.....	6,481	426	4,404	168	19,467	502	1,775,767	72,883
Salted.....							1,000	50
Sunfish.....			50	2	300	12	1,650	68
Trout, lake:								
Fresh.....	1,242	143	42,429	4,515			2,070,797	213,790
Salted.....							8,658	784
Whitefish:								
Common, fresh.....	2,107	296	37,014	5,556	273	38	993,501	124,050
Common, salted.....							3,350	330
Common, caviar.....							1,375	257
Menominee, fresh.....							46,457	2,191
Menominee, salted.....							20,017	1,200
Yellow perch.....	731	74	6,958	972	31,836	2,311	844,019	56,464
<b>Total.....</b>	<b>94,316</b>	<b>7,145</b>	<b>841,915</b>	<b>40,233</b>	<b>170,378</b>	<b>9,547</b>	<b>13,363,207</b>	<b>857,478</b>

## FISHERIES, BY APPARATUS.

The vessel fisheries of Lake Huron in 1917 were credited with 2,675,783 pounds, valued at \$258,297, and the shore or boat fisheries with 10,687,424 pounds, valued at \$599,181. In the vessel fisheries, the principal form of apparatus was the gill net, the catch of all species amounting to 2,350,721 pounds, with a value of \$224,787. The principal species were lake trout, 1,094,301 pounds, valued at \$116,925; ciscoes, 826,537 pounds, valued at \$53,125; and common whitefish, 410,475 pounds, valued at \$53,716. The catch with lines, consisting of lake trout, was 325,062 pounds, valued at \$33,510.

The principal apparatus of capture used in the shore or boat fisheries was pound nets and trap nets, the catch amounting to 7,936,249 pounds, consisting principally of ciscoes, pike perch, suckers, common whitefish, and yellow perch, valued at \$420,409. The catch with other forms of apparatus in the shore fisheries was as follows: Gill nets, 994,759 pounds, principally ciscoes, lake trout, and common whitefish, valued at \$88,257; seines, 1,306,502 pounds, principally carp, valued at \$56,474; fyke nets, 263,999 pounds, principally yellow perch, suckers, carp, and pike perch, valued at \$14,108; lines, 106,655 pounds, consisting of catfish, lake trout, common whitefish, and yellow perch, valued at \$10,644; and spears, 79,260 pounds, consisting of carp, pike, pike perch, lake trout, and yellow perch, valued at \$9,289. The total catch with gill nets in both vessels and shore fisheries amounted to 3,345,480 pounds, valued at \$313,044, and with lines, 431,717 pounds, valued at \$44,154.

The following tables give the products of the vessel and shore fisheries of Lake Huron in 1917:

## YIELD OF VESSEL FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS.

Apparatus and species.	Alpena.		Cheboygan.		Chippewa.		Huron.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Gill nets:								
Burbot.....			300	\$6				
Carp, Asiatic.....							75	\$3
Ciscoes.....	314,232	\$24,074	29,704	1,492	54,000	\$2,700	162,420	9,978
Pike perch (wall-eyed or yellow pike).....	1,000	91	155	19			206	36
Sturgeon.....			60	15				
Suckers.....							100	2
Trout, lake.....	489,041	58,220	72,187	7,192	15,000	1,500	192,354	21,983
Whitefish—								
Common.....	165,463	23,762	89,345	11,027			82,755	10,536
Menominee.....	8,460	338	750	35				
Yellow perch.....			221	27			1,571	188
Total.....	978,196	106,485	192,722	19,813	69,000	4,200	439,481	42,726
Lines:								
Trout, lake—								
Fresh.....	4,500	450					292,193	30,518
Salted.....							2,235	90
Total.....	4,500	450					294,428	30,608
Grand total.....	982,696	106,935	192,722	19,813	69,000	4,200	733,909	73,334

YIELD OF VESSEL FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS—Continued.

Apparatus and species.	Iosco.		Presque Isle.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:						
Burbot.....					300	\$6
Carp, Asiatic.....					75	3
Ciscoes.....			266,181	\$14,881	\$26,537	53,125
Pike perch (wall-eyed or yellow pike).....	2,160	\$173			3,521	319
Sturgeon.....					60	15
Suckers.....	3,250	33			3,350	35
Trout, lake.....	236,450	18,916	76,328	7,820	1,094,301	116,925
Whitefish—						
Common.....	45,650	5,021	27,262	3,370	410,475	53,716
Menominee.....			1,100	55	10,310	428
Yellow perch.....					1,792	215
Total.....	287,510	24,143	370,871	26,126	2,350,721	224,787
Lines:						
Trout, lake—						
Fresh.....	10,000	1,000	16,134	1,452	322,827	33,420
Salted.....					2,235	90
Total.....	10,000	1,000	16,134	1,452	325,062	33,510
Grand total.....	297,510	25,143	387,005	27,578	2,675,783	258,297

YIELD OF THE SHORE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS.

Apparatus and species.	Alcona.		Alpena.		Arenac.		Bay.		Cheboygan.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets and trap nets:										
Burbot.....							200	\$4	50	\$1
Carp, Asiatic.....					2,927	\$138	19,871	720	850	34
Catfish and bullheads.....			21	\$1			6,300	564	450	22
Ciscoes—										
Fresh.....	181,550	\$5,360	69,934	2,715	168,594	4,695	339,262	5,644	7,295	360
Salted.....			300	12	174,855	9,242	207,589	9,341		
Muskellunge.....			45	5						
Pike.....	300	32	510	47			450	37	825	66
Pike perch (wall-eyed or yellow pike).....	7,100	855	11,510	2,136	19,444	2,036	172,850	17,699	24,702	2,478
Rock bass.....					300	12	200	8	833	34
Sheepshead or drum.....					300	12	600	18		
Sturgeon.....	193	25	665	133	70	21	200	50	200	44
Sturgeon caviar.....			23	46			12	24		
Suckers, fresh.....	37,825	1,497	115,598	6,115	15,130	469	292,716	9,165	369,588	15,317
Sunfish.....					300	12	400	16		
Trout, lake.....	1,300	170	8,369	938	140	14	2,400	244	1,600	160
Whitefish—										
Common.....	1,200	169	23,049	2,858	21,255	2,691	45,165	4,541	36,545	4,367
Common caviar.....							300	60		
Menominee.....	11,100	269							529	25
Yellow perch.....	2,000	150	8,812	910	48,989	2,980	360,432	20,934	13,073	924
Total.....	242,568	8,527	238,796	15,916	452,301	22,322	1,448,943	69,069	456,540	23,832
Gill nets:										
Bowfin.....					200	4				
Carp, Asiatic.....					400	16				
Catfish and bullheads.....					150	6				
Ciscoes—										
Fresh.....	500	30	11,200	508					7,500	481
Salted.....			2,180	93						
Smoked.....			3,000	120						
Pike.....									100	10
Pike perch (wall-eyed or yellow pike, fresh).....			112	11	400	40				
Suckers.....			2,900	87	1,060	20	2,000	40	8,163	369
Trout, lake—										
Fresh.....	15,200	1,525	8,085	784					62,728	6,264
Salted.....			4,475	448						
Whitefish—										
Common, fresh.....	1,400	180							36,772	4,546
Common, salted.....			850	130						
Menominee, fresh.....	100	10	7,231	356					4,326	312
Menominee, salted.....			1,800	90					14,417	787
Yellow perch.....			1,500	110	250	18	6,000	550	7,562	531
Total.....	17,200	1,745	43,333	2,737	2,400	104	8,000	590	141,568	13,300

## YIELD OF THE SHORE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS—Continued.

Apparatus and species.	Alcona.		Alpena.		Arenac.		Bay.		Cheboygan.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
<b>Fyke nets:</b>										
Carp, Asiatic.....							8,925	\$353		
Catfish and bullheads.....							1,800	148		
Ciscoes, fresh.....							6,500	275		
Pike perch (wall-eyed or yellow pike).....							12,572	1,431		
Rock bass.....							400	32		
Suckers.....					423	\$13	54,544	1,514		
Sunfish.....							200	8		
Whitefish, common.....							500	80		
Yellow perch.....					4,800	240	59,571	3,605		
<b>Total.....</b>					5,223	253	145,012	7,446		
<b>Seines:</b>										
Carp, Asiatic.....					11,681	482	190,309	7,224		
Catfish and bullheads.....					700	56	5,438	533		
Pike.....					100	10	700	60		
Pike perch (wall-eyed or yellow pike).....					27,215	2,701	77,777	7,973		
Rock bass.....							200	8		
Suckers.....					42,578	1,304	64,187	1,502		
Sunfish.....							200	8		
Whitefish, common.....							212	28		
Yellow perch.....					5,643	373	16,508	1,095		
<b>Total.....</b>					87,917	4,926	355,531	18,431		
<b>Lines: Trout, lake.....</b>	350	\$42								
<b>Spears:</b>										
Pike perch (wall-eyed or yellow pike).....					4,000	560	20,000	2,800		
Yellow perch.....					500	25	2,000	200		
<b>Total.....</b>					4,500	585	22,000	3,000		
<b>Grand total.....</b>	260,118	10,314	282,129	\$18,653	552,344	28,190	1,979,486	98,536	598,108	\$37,132

Apparatus and species.	Chippewa.		Huron.		Iosco.		Mackinac.		Presque Isle.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
<b>Pound nets and trap nets:</b>										
Burbot.....					824	\$24				
Carp, Asiatic.....			20,700	\$828	200	8				
Catfish and bullheads.....	1,077	\$178	4,473	437	300	30				
Ciscoes—										
Fresh.....			557,028	14,866	488,389	12,777	9,500	\$380		
Salted.....			1,243,019	53,355	125,700	7,542	61,000	2,495		
Muskellunge.....	100	10								
Pike.....	6,000	600	284	28	200	16	750	56		
Pike perch (wall-eyed or yellow pike).....	19,072	2,779	337,833	46,932	112,242	10,848	2,896	299	500	\$50
Rock bass.....	2,000	100								
Sheepshead or drum.....			5,300	159						
Sturgeon.....			930	187	650	100	240	49		
Sturgeon caviar.....					20	40	20	50		
Suckers—										
Fresh.....	228,412	13,170	60,411	1,560	39,117	1,695	280,396	13,237	25,877	1,061
Salted.....							1,000	50		
Sunfish.....	200	10								
Trout, lake.....	9,187	919	9,465	701	12,829	1,190	23,929	2,706		
Whitefish—										
Common.....	1,923	261	94,731	10,184	42,379	4,375	99,942	14,468		
Common caviar.....			1,075	197						
Menominee.....					136	6				
Yellow perch.....	9,371	945	97,354	6,273	5,795	367	49,199	3,869	150	15
<b>Total.....</b>	277,342	18,972	2,432,603	135,707	828,781	39,078	528,872	37,659	26,527	1,126

YIELD OF THE SHORE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS—Continued.

Apparatus and species.	Chippewa.		Huron.		Ioseo.		Mackinac.		Presque Isle.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:										
Burbot.....							800	\$16		
Ciscoes, fresh.....	47,300	\$2,365	27,850	\$1,311	4,000	\$80	700	34	9,300	\$292
Pike perch (wall-eyed or yellow pike)—										
Fresh.....	10,926	1,501	13,508	1,394	1,789	216	196	40	550	63
Salted.....									30	3
Suckers.....	13,300	439	24,900	933	700	14	11,500	545	2,900	100
Trout, lake—										
Fresh.....	122,480	9,929	33,790	3,379	159,221	15,868	60,604	6,219	3,850	393
Salted.....	900	90					1,000	150	48	6
Whitefish—										
Common, fresh.....	15,190	1,622	7,298	904	67,787	7,749	41,353	4,557	3,660	446
Common, salted.....							2,500	200		
Menominee, fresh.....	650	52					9,475	513	2,600	220
Menominee, salted.....							3,800	323		
Yellow perch.....	15,000	1,280	22,082	1,750			5,984	479	50	4
Total.....	225,746	17,278	129,428	9,671	233,497	23,927	137,912	13,076	22,988	1,527
Fyke nets:										
Carp, Asiatic.....			3,500	139						
Catfish and bullheads.....			1,220	108						
Ciscoes, fresh.....			500	25						
Pike.....			135	13						
Pike perch (wall-eyed or yellow pike).....			1,584	171						
Sheepshead or drum.....			50	2						
Suckers.....			44,685	1,458	300	7				
Yellow perch.....			44,052	3,636	2,000	160				
Total.....			95,726	5,552	2,300	167				
Seines:										
Carp, Asiatic.....			817,701	30,604						
Catfish and bullheads.....			800	80						
Pike perch (wall-eyed or yellow pike).....					1,625	187				
Sheepshead or drum.....			500	15						
Suckers.....					2,955	121				
Whitefish, common.....					3,195	413				
Yellow perch.....			2,500	250	500	90				
Total.....			821,501	30,949	8,675	811				
Lines:										
Catfish.....			8,000	880						
Trout, lake.....			53,656	5,110	14,500	1,450	3,400	416	1,665	166
Whitefish, common.....							76	5		
Yellow perch.....			2,675	200						
Total.....			64,331	6,190	14,500	1,450	3,476	421	1,665	166
Spears:										
Carp, Asiatic.....			20,000	1,000						
Pike.....			2,000	200						
Pike perch (wall-eyed or yellow pike).....			21,560	3,375						
Trout, lake.....			1,250	200						
Yellow perch.....			7,950	929						
Total.....			52,760	5,704						
Grand total.....	503,088	36,250	3,596,349	193,773	1,087,753	65,433	670,260	51,156	51,180	2,819

## YIELD OF THE SHORE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS—Continued.

Apparatus and species.	St. Clair.		Sanilac.		Tuscola.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Pound nets and trap nets:</b>								
Burbot							1,074	\$29
Carp, Asiatic			1,800	\$72	6,383	\$255	52,731	2,055
Catfish and bullheads			200	16	400	36	13,221	1,284
Ciscoes—								
Fresh	45,914	\$1,289	443,257	13,298	24,963	795	2,335,686	62,179
Salted			286,053	12,873			2,098,512	94,860
Muskellunge							145	15
Pike							9,319	882
Pike perch (wall-eyed or yellow pike)	26,320	3,980	19,010	2,594	43,278	3,708	796,757	96,394
Rock bass			50	2			3,383	156
Sheepshead or drum	10,181	382	200	6	300	12	16,881	589
Sturgeon	1,218	287	460	92			4,826	1,048
Sturgeon caviar	122	268	30	67			227	495
Suckers—								
Fresh	6,481	426	4,404	168	15,229	417	1,491,144	64,297
Salted							1,000	50
Sunfish			50	2			950	40
Trout, lake	192	23	3,011	320			72,422	7,385
Whitefish—								
Common	2,107	296	25,369	3,476	273	38	393,938	47,724
Common caviar							1,375	257
Menominee							11,765	300
Yellow perch	731	74	6,051	890	28,936	2,039	630,893	40,370
<b>Total</b>	<b>93,266</b>	<b>7,025</b>	<b>789,945</b>	<b>33,876</b>	<b>119,762</b>	<b>7,300</b>	<b>7,936,249</b>	<b>420,409</b>
<b>Gill nets:</b>								
Bowfin							200	4
Burbot							800	16
Carp, Asiatic							400	16
Catfish and bullheads							150	6
Ciscoes—								
Fresh							108,350	5,101
Salted							2,180	93
Smoked							3,000	120
Pike							100	10
Pike perch (wall-eyed or yellow pike)—								
Fresh							27,481	3,265
Salted							30	3
Suckers							67,363	2,547
Trout, lake—								
Fresh	250	40	19,885	2,100			486,093	46,501
Salted							6,423	694
Whitefish—								
Common, fresh			11,645	2,080			185,105	22,084
Common, salted							3,350	330
Menominee, fresh							24,382	1,463
Menominee, salted							20,017	1,200
Yellow perch			907	82			59,335	4,804
<b>Total</b>	<b>250</b>	<b>40</b>	<b>32,437</b>	<b>4,202</b>			<b>994,759</b>	<b>88,257</b>
<b>Fyke nets:</b>								
Carp, Asiatic					7,050	241	19,475	733
Catfish and bullheads							3,020	256
Ciscoes—								
Fresh							7,000	300
Salted					100	4	100	4
Pike							135	13
Pike perch (wall-eyed or yellow pike)								
Fresh					550	55	14,706	1,657
Salted					300	12	700	44
Rock bass					300	9	350	11
Sheepshead or drum					4,238	85	104,190	3,077
Suckers					300	12	500	20
Sunfish							500	80
Whitefish, common							500	80
Yellow perch					2,900	272	113,323	7,913
<b>Total</b>					<b>15,738</b>	<b>690</b>	<b>263,999</b>	<b>14,108</b>

YIELD OF THE SHORE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS—Continued..

Apparatus and species.	St. Clair.		Sanilac.		Tuscola.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Seines:</b>								
Carp, Asiatic.....					32,878	\$1,357	1,052,695	\$39,667
Catfish and bullheads.....							6,938	669
Pike.....							800	70
Pike perch (wall-eyed or yellow pike).....							106,617	10,861
Rock bass.....							200	8
Sheepshead or drum.....							500	15
Suckers.....							109,720	2,927
Sunfish.....							200	8
Whitefish, common.....							3,407	441
Yellow perch.....							25,551	1,808
<b>Total.....</b>					<b>32,878</b>	<b>1,357</b>	<b>1,306,502</b>	<b>56,474</b>
<b>Lines:</b>								
Catfish.....					2,000	200	10,000	1,080
Trout, lake.....	800	\$0.80	19,533	\$2,095			93,904	9,359
Whitefish, common.....							76	5
Yellow perch.....							2,675	200
<b>Total.....</b>	<b>800</b>	<b>80</b>	<b>19,533</b>	<b>2,095</b>	<b>2,000</b>	<b>200</b>	<b>106,655</b>	<b>10,644</b>
<b>Spears:</b>								
Carp, Asiatic.....							20,000	1,000
Pike.....							2,000	200
Pike perch (wall-eyed or yellow pike).....							45,560	6,735
Trout, lake.....							1,250	200
Yellow perch.....							10,450	1,154
<b>Total.....</b>							<b>79,260</b>	<b>9,289</b>
<b>Grand total.....</b>	<b>91,316</b>	<b>7,145</b>	<b>811,915</b>	<b>40,233</b>	<b>170,378</b>	<b>9,547</b>	<b>10,687,421</b>	<b>599,181</b>

WHOLESALE FISHERY TRADE.

In 1917 there were 23 establishments engaged in the wholesale fishery trade of Lake Huron, employing 147 persons, to whom \$95,648 were paid in wages. The value of these establishments with their equipment, etc., was \$262,507; and the cash capital utilized amounted to \$156,100. Compared with 1903 there was an increase of 7 in the number of establishments, 13 in the number of persons engaged, \$57,228 in wages paid, \$166,007 in the value of the establishments and their equipment, and \$60,600 in cash capital.

The following table shows the extent of the wholesale fishery trade of Lake Huron in 1917:

WHOLESALE FISHERY TRADE OF LAKE HURON IN 1917.

Cities and towns.	State.	Number of firms.	Persons engaged.	Wages paid.	Shore and accessory property.	Cash capital.
Bay City and East Tawas.....	Michigan.....	6	57	\$44,450	\$78,197	\$51,500
Alpena.....	do.....	4	14	7,300	34,300	37,000
Cheboygan and Rogers.....	do.....	3	13	11,280	19,100	25,000
St. Ignace and Detour.....	do.....	3	8	4,100	8,800	12,000
Sebewaing, Bayport, Harbor Beach, and Port Huron.....	do.....	7	55	28,518	122,110	30,600
<b>Total.....</b>		<b>23</b>	<b>147</b>	<b>95,648</b>	<b>262,507</b>	<b>156,100</b>

## FISHERIES OF LAKE ST. CLAIR AND ST. CLAIR RIVER.

The fisheries of Lake St. Clair and St. Clair River in 1917 gave employment to 64 men. The number of boats in use was 64, valued at \$2,540. The apparatus of capture included 6 seines, valued at \$1,365, and hand lines to the value of \$50; and the shore and accessory property was valued at \$12,000. The products of the fisheries amounted to 133,330 pounds, valued at \$11,852, of which 85,330 pounds, valued at \$4,652, were carp taken with seines and 48,000 pounds, valued at \$7,200, pike perch caught with hand lines. Because of legal restrictions, the fisheries of the connecting waters between Lakes Erie and Huron are of much less importance than formerly.

## FISHERIES, BY COUNTIES.

The following table shows, by counties, the number of persons employed, investment, and quantity and value of the products of the fisheries in 1917:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS BY APPARATUS IN THE FISHERIES OF LAKE ST. CLAIR AND ST. CLAIR RIVER IN 1917, BY COUNTIES.

Items.	Macomb.		St. Clair.		Total.	
	Number. 10	Value.	Number. 51	Value.	Number. 64	Value.
<b>PERSONS ENGAGED.</b>						
Fishermen.....						
<b>INVESTMENT.</b>						
Row boats.....	3	\$215	57	\$1,425	60	\$1,640
Power boats.....	1	100	3	800	4	900
Seines.....	1	500	5	865	6	1,365
Hand lines.....				50		50
Shore and accessory property.....		2,000		10,000		12,000
Total.....	5	2,815	65	13,140	70	15,955
<b>PRODUCTS BY APPARATUS.</b>						
Seines: Carp.....	Pounds. 50,757	Value. 2,436	Pounds. 34,573	Value. 2,216	Pounds. 85,330	Value. 4,652
Hand lines: Pike perch (wall-eyed or yellow pike).....			48,000	7,200	48,000	7,200
Total.....	50,757	2,436	82,573	9,416	133,330	11,852

## FISHERIES OF LAKE ERIE.

In 1917 Lake Erie ranked first among the Great Lakes in the amount of capital invested and quantity and value of the products and second in the number of persons engaged. The fisheries gave employment to 2,770 persons, of which number 1,761 are credited to Ohio, 446 to Pennsylvania, 305 to New York, and 258 to Michigan. Of the total, 565 men were on fishing and transporting vessels, 1,487 in the shore or boat fisheries, and 718 shoremen in wholesale establishments and other fishery industries on shore.

The amount of capital invested was \$4,332,767, which includes 93 fishing vessels of 1,883 net tons, valued at \$508,398, with outfits valued at \$101,665; 24 transporting vessels, of 304 net tons, valued at \$66,100, with outfits valued at \$14,655; 1,016 boats, valued at \$206,185; fishing apparatus used on vessels and boats to the value of \$1,094,713; shore and accessory property valued at \$1,884,165; and cash capital utilized in the fishery industries amounting to \$456,886. The investment in New York was \$655,062; in Pennsylvania, \$919,919; in Ohio, \$2,462,822; and in Michigan, \$294,964. The apparatus used in the fisheries of Lake Erie included 47,578 gill

nets, valued at \$329,632; 5,011 pound nets and trap nets, valued at \$681,060; 801 fyke nets, valued at \$44,403; 285 seines valued at \$38,867; and lines to the value of \$751.

The products aggregated 38,710,238 pounds, for which the fishermen received \$2,327,299. Of this quantity, New York is credited with 2,426,848 pounds, valued at \$167,358; Pennsylvania, with 8,151,241 pounds, valued at \$508,382; Ohio, with 26,442,993 pounds, valued at \$1,570,230; and Michigan, with 1,689,156 pounds, valued at \$81,329. Ciscoes are the principal species represented in the fisheries of Lake Erie in both quantity and value, the catch being 17,160,852 pounds, or 44.33 per cent of the total quantity, valued at \$1,046,862, or 44.98 per cent of the total value of all products. The pike perch, including sauger, ranked second, the yield being 7,277,701 pounds, valued at \$524,439; and carp, third, with a yield of 6,044,792 pounds, valued at \$274,139. Other important species include the common whitefish, 1,755,947 pounds, valued at \$232,761; sheepshead, 2,855,551 pounds, valued at \$69,502; suckers, 1,035,934 pounds, valued at \$36,403; and yellow perch, 959,357 pounds, valued at \$69,864. The catch of burbot, the use of which for food the Bureau has been encouraging, amounted to 652,870 pounds, valued at \$8,027.

In comparison with 1903 there was an increase of 43, or 1.58 per cent, in the number of persons employed; \$2,136,370, or 97.27 per cent, in the capital invested in the fisheries; 15,521,682 pounds, or 66.93 per cent, in the quantity, and \$1,547,284, or 198.36 per cent, in the value of the products.

## FISHERIES, BY STATES AND COUNTIES.

The following tables show, by States and counties, the extent of the fisheries of Lake Erie in 1917:

STATISTICS OF THE FISHERIES OF LAKE ERIE IN 1917, BY STATES AND COUNTIES.  
PERSONS ENGAGED.

State and county.	On ves- sels fishing.	On ves- sel trans- porting.	In shore or boat fisheries.	Shores- men.	Total.
New York:					
Chautauqua.....	65		61	18	144
Erie.....	15		37	109	161
Total.....	80		98	127	305
Pennsylvania: Erie.....	247	7	47	145	446
Ohio:					
Ashtabula.....	22		75	30	127
Cuyahoga.....	63		63	80	206
Erie.....	77	14	308	133	532
Lake.....		3	103	33	139
Lorain.....	21		30	4	55
Lucas.....	5	13	232	39	289
Ottawa.....		11	348	42	401
Sandusky.....			12		12
Total.....	188	41	1,171	361	1,761
Michigan:					
Monroe.....			112	10	122
Wayne.....	2		59	75	136
Total.....	2		171	85	258
Grand total.....	517	48	1,487	718	2,770

<sup>1</sup> Includes persons engaged in the wholesale fish trade of Detroit.

STATISTICS OF THE FISHERIES OF LAKE ERIE IN 1917, BY STATES AND COUNTIES—  
Continued.

## INVESTMENT.

State and county.	Vessels fishing.								Vessels transporting.			
	Steam.				Gasoline.				Steam.			
	Num-ber.	Ton-nage.	Value.	Value of outfit.	Num-ber.	Ton-nage.	Value.	Value of outfit.	Num-ber.	Ton-nage.	Value.	Value of outfit.
New York:												
Chautauqua.....	9	208	\$64,000	\$9,680	3	21	\$5,300	\$900				
Erie.....	2	28	15,000	550	1	9	2,200	260				
Total.....	11	236	79,000	10,230	4	30	7,500	1,160				
Pennsylvania: Erie.....	36	812	233,440	43,684	9	93	18,200	3,276	1	23	\$3,000	\$250
Ohio:												
Ashtabula.....	3	65	16,800	3,100	1	8	1,500	350				
Cuyahoga.....	10	263	71,175	21,900								
Erie.....	10	250	44,983	11,715	3	31	8,000	1,750	1	43	10,000	3,500
Lorain.....	3	74	19,000	3,050	1	6	1,000	350	1	17	3,500	150
Lucas.....					1	10	1,500	1,090				
Ottawa.....									2	28	8,000	1,300
Total.....	26	652	151,958	39,765	6	55	12,000	3,540	4	88	21,500	4,950
Michigan: Wayne.....					1	5	1,300	10				
Grand total.....	73	1,700	469,398	93,679	20	183	39,000	7,986	5	111	24,500	5,200

State and county.	Vessels transporting—Contd.				Sail and row boats.		Power boats.		Vessel fisheries.	
	Gasoline.								Gill nets.	
	Num-ber.	Ton-nage.	Value.	Value of outfit.	Num-ber.	Value.	Num-ber.	Value.	Num-ber.	Value.
New York:										
Chautauqua.....					3	\$75	22	\$16,100	6,286	\$45,137
Erie.....					10	285	9	2,575	1,184	8,640
Total.....					13	360	31	18,675	7,470	53,777
Pennsylvania: Erie.....					17	765	14	7,200	20,154	141,273
Ohio:										
Ashtabula.....					29	2,300	23	13,850	2,192	15,320
Cuyahoga.....					13	1,010	24	14,300	3,052	18,312
Erie.....	4	39	\$11,500	\$2,750	53	1,040	117	42,465	3,974	34,016
Lake.....	1	31	4,500	300	39	1,250	37	22,950		
Lorain.....					7	805	4	5,275	766	6,928
Lucas.....	8	58	15,100	3,880	111	5,890	47	16,025	395	2,900
Ottawa.....	6	65	10,500	2,525	258	13,225	89	30,635		
Sandusky.....					6	90				
Total.....	19	193	41,600	9,455	516	24,810	341	145,500	10,379	77,476
Michigan:										
Monroe.....					45	1,120	21	5,090		
Wayne.....					11	315	7	2,350	4	51
Total.....					56	1,435	28	7,440	4	51
Grand total.....	19	193	41,600	9,455	602	27,370	414	178,815	38,007	272,577

STATISTICS OF THE FISHERIES OF LAKE ERIE IN 1917, BY STATES AND COUNTIES—  
Continued.

INVESTMENT—Continued..

State and county.	Apparatus of capture, shore fisheries.								Shore and accessory property.	Cash capital.	Total investment.	
	Gill nets.		Pound nets and trap nets.		Fyke nets.		Seines.					Value of lines.
	Num-ber.	Value.	Num-ber.	Value.	Num-ber.	Value.	Num-ber.	Value.				
New York:												
Chautauqua.....	2,919	\$22,376					8	\$240	\$698	\$27,691	\$23,000	\$215,197
Erie.....	403	4,075	30	\$2,820						309,574	93,886	439,865
Total.....	3,322	26,451	30	2,820			8	240	698	337,265	116,886	655,062
Pennsylvania:												
Erie.....	362	2,214	69	16,930					8	366,679	78,000	919,919
Ohio:												
Ashtabula....	420	3,172	457	72,945			3	65		103,022	30,000	262,424
Cuyahoga.....	300	2,000	256	32,625			2	60		171,935	22,500	355,017
Erie.....	1,962	10,096	1,557	207,980	97	\$3,070	32	6,975	30	286,895	41,000	728,365
Lake.....	20	180	641	86,200			7	290		73,419	25,000	214,089
Lorain.....	222	325	50	11,900			1	25	15	60,010	2,000	114,333
Lucas.....			863	127,685	234	20,000	50	3,547		155,780	22,000	375,497
Ottawa.....	2,932	11,902	1,002	113,800	192	4,090	117	21,110		136,910	52,500	406,497
Sandusky.....	25	50					7	1,025		5,335		6,700
Total.....	5,881	28,325	4,826	653,135	523	27,160	219	33,097	45	993,506	195,000	2,462,822
Michigan:												
Monroe.....	5	25	86	8,175	222	16,718	41	3,575		23,740	5,000	63,443
Wayne.....	1	40			56	525	17	1,955		162,975	62,000	231,521
Total.....	6	65	86	8,175	278	17,243	58	5,530		186,715	67,000	294,964
Grand total.....	9,571	57,055	5,011	681,060	801	44,403	285	38,867	751	1,884,165	456,886	4,332,767

YIELD, BY SPECIES.

State and county.	Bowfin.		Burbot.		Carp, Asiatic.		Catfish and bullheads.		Ciscoes.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
New York:										
Chautauqua.....			15,190	\$243	27,968	\$1,492	695	\$81	1,744,054	\$115,563
Erie.....			75	2	1,540	78			299,306	17,522
Total.....			15,265	245	29,508	1,570	695	81	2,043,360	133,085
Pennsylvania: Erie ..			148,719	1,541	22,427	718	990	61	7,381,256	447,744
Ohio:										
Ashtabula.....			69,623	717	7,939	315	2,498	241	630,234	40,406
Cuyahoga.....			171,929	1,720	19,441	961	5,370	287	3,536,647	209,030
Erie.....	3,375	\$50	129,037	1,656	965,156	43,821	278,109	14,410	2,806,913	169,092
Lake.....			99,832	1,993	45,851	1,960	11,991	637	62,193	4,048
Lorain.....			8,635	87	11,289	474	1,025	61	677,616	41,936
Lucas.....					907,638	36,345	56,781	3,138	9,467	571
Ottawa.....	1,790	19	9,830	68	2,571,774	127,544	270,748	20,291	12,066	900
Sandusky.....					60,030	2,700	325	25		
Total.....	5,165	69	488,886	6,241	4,589,118	214,120	626,847	39,090	7,735,136	465,983
Michigan:										
Monroe.....					814,666	28,545			1,100	50
Wayne.....					589,073	29,186				
Total.....					1,403,739	57,731			1,100	50
Grand total.....	5,165	69	652,870	8,027	6,044,792	274,139	628,532	39,232	17,160,852	1,046,862

<sup>a</sup> Includes investment in the wholesale fish trade of Detroit.

STATISTICS OF THE FISHERIES OF LAKE ERIE IN 1917, BY STATES AND COUNTIES—  
Continued.

## YIELD, BY SPECIES—Continued.

State and county.	Gold-eye or moon-eye.		Pike.		Pike perch.				Rock bass.		
					Blue pike.		Wall-eyed or yellow pike.				
					Lbs.	Value.	Lbs.	Value.			Lbs.
New York:											
Chautauqua.....					12,489	\$1,053	119	\$13			
Erie.....					7,155	616	5,679	706	100		\$5
Total.....					19,644	1,669	5,798	719	100		5
Pennsylvania: Erie.....			1,238	\$148	162,878	13,049	3,214	412			
Ohio:											
Ashtabula.....					391,146	31,291	12,987	1,298			
Cuyahoga.....					312,164	14,226	11,773	1,387			
Erie.....					588,177	30,123	325,037	39,428			
Lake.....					187,138	14,915	17,932	1,970			
Lorain.....					54,899	2,832	14,072	1,407			
Lucas.....	10,335	\$104	4,428	402			370,843	48,274			
Ottawa.....					341,027	27,086	458,880	46,108			
Sandusky.....							50	5			
Total.....	10,335	104	4,428	402	1,874,551	120,523	1,211,574	139,877			
Michigan:											
Monroe.....							66,870	7,755			
Wayne.....							4,000	400			
Total.....							70,870	8,155			
Grand total.....	10,335	104	5,666	550	2,057,073	135,241	1,291,456	149,163	100		5

State and county.	Sauger.		Sheepshead or drum.		Sturgeon.		Sturgeon caviar.		Suckers.	
	Pounds.	Value.	Pounds.	Value.	Lbs.	Value.	Lbs.	Value.	Pounds.	Value.
New York:										
Chautauqua.....	77,598	\$3,879	55	\$3	7,563	\$1,720	18	\$45	28,604	\$1,867
Erie.....					14,576	3,427	1,000	2,000	18,384	721
Total.....	77,598	3,879	55	3	22,139	5,147	1,018	2,045	46,988	2,588
Pennsylvania: Erie.....	33,993	2,245	10,863	309	2,730	348			28,626	824
Ohio:										
Ashtabula.....	41,656	2,406	18,795	826	34	6			23,991	724
Cuyahoga.....	102,410	4,162	84,954	1,720	128	13			32,092	1,247
Erie.....	2,344,241	154,930	1,520,818	40,544	1,623	196			376,827	12,697
Lake.....	116,415	7,431	68,851	1,799	33	8			32,538	1,038
Lorain.....	20,362	1,368	33,383	674	500	85			5,865	120
Lucas.....	198,450	11,937	309,716	6,193	330	69			166,403	4,992
Ottawa.....	994,047	51,677	804,116	17,314	427	105			219,602	8,510
Sandusky.....			4,000	120						
Total.....	3,817,581	233,911	2,844,633	69,190	3,075	482			857,318	29,328
Michigan:										
Monroe.....					440	87			87,502	3,298
Wayne.....									15,500	365
Total.....					440	87			103,002	3,663
Grand total.....	3,929,172	240,035	2,855,551	69,502	28,384	6,064	1,018	2,045	1,035,934	36,403

STATISTICS OF THE FISHERIES OF LAKE ERIE IN 1917, BY STATES AND COUNTIES—  
Continued.

YIELD, BY SPECIES—Continued.

State and county.	Trout, lake.		White bass.		Whitefish, common.		Yellow perch.		Total.	
	Lbs.	Value.	Pounds.	Value.	Pounds.	Value.	Lbs.	Value.	Pounds.	Value.
New York:										
Chautauqua.....	734	\$91	30	\$2	139,225	\$13,964	13,486	\$1,108	2,067,828	\$141,124
Erie.....	807	65			3,843	546	6,555	546	359,020	26,234
Total.....	1,541	156	30	2	143,068	14,510	20,041	1,654	2,426,848	167,358
Pennsylvania: Erie....	120	13	1,323	118	300,293	37,015	52,571	3,837	8,151,241	508,382
Ohio:										
Ashtabula.....			7,354	586	95,295	14,128	46,903	3,610	1,348,455	96,554
Cuyahoga.....			13,307	577	98,046	13,655	33,701	2,072	4,421,962	251,057
Erie.....	261	32	89,272	6,010	240,253	30,876	349,911	23,002	10,019,010	566,867
Lake.....			2,040	144	61,795	9,257	27,981	2,238	734,590	47,438
Lorain.....			5,625	340	38,276	4,311	20,840	1,315	892,387	55,060
Lucas.....			101,470	6,088	316,137	44,262	141,950	11,375	2,593,948	173,750
Ottawa.....			65,591	3,340	435,509	61,046	182,729	12,639	6,368,136	376,647
Sandusky.....			100	7					64,505	2,857
Total.....	261	32	284,759	17,092	1,285,311	177,535	804,015	56,251	26,442,993	1,570,230
Michigan:										
Monroe.....					27,275	3,701	79,363	7,680	1,077,216	51,116
Wayne.....						3,367	262		611,940	30,213
Total.....					27,275	3,701	82,730	7,942	1,689,156	81,329
Grand total.....	1,922	201	286,112	17,212	1,755,947	232,761	959,357	69,684	38,710,238	2,327,299

FISHERIES, BY APPARATUS.

The catch of the vessel fisheries amounted to 17,151,247 pounds, valued at \$1,057,079, and of the shore or boat fisheries to 21,558,991 pounds, valued at \$1,270,220. The catch of the vessel fisheries was all taken with gill nets, the principal species being ciscoes to the amount of 15,497,879 pounds, valued at \$949,894; pike perch and sauger, 710,951 pounds, valued at \$43,508; common whitefish, 388,614 pounds, valued at \$45,914; burbot, 288,142 pounds, valued at \$2,881; and yellow perch, 174,837 pounds, valued at \$11,883.

The catch with the principal forms of apparatus used in the shore or boat fisheries was as follows: Pound nets and trap nets, 13,319,548 pounds, consisting principally of sauger, pike perch, sheepshead or drum, whitefish, ciscoes, and yellow perch, valued at \$840,640; seines, 5,505,997 pounds, mainly carp, valued at \$251,409; gill nets, 1,853,294 pounds, mainly ciscoes, valued at \$123,293; fyke nets, 857,176 pounds, consisting principally of carp, pike perch, sheepshead, suckers, sauger, and yellow perch, valued at \$51,971; and set lines, 20,976 pounds, consisting principally of catfish, bullheads, and sturgeon, valued at \$2,807.

The following tables give the products of the vessel and shore fisheries of Lake Erie, by States and counties, in 1917:

YIELD OF GILL-NET VESSEL FISHERIES OF LAKE ERIE IN 1917, BY STATES, COUNTIES, AND SPECIES.

Species.	New York.						Pennsylvania.	
	Chautauqua.		Erie.		Total.		Erie.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Burbot.....	12,542	\$126	75	\$2	12,617	\$128	136,162	\$1,384
Carp, Asiatic.....	348	14			348	14	20,127	611
Ciscoes.....	1,341,656	90,643	182,476	11,043	1,524,132	101,686	6,965,349	425,556
Pike.....							60	7
Pike perch:								
Blue pike.....	4,152	333	1,945	161	6,097	494	134,776	10,777
Wall-eyed or yellow pike.....	119	13			119	13	381	45
Sauger.....	77,598	3,879			77,598	3,879	27,993	1,945
Sheepshead or drum.....	55	3			55	3	88	2
Suckers.....	3,351	143			3,351	143	7,041	127
Trout, lake.....	451	38	807	65	1,258	103	102	11
White bass.....	30	2			30	2		
Whitefish, common.....	102,278	9,987	3,633	524	105,911	10,511	217,046	25,978
Yellow perch.....	5,191	419	2,690	199	7,881	618	35,502	2,488
Total.....	1,547,771	105,600	191,626	11,994	1,739,397	117,594	7,544,627	468,931

Species.	Ohio.							
	Ashtabula.		Cuyahoga.		Erie.		Lorain.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Burbot.....	266	\$5	94,129	\$940	44,868	\$423	100	\$1
Carp, Asiatic.....	45	2			27	1	600	24
Catfish and bullheads.....					23	3		
Ciscoes.....	518,419	34,358	3,449,050	203,576	2,393,014	144,528	639,363	39,675
Pike perch:								
Blue pike.....	19,444	1,556	239,671	10,026	21,634	1,765	12,981	1,034
Wall-eyed or yellow pike.....	50	4			1,444	134	40	5
Sauger.....	8,383	451			140,496	9,987	16,030	1,088
Sheepshead or drum.....	770	39			2,796	62	100	3
Suckers.....	1,391	43	23,864	949	25,554	710	500	8
Trout, lake.....					261	32		
White bass.....					10	1	100	5
Whitefish, common.....	50,712	7,607	13,451	1,614	225	26	65	8
Yellow perch.....	5,875	443	14,000	1,840	72,558	4,682	16,575	997
Total.....	605,385	44,508	3,834,165	217,945	2,702,910	162,354	686,454	42,848

Species.	Ohio—Continued.				Michigan.		Grand total.	
	Lucas.		Total.		Wayne.			
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Burbot.....			139,363	\$1,369			288,142	\$2,881
Carp, Asiatic.....			672	27			21,147	652
Catfish and bullheads.....	252	\$21	275	24			245	24
Ciscoes.....	8,522	515	7,008,398	422,652			15,497,879	949,894
Pike.....	376	38	376	38			436	45
Pike perch:								
Blue pike.....			293,730	14,381			434,603	25,652
Wall-eyed or yellow pike.....	338	45	1,872	188	500	\$50	2,872	296
Sauger.....	2,976	210	167,885	11,736			273,476	17,560
Sheepshead or drum.....	1,575	32	5,241	136			5,384	141
Suckers.....	120	3	51,429	1,713			61,821	1,983
Trout, lake.....			261	32			1,621	146
White bass.....			110	6			140	8
Whitefish, common.....	1,204	170	65,657	9,425			388,614	45,914
Yellow perch.....	21,946	1,775	130,954	8,737	500	40	174,837	11,883
Total.....	37,309	2,809	7,866,223	470,464	1,000	90	17,151,247	1,057,079

## YIELD OF SHORE FISHERIES OF LAKE ERIE IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	New York.						Pennsylvania.	
	Chataqua.		Erie.		Total.		Erie.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Found nets and trap nets:								
Burbot.....							7,496	\$106
Carp, Asiatic.....			1,140	\$58	1,140	\$58	2,300	107
Catfish and bullheads.....							990	61
Ciscoes.....			50	3	50	3	301,874	15,722
Pike.....							1,178	141
Pike perch—								
Blue pike.....			2,060	173	2,060	173	23,594	1,886
Wall-eyed or yellow pike.....			5,679	706	5,679	706	2,833	367
Rock bass.....			100	5	100	5		
Sauger.....							6,000	300
Sheepshead or drum.....							10,775	307
Sturgeon.....			1,876	513	1,876	513	2,175	298
Suckers.....			13,784	502	13,784	502	21,385	695
Trout, lake.....							18	2
White bass.....							1,323	118
Whitefish, common.....							79,350	10,396
Yellow perch.....			1,865	147	1,865	147	16,799	1,327
Total.....			26,554	2,107	26,554	2,107	478,090	31,833
Gill nets:								
Burbot.....	2,648	\$117			2,648	117	5,061	51
Carp, Asiatic.....			400	20	400	20		
Ciscoes.....	402,398	24,920	116,780	6,476	519,178	31,396	114,033	6,466
Pike perch—Blue pike.....	8,337	720	3,150	282	11,487	1,002	4,508	386
Sturgeon.....			12,700	2,914	12,700	2,914		
Sturgeon caviar.....			1,000	2,000	1,000	2,000		
Suckers.....	3,853	208	4,600	219	8,453	427	200	2
Trout, lake.....	283	53			283	53		
Whitefish, common.....	36,947	3,977	210	22	37,157	3,999	3,897	641
Yellow perch.....	8,295	689	2,000	200	10,295	889	270	22
Total.....	462,761	30,684	140,840	12,133	603,601	42,817	127,969	7,568
Seines:								
Carp, Asiatic.....	27,620	1,478			27,620	1,478		
Catfish and bullheads.....	695	81			695	81		
Suckers.....	21,400	1,516			21,400	1,516		
Total.....	49,715	3,075			49,715	3,075		
Set lines:								
Sturgeon.....	7,563	1,720			7,563	1,720	555	50
Sturgeon caviar.....	18	45			18	45		
Total.....	7,581	1,765			7,581	1,765	555	50
Grand total.....	520,057	35,524	167,394	14,240	687,451	49,764	606,614	39,451

## YIELD OF SHORE FISHERIES OF LAKE ERIE IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Ohio.									
	Ashtabula.		Cuyahoga.		Erie.		Lake.		Lorain.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets and trap nets:										
Bowfin.....					3,375	\$50				
Burbot.....	68,777	\$702	77,800	\$780	83,564	1,225	99,832	\$1,993	8,535	\$86
Carp, Asiatic.....	2,329	94	16,841	811	143,971	6,315	7,863	315	8,092	325
Catfish and bullheads.....	1,377	129	5,370	287	175,744	9,252	11,637	609	825	49
Ciscoes.....	91,130	4,705	47,397	3,042	105,786	6,187	62,193	4,048	37,000	2,211
Pike perch—										
Blue pike.....	371,002	29,679	71,128	4,090	564,723	28,256	186,705	14,880	41,818	1,840
Wall-eyed or yellow pike.....	12,868	1,287	11,773	1,387	310,651	37,820	17,932	1,970	14,032	1,402
Sauger.....	33,133	1,947	102,410	4,162	2,017,175	132,465	116,415	7,431		
Sheepshead or drum.....	17,315	751	84,954	1,720	1,313,371	35,443	65,851	1,734	32,901	662
Sturgeon.....	34	6	128	13	1,623	196	33	8	500	85
Suckers.....	22,190	666	7,928	289	313,521	10,808	30,110	962	5,215	107
White bass.....	7,204	574	13,307	577	81,739	5,438	1,857	129	5,425	325
Whitefish, common.....	36,243	5,270	84,420	12,016	223,470	28,785	60,195	9,017	38,211	4,303
Yellow perch.....	40,978	3,163	19,651	1,229	236,980	15,600	27,981	2,238	3,587	266
Total.....	704,580	48,973	543,107	30,403	5,575,696	317,900	688,604	45,334	196,741	11,661
Fyke nets:										
Carp, Asiatic.....					85,955	6,017				
Catfish and bullheads.....					34,387	1,585				
Pike perch—Wall-eyed or yellow pike.....					9,368	1,070				
Sauger.....					68,772	4,350				
Sheepshead or drum.....					42,914	1,065				
Suckers.....					22,435	695				
White bass.....					5,958	468				
Yellow perch.....					4,000	260				
Total.....					273,879	15,510				
Gillnets:										
Burbot.....	580	10			105	2				
Carp, Asiatic.....	855	34			255,863	10,885			97	5
Catfish and bullheads.....	1,025	102			3,375	162				
Ciscoes.....	20,510	1,333	40,200	2,412	308,113	18,377			653	50
Pike perch—										
Blue pike.....	600	48	1,365	110	1,563	85	200	16		
Wall-eyed or yellow pike.....					2,459	287				
Sauger.....	115	7			110,223	8,027			4,182	268
Sheepshead or drum.....	360	18			46,248	1,040			232	5
Suckers.....	275	8	300	9	14,973	473				
White bass.....					45	3				
Whitefish, common.....	6,660	999	175	25	16,558	2,065	1,600	240		
Yellow perch.....	50	4	50	3	33,548	2,347			653	50
Total.....	31,030	2,563	42,090	2,559	801,073	43,753	1,800	256	5,817	378
Seines:										
Carp, Asiatic.....	4,710	185	2,600	150	479,240	20,598	37,988	1,645	500	20
Catfish and bullheads.....	96	10			55,055	2,640	354	28		
Ciscoes.....	145	10								
Pike perch—										
Blue pike.....	100	8			157	9	233	19		
Wall-eyed or yellow pike.....	69	7			312	32				
Sauger.....	25	1			1,375	86				
Sheepshead or drum.....	350	18			115,429	2,932	3,000	65		
Suckers.....	135	7			344	11	2,428	76		
White bass.....	150	12			1,440	95	183	15		
White fish, common.....	1,680	252								
Yellow perch.....					155	8				
Total.....	7,460	510	2,600	150	653,487	26,411	44,186	1,848	500	20
Set lines:										
Burbot.....					500	6				
Carp.....					100	5				
Catfish and bullheads.....					9,525	768			200	12
Pike perch—										
Blue pike.....					100	8			100	8
Wall-eyed or yellow pike.....					800	85				
Sauger.....					200	15			150	12
Sheepshead or drum.....					60	2			150	4
Suckers.....									150	5
White bass.....					80	5			100	10
Yellow perch.....					600	45			25	2
Total.....					11,965	939			875	53
Minor apparatus: Carp, Asiatic.....									2,000	100
Grand total.....	743,070	52,046	587,797	33,112	7,316,100	404,513	734,590	47,438	205,933	12,212

YIELD OF SHORE FISHERIES OF LAKE ERIE IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Ohio—Continued.							
	Lucas.		Ottawa.		Sandusky.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Pound nets and trap nets:</b>								
Bowfin.....			410	\$5			3,785	\$55
Burbot.....			9,645	64			348,153	4,850
Carp, Asiatic.....	142,856	\$5,715	114,693	5,370			436,645	18,945
Catfish and bullheads.....	41,111	2,272	123,268	9,332			359,332	21,930
Ciscoes.....	945	56	10,164	782			355,215	21,031
Gold-eye or moon-eye.....	875	9					875	9
Pike.....	4,052	364					4,052	364
Pike perch—								
Blue pike.....			335,689	26,627			1,571,065	105,372
Wall-eyed or yellow pike.....	311,345	40,538	438,557	44,068			1,117,161	128,472
Sauger.....	191,111	11,466	924,319	47,714			3,384,563	205,185
Sheepshead or drum.....	280,196	5,603	689,501	14,999			2,484,089	60,912
Sturgeon.....	330	69	427	105			3,075	482
Suckers.....	146,631	4,400	206,805	8,016			732,400	25,248
White bass.....	63,935	3,836	46,657	2,392			220,124	13,271
Whitefish, common.....	314,921	44,088	311,968	44,196			1,069,428	147,675
Yellow perch.....	118,493	9,479	173,776	12,030			621,446	44,065
<b>Total.....</b>	<b>1,616,801</b>	<b>127,895</b>	<b>3,385,879</b>	<b>215,700</b>			<b>12,711,408</b>	<b>797,866</b>
<b>Fyke nets:</b>								
Bowfin.....			1,380	14			1,380	14
Burbot.....			40	1			40	1
Carp, Asiatic.....	35,245	1,409	64,598	2,583			185,798	10,009
Catfish and bullheads.....	11,983	670	14,124	1,052			60,494	3,307
Gold-eye or moon-eye.....	9,460	95					9,460	95
Pike perch—								
Blue pike.....			3,693	295			3,693	295
Wall-eyed or yellow pike.....	59,085	7,681	1,094	110			69,547	8,861
Sauger.....	4,316	258	3,635	182			76,723	4,790
Sheepshead or drum.....	24,175	483	32,305	646			99,394	2,194
Suckers.....	10,405	312	4,755	190			37,595	1,197
White bass.....	37,500	2,250	14,985	750			58,443	3,468
Whitefish, common.....	12	4					12	4
Yellow perch.....	1,459	117	720	55			6,269	432
<b>Total.....</b>	<b>193,640</b>	<b>13,279</b>	<b>141,329</b>	<b>5,878</b>			<b>608,848</b>	<b>34,667</b>
<b>Gill nets:</b>								
Burbot.....			25	1			710	13
Carp, Asiatic.....			18,405	910	4,600	\$200	279,820	12,034
Catfish and bullheads.....			400	34			4,800	298
Ciscoes.....			1,902	118			371,378	22,290
Pike perch—								
Blue pike.....			1,645	164			5,373	423
Wall-eyed or yellow pike.....			12,971	1,305			15,430	1,592
Sauger.....			65,243	3,738			185,763	12,040
Sheepshead or drum.....			2,445	62			49,285	1,125
Suckers.....			3,281	113			18,829	603
White bass.....			244	13			289	16
Whitefish, common.....			118,652	16,117			143,645	19,446
Yellow perch.....			5,958	383			42,259	2,787
<b>Total.....</b>			<b>231,171</b>	<b>22,958</b>	<b>4,600</b>	<b>200</b>	<b>1,117,581</b>	<b>72,667</b>
<b>Seines:</b>								
Burbot.....			120	2			120	2
Carp, Asiatic.....	729,537	29,221	2,374,078	118,681	55,430	2,500	3,684,083	173,000
Catfish and bullheads.....	3,435	175	132,956	9,873	325	25	192,221	12,751
Ciscoes.....							145	10
Pike perch—								
Blue pike.....							490	36
Wall-eyed or yellow pike.....	75	10	6,258	625	50	5	6,764	679
Sauger.....	47	3	850	43			2,297	133
Sheepshead or drum.....	3,770	75	79,865	1,607	4,000	120	206,414	4,817
Suckers.....	9,247	277	4,761	191			16,915	562
White bass.....	35	2	3,705	185	100	7	5,613	316
White fish, common.....			4,889	733			6,569	985
Yellow perch.....	52	4	2,275	171			2,462	183
<b>Total.....</b>	<b>746,198</b>	<b>29,767</b>	<b>2,609,757</b>	<b>132,111</b>	<b>59,905</b>	<b>2,657</b>	<b>4,124,093</b>	<b>193,474</b>

## YIELD OF SHORE FISHERIES OF LAKE ERIE IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Ohio—Continued.							
	Lucas.		Ottawa.		Sandusky.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Set lines:								
Burbot.....							500	\$6
Carp.....							100	5
Catfish and bullheads.....							9,725	780
Pike perch—								
Blue pike.....							200	16
Wall-eyed or yellow pike.....							800	85
Sauger.....							350	27
Sheepshead or drum.....							210	6
Suckers.....							150	5
White bass.....							180	15
Yellow perch.....							625	47
Total.....							12,840	992
Minor apparatus:								
Carp, Asiatic.....							2,000	100
Grand total.....	2,556,639	\$170,941	6,358,136	\$376,647	64,505	\$2,857	18,576,770	1,099,766

Apparatus and species.	Michigan.						Grand total.	
	Monroe.		Wayne.		Total.			
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Pound nets and trap nets:								
Bowfin.....							3,785	\$55
Burbot.....							355,649	4,956
Carp, Asiatic.....	10,000	\$300			10,000	\$300	450,085	19,410
Catfish and bullheads.....							360,322	21,991
Ciscoes.....	1,100	50			1,100	50	658,239	36,806
Gold-eye or moon-eye.....							875	9
Pike.....							5,230	505
Pike perch—								
Blue pike.....							1,596,719	107,431
Wall-eyed or yellow pike.....	27,432	3,226			27,432	3,226	1,153,105	132,771
Rock bass.....							100	5
Sauger.....							3,390,563	205,485
Sheepshead or drum.....							2,494,864	61,219
Sturgeon.....	400	80			400	80	7,526	1,373
Suckers.....	25,143	545			25,143	545	792,712	26,990
Trout, lake.....							18	2
White bass.....							221,447	13,389
Whitefish, common.....	27,275	3,701			27,275	3,701	1,176,053	161,772
Yellow perch.....	12,146	932			12,146	932	652,256	46,471
Total.....	103,496	8,834			103,496	8,834	13,319,548	840,640
Fyke nets:								
Bowfin.....							1,380	14
Burbot.....							40	1
Carp, Asiatic.....	46,815	1,821	39,500	\$1,533	86,315	3,354	272,113	\$13,363
Catfish and bullheads.....							60,494	3,307
Gold-eye or moon-eye.....							9,460	95
Pike perch—								
Blue pike.....							3,693	295
Wall-eyed or yellow pike.....	36,558	4,241	2,800	280	39,358	4,521	108,905	13,382
Sauger.....							76,723	4,790
Sheepshead or drum.....							99,394	2,194
Sturgeon.....	15	2			15	2	15	2
Suckers.....	45,569	2,434	10,000	245	55,569	2,679	93,164	3,876
White bass.....							58,443	3,468
Whitefish, common.....							12	4
Yellow perch.....	65,147	6,602	1,924	146	67,071	6,748	73,340	7,180
Total.....	194,104	15,100	54,224	2,204	248,328	17,304	857,176	51,971

## YIELD OF SHORE FISHERIES OF LAKE ERIE IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Michigan.						Grand total.	
	Monroe.		Wayne.		Total.			
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Gill nets:								
Burbot							8,419	\$181
Carp, Asiatic	850	\$38			850	\$38	281,070	12,092
Catfish and bullheads							4,800	298
Ciscoes							1,004,589	60,152
Pike perch—								
Blue pike							21,368	1,811
Wall-eyed or yellow pike	150	15	700	\$70	850	85	16,280	1,677
Sauger							185,763	12,040
Sheepshead or drum							49,285	1,125
Sturgeon							12,700	2,914
Sturgeon caviar							1,000	2,000
Suckers	800	16	500	10	1,300	26	28,782	1,058
Trout, lake							283	53
White bass							289	16
Whitefish, common							184,699	24,086
Yellow perch	200	16	943	76	1,143	92	53,967	3,790
Total	2,000	85	2,143	156	4,143	241	1,853,294	123,293
Seines:								
Burbot							120	2
Carp, Asiatic	757,001	26,386	549,573	27,653	1,306,574	54,039	5,018,277	228,517
Catfish and bullheads							192,916	12,832
Ciscoes							145	10
Pike perch—								
Blue pike							490	36
Wall-eyed or yellow pike	2,730	273			2,730	273	9,494	952
Sauger							2,297	133
Sheepshead or drum							206,414	4,817
Sturgeon	25	5			25	5	25	5
Suckers	15,990	303	5,000	110	20,990	413	59,305	2,491
White bass							5,613	316
White fish, common							6,569	985
Yellow perch	1,870	130			1,870	130	4,332	313
Total	777,616	27,097	554,573	27,763	1,332,189	54,860	5,505,997	251,409
Set lines:								
Burbot							500	6
Carp							100	5
Catfish and bullheads							9,725	780
Pike perch—								
Blue pike							200	16
Wall-eyed or yellow pike							800	85
Sauger							350	27
Sheepshead or drum							210	6
Sturgeon							8,118	1,770
Sturgeon caviar							18	45
Suckers							150	5
White bass							180	15
Yellow perch							625	47
Total							20,976	2,807
Minor apparatus:								
Carp, Asiatic							2,000	100
Grand total	1,077,216	51,116	610,940	30,123	1,688,156	83,239	21,558,991	1,270,220

## WHOLESALE FISHERY TRADE.

There were 70 establishments engaged in the wholesale fishery trade of Lake Erie in 1917, employing 728 persons, to whom \$565,053 were paid in wages, representing a total investment of \$1,559,788 and utilizing cash capital to the amount of \$456,886. Compared with 1903, there was an increase of 38 in the number of establishments, 230 in the number of persons employed, \$296,515 in wages paid, and \$746,804 in the investment, including cash or working capital.

The following table shows the extent of the wholesale fishery trade of Lake Erie in 1917:

WHOLESALE FISHERY TRADE OF LAKE ERIE IN 1917.

Cities.	State.	Number of firms.	Persons engaged.	Wages paid.	Shore and accessory property.	Cash capital.
Buffalo.....	New York.....	9	109	\$78,913	\$308,724	\$93,886
Dunkirk and Westfield.....	do.....	3	28	16,472	24,641	23,000
Erie.....	Pennsylvania.....	7	145	90,086	324,529	78,000
Cleveland.....	Ohio.....	7	80	69,839	151,610	22,500
Toledo.....	do.....	4	39	31,842	126,970	22,000
Port Clinton.....	do.....	5	42	29,719	84,138	52,500
Sandusky.....	do.....	5	82	104,151	156,500	23,000
Grand River.....	do.....	4	33	19,251	12,019	25,000
Huron, Vermilion, and Lorain.....	do.....	7	55	32,360	108,200	20,000
Ashtabula.....	do.....	3	30	35,798	94,357	30,000
Detroit and Monroe.....	Michigan.....	16	85	56,622	168,100	67,000
Total.....		70	728	565,053	1,559,788	456,886

## FISHERIES OF LAKE ONTARIO AND CERTAIN TRIBUTARIES.

## FISHERIES OF LAKE ONTARIO.

In 1917 the fishing industry of Lake Ontario gave employment to 289 persons, 4 of whom were on fishing and transporting vessels, 274 in the shore or boat fisheries, and the remainder employed as shoresmen.

The investment amounted to \$132,653, which included 2 vessels of 18 net tons, valued at \$2,585, including outfits; 196 boats, valued at \$18,900; fishery apparatus used on vessels and boats, valued at \$41,243; shore and accessory property to the value of \$49,925; and cash capital amounting to \$20,000. The apparatus included 165 gill nets, valued at \$15,175; 353 trap nets, valued at \$21,460; 334 fyke nets, valued at \$4,374; and seines, set lines, etc., to the value of \$234.

The products of the fisheries amounted to 915,616 pounds, valued at \$84,113. The catch of the more important species was made up of 424,744 pounds of ciscoes, value \$38,115; common whitefish, 88,347 pounds, value \$11,720; suckers, 71,826 pounds, value \$5,350; burbot, 61,760 pounds, value \$2,388; catfish and bullheads, 45,124 pounds, value \$5,719; eels, 41,424 pounds, value \$3,249; and pike perch, 35,688 pounds, value \$4,083.

Compared with 1903 there was a decrease of 16, or 5.25 per cent, in the number of persons employed and of 159,832 pounds, or 14.86 per cent, in the quantity of the products, and an increase of \$36,374, or 76.19 per cent, in the value of the products and of \$38,274, or 40.55 per cent, in the investment.

FISHERIES, BY COUNTIES.—The following table shows, by counties, the extent of the fisheries of Lake Ontario in 1917:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS, BY SPECIES, IN THE FISHERIES OF LAKE ONTARIO IN 1917, BY COUNTIES.

Items.	Cayuga.		Jefferson.		Monroe.		Niagara.	
	Number	Value.	Number	Value.	Number	Value.	Number	Value.
<b>PERSONS ENGAGED.</b>								
In shore or boat fisheries . . . . .	29		89		23		31	
Shoresmen . . . . .			11					
Total . . . . .	29		100		23		31	
<b>INVESTMENT.</b>								
Rowboats . . . . .	24	\$480	30	\$660	7	\$195	7	\$170
Power boats . . . . .	1	1,500	27	5,896	5	625	13	2,175
Apparatus, shore fisheries:								
Trap nets . . . . .	46	3,800	244	15,390				
Gill nets . . . . .	4	270	40	5,645	16	915	30	1,680
Fyke nets . . . . .			240	3,459				
Seines . . . . .							1	50
Set lines . . . . .				18		9		41
Scap nets . . . . .			2	6				
Shore and accessory property . . . . .		650		41,215		425		2,000
Cash capital . . . . .				20,000				
Total . . . . .		6,700		92,283		2,169		6,119
<b>PRODUCTS.</b>								
Burbot . . . . .				2,163		44		6,185
Carp, Asiatic . . . . .	244	19	9,043	483		421	6,120	325
Catfish and bullheads . . . . .	1,300	224	32,514	4,135	377	34	153	19
Ciscoes:								
Fresh . . . . .	96,680	7,321	59,271	4,066	5,622	477	30,222	1,755
Salted . . . . .			6,909	801				
Eels . . . . .	134	9	40,393	3,153				
Pike . . . . .			15,330	2,029	93	12	20	3
Pike perch:								
Blue pike . . . . .			12,798	1,650	2,254	207	14,177	1,293
Wall-eyed or yellow perch . . . . .			1,674	322	546	66	60	12
Rock bass . . . . .			7,291	443	162	13		
Sheepshead or drum . . . . .			300	23				
Suckers . . . . .			59,261	4,516	2,985	161	381	11
Sunfish . . . . .	2,701	123	12,972	713				
Sturgeon . . . . .			3,872	888	370	60	2,906	669
Sturgeon caviar . . . . .							6	18
Trout, lake . . . . .			10,600	1,287	366	65	222	34
Whitefish, common . . . . .			17,117	2,011	7,522	1,082	31,733	3,771
Yellow perch . . . . .	500	50	27,037	1,434	615	68	160	14
Total . . . . .	101,559	7,746	318,545	27,998	27,097	2,666	86,160	7,924

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS, BY SPECIES, IN THE FISHERIES OF LAKE ONTARIO IN 1917, BY COUNTIES—Continued.

Items.	Orleans.		Oswego.		Wayne.		Total.	
	Number	Value.	Number	Value.	Number	Value.	Number	Value.
<b>PERSONS ENGAGED.</b>								
On vessels, fishing.....					2		2	
On vessels, transporting.....					2		2	
In shore or boat fisheries.....	8		46		48		274	
Shoresmen.....							11	
Total.....	8		46		52		289	
<b>INVESTMENT.</b>								
Vessels fishing, gasoline.....					1	\$1,200	1	\$1,200
Tonnage.....					8		8	
Outfit.....						20		20
Vessels transporting, gasoline.....					1	1,300	1	1,300
Tonnage.....					10		10	
Outfit.....						65		65
Rowboats.....	3	\$150	24	\$900	30	465	125	3,020
Power boats.....	1	300	13	2,390	11	3,000	71	15,880
Apparatus, vessel fisheries: Gill nets.....					3	40	3	40
Apparatus, shore fisheries:								
Trap nets.....					63	2,270	353	21,460
Gill nets.....	7	450	37	3,045	28	3,130	162	15,135
Fyke nets.....			70	675	24	240	334	4,374
Seines.....					2	65	3	115
Set lines.....		22		10		10		113
Scap nets.....							2	6
Shore and accessory property.....		300		3,635		1,700		49,925
Cash capital.....								20,000
Total.....		1,222		10,655		13,505		132,653
<b>PRODUCTS.</b>								
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bowfin.....			2,341	\$105	4,705	\$245	7,046	\$350
Burbot.....			4,247	297	49,165	1,626	61,760	2,388
Carp, Asiatic.....			87	5	10,088	519	25,582	1,351
Catfish and bullheads.....			2,131	320	8,649	987	45,124	5,719
Ciscoes:								
Fresh.....	2,390	\$490	70,229	10,269	151,421	12,686	415,835	37,064
Salted.....			2,000	250			8,909	1,051
Eels.....	227	25	527	47	143	15	41,424	3,249
Pike.....	50	8	257	40	71	1	15,821	2,093
Pike perch:								
Blue pike.....	425	78	1,551	203	1,933	202	33,138	3,633
Wall-eyed or yellow perch.....	100	20	100	16	70	14	2,550	450
Rock bass.....					22	2	7,475	458
Sheepshead or drum.....							300	23
Suckers.....	1,350	150	5,921	367	1,928	145	71,826	5,350
Sunfish.....			2,690	181	5,522	310	23,885	1,327
Sturgeon.....	140	43	2,540	670	1,020	375	10,848	2,705
Sturgeon caviar.....			125	400			131	418
Trout, lake.....	300	42	12,146	1,388	60	2	23,694	2,818
Whitefish, common.....	3,500	700	20,154	2,885	8,321	1,271	88,347	11,720
Yellow perch.....	48	8	246	36	3,315	336	31,921	1,946
Total.....	8,530	1,564	127,292	17,479	246,433	18,736	915,616	84,113

FISHERIES, BY APPARATUS.—The catch of the vessel fisheries amounted to 4,930 pounds, valued at \$413, consisting of 4,500 pounds of ciscoes, value \$360; 200 pounds of whitefish, value \$30; and 230 pounds of yellow perch, value \$23, all of which was taken with gill nets by a vessel in Wayne County.

The catch taken by boats amounted to 910,686 pounds, valued at \$83,700, of which gill nets took 402,170 pounds, value \$43,112; trap nets, 359,298 pounds, value \$28,826; fyke nets, 89,312 pounds, value \$8,823; seines, 54,386 pounds, value \$1,704; lines, 4,688 pounds, value \$1,159; and scap or dip nets, 832 pounds, value \$76. The principal species taken with trap nets were catfish and bullheads, ciscoes, eels, suckers, sunfish, and yellow perch; with gill nets, burbot, ciscoes, pike perch, suckers, lake trout, and whitefish; with fyke nets, catfish and bullheads, eels, pike, suckers, sunfish, and yellow perch; and with

lines, sturgeon and eels. The catch of the seines consisted of burbot carp, catfish, and bullheads; and of seap or dip nets, suckers.

The following table gives the products of the shore fisheries, by counties, in 1917:

YIELD OF SHORE FISHERIES OF LAKE ONTARIO IN 1917, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Cayuga.		Jefferson.		Monroe.		Niagara.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Trap nets:								
Burbot			1,663	\$34				
Carp, Asiatic	244	\$19	8,167	423				
Catfish and bullheads	1,300	224	19,252	2,274				
Ciscoes—								
Fresh	94,360	7,189	15,858	1,133				
Salted			150	18				
Eels	134	9	29,823	2,165				
Pike			9,929	1,289				
Pike perch—								
Blue pike			10,585	1,463				
Wall-eyed or yellow pike			1,611	313				
Rock bass			7,031	384				
Sheepshead or drum			300	23				
Suckers			26,633	1,757				
Sunfish	2,701	123	9,711	467				
Sturgeon			177	31				
Trout, lake			1,006	129				
Whitefish, common			2,757	287				
Yellow perch			16,760	913				
Total	98,739	7,564	161,413	13,103				
Gill nets:								
Burbot			500	10	6,185	\$421		
Carp, Asiatic							100	\$8
Catfish and bullheads					377	34		
Ciscoes—								
Fresh	2,320	132	43,413	2,933	5,622	477	30,217	1,754
Salted			6,759	783				
Pike			37	7	93	12	20	3
Pike perch—								
Blue pike			2,213	187	2,254	207	14,177	1,293
Wall-eyed or yellow pike			63	9	546	66	60	12
Rock bass					162	13		
Sturgeon			3,377	758	145	20	315	60
Suckers			379	22	2,985	161	381	11
Trout, lake			9,594	1,158	366	65	222	34
Whitefish, common			14,360	1,724	7,522	1,082	31,733	3,771
Yellow perch	500	50	1,476	74	615	68	160	14
Total	2,820	182	82,171	7,665	26,872	2,626	77,385	6,960
Fyke nets:								
Carp, Asiatic			876	60				
Catfish and bullheads			13,262	1,861				
Eels			10,337	972				
Pike			5,364	733				
Rock bass			260	59				
Suckers			31,417	2,661				
Sunfish			3,231	246				
Yellow perch			8,801	447				
Total			73,548	7,039				
Seines:								
Carp, Asiatic							6,020	317
Catfish and bullheads							130	16
Total							6,150	333
Lines:								
Catfish and bullheads							23	3
Ciscoes							5	1
Eels			233	16				
Sturgeon			318	99	225	40	2,591	609
Sturgeon caviar							6	18
Total			551	115	225	40	2,625	631
Seap nets: Suckers			832	76				
Grand total	101,559	7,746	318,545	27,998	27,097	2,666	86,160	7,924

## YIELD OF SHORE FISHERIES OF LAKE ONTARIO IN 1917, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Orleans.		Oswego.		Wayne.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Trap nets:</b>								
Bowfin.....					3,705	\$197	3,705	\$197
Burbot.....							1,663	34
Carp, Asiatic.....					2,039	159	10,450	601
Catfish and bullheads.....					6,513	707	27,065	3,205
Ciscoes—								
Fresh.....					74,944	5,858	185,162	14,180
Salted.....							150	18
Eels.....					143	15	30,100	2,189
Pike.....							9,929	1,289
Pike perch—								
Blue pike.....							10,585	1,463
Wall-eyed or yellow pike.....							1,611	313
Rock bass.....					22	2	7,053	386
Sheepshead or drum.....							300	23
Suckers.....					540	39	27,173	1,796
Sunfish.....					4,749	265	17,191	855
Sturgeon.....					400	120	577	151
Trout, lake.....					60	2	1,066	131
Whitefish, common.....					3,926	589	6,683	876
Yellow perch.....					2,075	206	18,835	1,119
<b>Total.....</b>					<b>99,116</b>	<b>8,159</b>	<b>359,298</b>	<b>28,826</b>
<b>Gill nets:</b>								
Burbot.....			4,247	\$297	9,165	626	20,097	1,354
Carp, Asiatic.....							100	8
Catfish and bullheads.....							377	34
Ciscoes—								
Fresh.....	2,390	\$490	65,796	9,486	71,977	6,468	221,735	21,740
Salted.....			2,000	250			8,759	1,033
Eels.....			137	15			137	15
Pike.....	50	8	257	40	71	1	528	71
Pike perch—								
Blue pike.....	425	78	1,551	203	1,933	202	22,553	2,170
Wall-eyed or yellow pike.....	100	20	100	16	70	14	939	137
Rock bass.....							162	13
Sturgeon.....			2,240	620			6,077	1,458
Sturgeon caviar.....			125	400			125	400
Suckers.....	1,350	150	5,721	356	1,358	102	12,174	802
Sunfish.....			260	19			260	19
Trout, lake.....	300	42	12,146	1,388			22,628	2,687
Whitefish, common.....	3,500	700	20,154	2,285	4,195	652	81,464	10,814
Yellow perch.....	48	8	246	36	1,010	107	4,055	357
<b>Total.....</b>	<b>8,163</b>	<b>1,496</b>	<b>114,980</b>	<b>16,011</b>	<b>89,779</b>	<b>8,172</b>	<b>402,170</b>	<b>43,112</b>
<b>Fyke nets:</b>								
Bowfin.....			2,341	105	1,000	48	3,341	153
Carp, Asiatic.....			87	5	363	33	1,326	98
Catfish and bullheads.....			2,131	320	1,586	236	16,979	2,417
Ciscoes.....			4,433	783			4,433	783
Eels.....			390	32			10,727	1,004
Pike.....							5,364	733
Rock bass.....							260	59
Suckers.....			200	11	30	4	31,647	2,676
Sunfish.....			2,430	162	773	45	6,434	453
Yellow perch.....							8,801	447
<b>Total.....</b>			<b>12,012</b>	<b>1,418</b>	<b>3,752</b>	<b>366</b>	<b>89,312</b>	<b>8,823</b>
<b>Seines:</b>								
Burbot.....					40,000	1,000	40,000	1,000
Carp, Asiatic.....					7,686	327	13,706	644
Catfish and bullheads.....					550	44	680	60
<b>Total.....</b>					<b>48,236</b>	<b>1,371</b>	<b>54,386</b>	<b>1,704</b>
<b>Lines:</b>								
Catfish and bullheads.....							23	3
Ciscoes.....							5	1
Eels.....	227	25					460	41
Sturgeon.....	140	43	300	50	620	255	4,194	1,096
Sturgeon caviar.....							6	18
<b>Total.....</b>	<b>367</b>	<b>68</b>	<b>300</b>	<b>50</b>	<b>620</b>	<b>255</b>	<b>4,688</b>	<b>1,159</b>
<b>Scap nets: Suckers.....</b>							832	76
<b>Grand total.....</b>	<b>8,530</b>	<b>1,564</b>	<b>127,292</b>	<b>17,479</b>	<b>241,503</b>	<b>18,323</b>	<b>910,686</b>	<b>83,700</b>

## FISHERIES OF ST. LAWRENCE RIVER.

The fisheries of the St. Lawrence River gave employment to 29 persons. The number of power and rowboats used was 26, valued at \$1,180; the apparatus of capture used was set lines, valued at \$620; and the investment amounted to \$1,810. The products of the fisheries amounted to 22,169 pounds, valued at \$5,324, of which 21,959 pounds were sturgeon, valued at \$5,091, and 78 pounds sturgeon caviar, valued at \$214.

FISHERIES, BY COUNTIES.—The following table shows, by counties, the persons, investment, and quantity and value of the products of the fisheries of the St. Lawrence in 1917:

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS, BY SET LINES, IN THE FISHERIES OF THE ST. LAWRENCE RIVER IN 1917, BY COUNTIES.

Items.	Jefferson.		St. Lawrence.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
Fishermen.....	9		20		29	
<b>INVESTMENT.</b>						
Rowboats.....			20	\$480	20	\$480
Power boats.....	6	\$700			6	700
Set lines.....		50		570		620
Shore and accessory property.....		10				10
Total.....	6	760	20	1,050	26	1,810
<b>PRODUCTS BY SET LINES.</b>						
Eels.....			12	\$3	12	\$3
Pike.....			30	5	30	5
Pike perch (wall-eyed or yellow pike).....			40	8	40	8
Sturgeon.....	3,867	\$888	18,092	4,203	21,959	5,091
Sturgeon caviar.....	40	100	38	114	78	214
Yellow perch.....			50	3	50	3
Total.....	3,907	988	18,262	4,336	22,169	5,324

## FISHERIES OF NIAGARA RIVER.

The fisheries of Niagara River are conducted in Erie and Niagara Counties, N. Y., and in 1917 gave employment to 60 persons. The number of power and rowboats used was 46, valued at \$1,815; the apparatus of capture included 9 seines, valued at \$495; 7 fishing machines, valued at \$795; and set lines to the value of \$441; and the value of the shore and accessory property was \$300. The total investment amounted to \$3,846. The yield of the fisheries of Niagara River was 116,603 pounds, valued at \$11,420, of which 81,819 pounds, valued at \$7,559, were taken with seines; 29,982 pounds, valued at \$2,806, with fishing machines; and 4,802 pounds, valued at \$1,055, with set lines. The principal species taken were: Ciscoes, 44,528 pounds, valued at \$2,927; sturgeon, including caviar, 18,669 pounds, valued at \$4,861; suckers, 17,285 pounds, valued at \$967; carp, 15,890 pounds, valued at \$822; and pike perch, 12,592 pounds, valued at \$1,151.

FISHERIES, BY COUNTIES.—The table following shows, by counties, the number of persons employed, investment, and quantity and value of the products of the fisheries of the Niagara River in 1917.

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS, BY APPARATUS, IN THE FISHERIES  
OF THE NIAGARA RIVER IN 1917, BY COUNTIES.

Items.	Erie.		Niagara.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
Fishermen.....	11		49		60	
<b>INVESTMENT.</b>						
Rowboats.....	11	\$530	33	\$735	44	\$1,265
Power boats.....			2	550	2	550
Seines.....			9	495	9	495
Fishing machines.....			7	795	7	795
Set lines.....		234		207		441
Shore and accessory property.....				300		300
<b>Total.....</b>	<b>11</b>	<b>764</b>	<b>51</b>	<b>3,082</b>	<b>62</b>	<b>3,846</b>
<b>PRODUCTS, BY APPARATUS.</b>						
<b>Seines:</b>	<b>Pounds.</b>	<b>Value.</b>	<b>Pounds.</b>	<b>Value.</b>	<b>Pounds.</b>	<b>Value.</b>
Carp, Asiatic.....			14,521	\$744	14,521	\$744
Catfish and bullheads.....			2,139	164	2,139	164
Ciscoes.....			32,860	2,059	32,860	2,059
Eels.....			436	64	436	64
Pike perch (blue pike).....			7,980	742	7,980	742
Sturgeon.....	11,092	\$2,755			11,092	2,755
Sturgeon caviar.....	160	320			160	320
Suckers.....			12,631	711	12,631	711
<b>Total.....</b>	<b>11,252</b>	<b>3,075</b>	<b>70,567</b>	<b>4,484</b>	<b>81,819</b>	<b>7,559</b>
<b>Fishing machines:</b>						
Carp, Asiatic.....			1,369	78	1,369	78
Catfish and bullheads.....			655	51	655	51
Ciscoes.....			11,668	868	11,668	868
Eels.....			1,109	83	1,109	83
Pike.....			340	51	340	51
Pike perch (blue pike).....			4,603	408	4,603	408
Rock bass.....			50	5	50	5
Sturgeon.....			2,585	461	2,585	461
Sturgeon caviar.....			175	280	175	280
Suckers.....			4,560	251	4,560	251
Yellow perch.....			2,868	270	2,868	270
<b>Total.....</b>			<b>29,982</b>	<b>2,806</b>	<b>29,982</b>	<b>2,806</b>
<b>Set lines:</b>						
Catfish and bullheads.....			16	1	16	1
Eels.....			26	3	26	3
Pike perch (blue pike).....			9	1	9	1
Sturgeon.....			4,657	1,045	4,657	1,045
Suckers.....			94	5	94	5
<b>Total.....</b>			<b>4,802</b>	<b>1,055</b>	<b>4,802</b>	<b>1,055</b>
<b>Grand total.....</b>	<b>11,252</b>	<b>3,075</b>	<b>105,351</b>	<b>8,345</b>	<b>116,603</b>	<b>11,420</b>

FISHERIES CONSIDERED BY STATES.

The States bordering on the Great Lakes and interested in the fisheries are: Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and New York. Of these, Michigan borders on Lakes Superior, Michigan, Huron, St. Clair, and Erie; Wisconsin, on Lakes Superior and Michigan; and New York on Lakes Erie and Ontario. It is therefore of importance to consider these statistics by States, as well as by lakes.

In 1917 there were 9,221 persons engaged in the fisheries of the Great Lakes, of whom 3,183 are credited to Michigan, 1,909 to Wisconsin, 1,761 to Ohio, 683 to New York, 608 to Minnesota, 564 to Illinois, 446 to Pennsylvania, and 67 to Indiana. In Michigan the investment amounted to \$2,937,086; Ohio, \$2,462,832; Wisconsin, \$1,668,529; Illinois, \$1,265,664; Pennsylvania, \$919,919; New York, \$793,371; Minnesota, \$428,443; and Indiana, \$79,825. On the basis of the value of the products the States ranked as follows: Michigan, 29,737,355 pounds, valued at \$2,035,889; Ohio, 26,442,993 pounds,

valued at \$1,570,230; Wisconsin, 24,042,103 pounds, valued at \$1,320,162; Pennsylvania, 8,151,241 pounds, valued at \$508,382; Minnesota, 10,041,846 pounds, valued at \$429,667; New York, 3,481,236 pounds, valued at \$268,215; Illinois, 1,356,294 pounds, valued at \$87,375; and Indiana, 1,016,155 pounds, valued at \$75,099.

Separate statistics, by lakes, are given for States whose fisheries are conducted in more than one lake.

The following table shows, by States, the number of persons engaged, apparatus and capital employed, and products of the fisheries of the Great Lakes in 1917:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS IN THE FISHERIES OF THE GREAT LAKES IN 1917, BY STATES.

Items.	New York.		Pennsylvania.		Ohio.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On fishing vessels.....	82		247		188	
On vessels transporting.....	2		7		41	
In shore fisheries.....	451		47		1,171	
Shoemen.....	148		145		361	
<b>Total.....</b>	<b>683</b>		<b>446</b>		<b>1,761</b>	
<b>INVESTMENT.</b>						
<b>Vessels fishing:</b>						
Steam.....	11	\$79,000	36	\$233,440	26	\$151,958
Tonnage.....	236		812		652	
Outfit.....		10,230		43,684		39,765
Gasoline.....	5	8,700	9	18,200	6	12,000
Tonnage.....	38		93		55	
Outfit.....		1,180		3,276		3,540
<b>Vessels transporting:</b>						
Steam.....			1	3,000	4	21,500
Tonnage.....			23		88	
Outfit.....				250		4,950
Gasoline.....	1	1,300			19	41,600
Tonnage.....	10				193	
Outfit.....		65				9,455
Sail and row boats.....	202	5,125	17	765	516	24,810
Power boats.....	110	35,805	14	7,200	341	145,500
Apparatus, vessel fisheries: Gill nets.....	7,473	53,817	20,154	141,273	10,379	77,476
<b>Apparatus, shore fisheries:</b>						
Pound nets and trap nets.....	383	24,280	69	16,930	4,826	653,135
Gill nets.....	3,484	41,586	362	2,214	5,881	28,325
Fyke nets.....	334	4,374			523	27,160
Seines.....	20	850			219	33,097
Lines.....		1,872		8		45
Fishing machines.....	7	795				10
Other apparatus.....		6				
Shore and accessory property.....		387,500		366,679		993,506
Cash capital.....		136,886		78,000		195,000
<b>Total.....</b>		<b>793,371</b>		<b>919,919</b>		<b>2,462,832</b>
<b>PRODUCTS.</b>						
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Bowfin.....	7,046	\$350			5,165	\$69
Burbot.....	77,025	2,633	148,719	\$1,541	488,886	6,241
Carp, Asiatic.....	70,980	3,743	22,427	718	4,589,118	214,120
Catfish and bullheads.....	48,629	6,016	990	61	626,847	39,090
<b>Ciscoes:</b>						
Fresh.....	2,503,723	173,076	7,381,256	447,744	7,735,136	465,983
Salted.....	8,909	1,051				
Eels.....	43,007	3,402				
Gold-eye, or moon-eye.....					10,335	104
Pike.....	16,191	2,149	1,238	148	4,428	402
<b>Pike perch:</b>						
Blue pike.....	65,374	6,453	162,878	13,049	1,874,551	120,523
Wall-eyed or yellow pike, fresh.....	8,388	1,177	3,214	412	1,211,574	139,877
Rock bass.....	7,625	468				
Sauger.....	77,598	3,879	33,993	2,245	3,817,581	233,911
Sheepshead or drum.....	355	26	10,863	309	2,844,633	69,190
Sturgeon.....	73,280	17,210	2,730	348	3,075	482
Sturgeon caviar.....	1,562	3,271				
Suckers, fresh.....	136,099	8,905	28,626	824	857,318	29,328
Sunfish.....	23,885	1,327				
Trout, lake, fresh.....	25,235	2,974				
White bass.....	30	2	120	13	261	32
Whitefish, common, fresh.....	231,415	26,230	300,293	37,015	1,285,311	177,535
Yellow perch, fresh.....	54,880	3,873	52,571	3,837	804,015	56,251
<b>Total.....</b>	<b>3,481,236</b>	<b>268,215</b>	<b>8,151,241</b>	<b>508,382</b>	<b>26,442,993</b>	<b>1,570,230</b>

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS IN THE FISHERIES OF THE GREAT LAKES IN 1917, BY STATES—Continued.

Items.	Indiana.		Michigan.		Illinois.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing.....	21		629		55	
On vessels transporting.....			65			
In shore fisheries.....	43		2,117		27	
Shoremen.....	3		372		482	
Total.....	67		3,183		564	
<b>INVESTMENT.</b>						
Vessels fishing:						
Steam.....	2	\$11,000	59	\$203,450		
Tonnage.....	51		1,150			
Outfit.....		3,610		80,690		
Gasoline.....	1	1,200	93	91,250	13	\$30,700
Tonnage.....	8		800		128	
Outfit.....		850		33,905		7,195
Vessels transporting:						
Steam.....			2	7,000		
Tonnage.....			24			
Outfit.....				500		
Gasoline.....			37	50,300		
Tonnage.....			365			
Outfit.....				7,215		
Sail and rowboats.....	23	610	741	17,153	9	195
Power boats.....	14	3,050	569	201,390	4	2,800
Apparatus vessel fisheries:						
Gill nets.....	1,695	35,940	37,584	356,624	2,355	20,225
Lines.....		200		11,143		
Apparatus shore fisheries:						
Pound nets and trap nets.....	18	7,600	2,755	347,811	8	3,000
Gill nets.....	369	7,130	13,849	115,010	190	1,645
Fyke nets.....			795	35,773		
Seines.....			147	15,330		
Lines.....		60		4,829		35
Other apparatus.....				1,520		
Shore and accessory property.....		7,575		1,001,093		1,087,369
Cash capital.....		1,000		355,100		112,500
Total.....		79,825		2,937,086		1,265,664
<b>PRODUCTS.</b>						
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bowfin.....			2,875	\$174		
Burbot.....	3,139	\$130	29,240	673	58	\$1
Carp, Asiatic.....	1,150	46	2,636,159	105,929		
Catfish and bullheads.....	120	17	33,329	3,295		
Ciscoes:						
Fresh.....	813,830	52,713	7,361,794	333,736	1,015,818	54,140
Salted.....			2,621,018	118,554		
Smoked.....			3,000	120		
Muskellunge.....			145	15		
Pike.....	225	30	21,174	2,031		
Pike perch:						
Walle-yed or yellow pike, fresh.....	1,400	240	1,207,407	147,254		
Walle-yed or yellow pike, salted.....			30	3		
Rack bass.....			4,283	208		
Sheepshead or drum.....	750	30	28,146	1,027		
Sturgeon.....	2,396	680	13,735	2,987		
Sturgeon caviar.....	65	115	508	1,284		
Suckres:						
Fresh.....	3,190	132	3,049,569	123,107	5,265	200
Salted.....			3,815	144		
Sunfish.....			1,650	68		
Trout, lake:						
Fresh.....	123,410	13,226	7,188,617	647,208	168,640	18,112
Salted.....			9,203	822		
Trout, steelhead.....	21,250	3,232	700	117		
White bass.....			600	50		
Whitefish:						
Common fresh.....	4,130	722	4,102,926	450,706	33,600	4,750
Common, salted.....			5,295	531		
Common, caviar.....			1,375	257		
Menominee, fresh.....			124,374	6,177		
Menominee, salted.....			45,315	3,133		
Yellow perch:						
Fresh.....	41,100	3,786	1,239,348	86,198	132,913	10,172
Salted.....			1,725	81		
Total.....	1,016,153	75,099	29,737,355	2,035,889	1,356,294	87,375

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS IN THE FISHERIES OF THE GREAT LAKES IN 1917, BY STATES—Continued.

Items.	Wisconsin.		Minnesota.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing.....	658		50		1,930	
On vessels transporting.....	48		48		211	
In shore fisheries.....	781		429		5,066	
Shoemen.....	422		81		2,014	
Total.....	1,909		608		9,221	
<b>INVESTMENT.</b>						
Vessels fishing:						
Steam.....	51	\$282,000	5	\$11,500	190	\$977,348
Tonnage.....	1,082		80		4,063	
Outfit.....		69,755		1,760		249,494
Gasoline.....	149	143,460	2	8,500	278	314,010
Tonnage.....	1,373		26		2,521	
Outfit.....		23,661		2,725		76,332
Vessels transporting:						
Steam.....			4	56,000	11	87,500
Tonnage.....			194		329	
Outfit.....				17,880		23,580
Gasoline.....	43	23,425	6	17,500	106	134,125
Tonnage.....	309		58		935	
Outfit.....		2,550		3,415		22,700
Sail and row boats.....	228	5,530	270	7,770	2,006	61,958
Apparatus, vessel fisheries:						
Gill nets.....	24,020	219,273	222	5,175	103,882	909,803
Lines.....		19,194				30,537
Apparatus, shore fisheries:						
Pound nets and trap nets.....	369	126,000	5	500	8,423	1,179,256
Gill nets.....	20,345	62,176	4,915	69,813	49,395	327,899
Fyke nets.....	3,286	33,400			4,938	100,707
Seines.....	60	17,970			446	67,247
Lines.....		2,834		1,325		11,008
Crawfish pots.....	6,400	1,600			6,400	1,600
Fishing machines.....					7	795
Other apparatus.....						1,536
Shore and accessory property.....		451,301		183,120		4,478,143
Cash capital.....		123,800		23,000		1,025,286
Total.....		1,668,529		428,443		10,556,669
<b>PRODUCTS.</b>						
Bowfin.....					15,086	\$593
Burbot.....					883,589	11,902
Carp, Asiatic.....					7,563,347	331,938
Catfish and bullheads.....					874,261	55,089
Ciscoes:						
Fresh.....	12,087,210	459,463	3,034,107	\$96,389	41,932,874	2,083,244
Frozen.....			3,302,357	150,810	3,302,357	150,810
Salted.....	2,466,040	118,110	3,189,727	137,596	8,285,694	375,311
Smoked.....			5,400	432	8,400	552
Eels.....					43,007	3,402
Gold-eye, or moon-eye.....					10,335	104
Muskellunge.....					145	15
Pike.....	37,252	3,044			80,508	7,804
Pike perch:						
Blue pike.....					2,102,803	140,025
Wall-eyed or yellow pike, fresh.....	64,708	9,311			2,496,691	298,271
Wall-eyed or yellow pike, salted.....					30	3
Rock bass.....	1,714	137			13,622	813
Sauger.....					3,929,172	240,035
Sheepshead or drum.....	17,247	354			2,901,994	70,936
Sturgeon.....					95,216	21,707
Sturgeon caviar.....					2,135	4,670
Suckers:						
Fresh.....	1,224,346	40,072	27,055	1,078	5,331,468	203,646
Salted.....	27,145	1,091			30,960	1,235
Sunfish.....					25,535	1,395
Trout, lake:						
Fresh.....	5,369,971	563,641	405,135	34,079	13,281,389	1,279,285
Frozen.....			44,000	5,800	44,000	5,800
Salted.....	2,275	221	7,272	576	18,750	1,619
Trout, steelhead.....					21,950	3,349
White bass.....	675	27			287,387	17,289

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS IN THE FISHERIES OF THE GREAT LAKES IN 1917, BY STATES—Continued.

Items.	Wisconsin.		Minnesota.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
PRODUCTS—continued.						
Whitefish:						
Common, fresh.....	210,685	\$23,393	17,093	\$2,285	6,185,453	\$722,636
Common, salted.....					5,295	531
Common, caviar.....					1,375	257
Menominee, fresh.....	27,695	1,131	6,800	394	158,869	7,702
Menominee, salted.....	805	40	2,900	228	49,020	3,401
Yellow perch:						
Fresh.....	1,879,459	81,025			4,204,286	245,142
Salted.....					1,725	81
Crawfish.....	80,495	4,427			80,495	4,427
Total.....	24,042,103	1,320,162	10,041,846	429,667	104,269,223	6,295,019

## FISHERIES OF MICHIGAN.

The fisheries of Michigan which were prosecuted in Lakes Erie, St. Clair and tributaries, Huron, Michigan, and Superior, but which were most extensive in Lake Huron and Lake Michigan, are shown in detail in the following table:

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MICHIGAN IN 1917, BY LAKES.

Items.	Lake Erie.		Lake St. Clair. <sup>1</sup>		Lake Huron.	
	Number.	Value.	Number.	Value.	Number.	Value.
PERSONS ENGAGED.						
On vessels fishing.....	2				149	
On vessels transporting.....					29	
In shore fisheries.....	171		64		1,023	
Shoresmen.....	10		75		147	
Total.....	183		139		1,348	
INVESTMENT.						
Vessels fishing:						
Steam.....					13	\$57,500
Tonnage.....					266	
Outfit.....						20,850
Gasoline.....	1	\$1,300			13	19,000
Tonnage.....	5				113	
Outfit.....		10				6,140
Vessels transporting:						
Steam.....					2	7,000
Tonnage.....					24	
Outfit.....						500
Gasoline.....					19	33,500
Tonnage.....					169	
Outfit.....						4,750
Sail and row boats.....	56	1,435	60	\$1,640	310	8,020
Power boats.....	28	7,440	4	900	260	103,960
Apparatus, vessel fisheries:						
Gill nets.....	4	51			6,613	69,575
Lines.....						3,844
Apparatus, shore fisheries:						
Pound nets and trap nets.....	86	8,175			1,731	207,904
Gill nets.....	6	65			3,997	33,260
Fyke nets.....	278	17,243			460	12,135
Seines.....	58	5,530	6	1,385	77	7,960
Lines.....				50		2,145
Other apparatus.....						1,520
Shore and accessory property.....		27,365		171,350		432,092
Cash capital.....		5,000		62,000		156,100
Total.....		73,614		237,305		1,188,705

<sup>1</sup> Includes St. Clair River and wholesale trade of Detroit.

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MICHIGAN  
IN 1917, BY LAKES—Continued.

Items.	Lake Erie.		Lake St. Clair.		Lake Huron.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>PRODUCTS.</b>						
Bowfins.....					200	\$4
Burbot.....					2,174	51
Carp, Asiatic.....	1,403,739	\$57,731	85,330	\$4,652	1,145,250	43,474
Catfish and bullheads.....					33,329	3,295
Ciscoes:						
Fresh.....	1,100	50			3,277,573	120,705
Salted.....					2,100,792	94,957
Smoked.....					3,000	120
Muskellunge.....					145	15
Pike.....					12,354	1,175
Pike perch:						
Wall-eyed or yellow pike—						
Fresh.....	70,870	8,155	48,000	7,200	994,642	119,231
Salted.....					30	3
Rock bass.....					4,283	208
Sheepshead or drum.....					17,731	615
Sturgeon.....	440	87			4,886	1,063
Sturgeon caviar.....					227	495
Suckers:						
Fresh.....	103,002	3,663			1,775,767	72,875
Salted.....					1,000	50
Sunfish.....					1,650	68
Trout, lake:						
Fresh.....					2,070,797	213,790
Salted.....					8,658	784
Whitefish:						
Common, fresh.....	27,275	3,701			993,501	124,050
Common, salted.....					3,350	330
Common, caviar.....					1,375	257
Menominee, fresh.....					46,457	2,191
Menominee, salted.....					20,017	1,200
Yellow perch, fresh.....	82,730	7,942			844,019	56,464
Total.....	1,689,156	\$1,329	133,330	11,852	13,363,207	\$57,470

Items.	Lake Michigan.		Lake Superior.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing.....	436		42		629	
On vessels transporting.....	33		3		65	
In shore fisheries.....	568		291		2,117	
Shoresmen.....	108		32		372	
Total.....	1,145		368		3,183	
<b>INVESTMENT.</b>						
Vessels fishing:						
Steam.....	43	\$134,450	3	\$11,500	59	\$203,450
Tonnage.....	758		126		1,150	
Outfit.....		52,040		7,800		80,600
Gasoline.....	78	65,950	1	5,000	93	91,250
Tonnage.....	616		66		800	
Outfit.....		25,155		2,600		33,905
Vessels transporting:						
Steam.....					2	7,000
Tonnage.....					24	
Outfit.....						500
Gasoline.....	17	14,800	1	2,000	37	50,300
Tonnage.....	186		10		365	
Outfit.....		1,965		500		7,215
Sail and row boats.....	241	4,828	74	1,230	741	17,153
Power boats.....	168	48,295	109	40,795	569	201,390
Apparatus, vessel fisheries:						
Gill nets.....	29,833	267,728	1,134	19,270	37,584	356,624
Lines.....		6,739		560		11,143
Apparatus, shore fisheries:						
Pound nets and trap nets.....	787	114,420	151	17,312	2,755	347,811
Gill nets.....	6,416	51,367	3,430	30,318	13,849	115,010
Fyke nets.....	57	6,395			795	35,773
Seine.....	1		5	325	147	15,330
Lines.....		515		2,119		4,829
Other apparatus.....						1,520

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MICHIGAN IN 1917, BY LAKES—Continued.

Items.	Lake Michigan.		Lake Superior.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
INVESTMENT—continued.						
Shore and accessory property.....		\$258,236		\$112,050		\$1,001,093
Cash capital.....		127,000		5,000		355,100
Total.....	1,178,883		258,379		2,937,086	
PRODUCTS.						
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bowfins.....			2,675	\$170	2,875	\$174
Burbot.....	27,066	\$622			29,240	673
Carp, Asiatic.....	1,840	72			2,636,159	105,920
Catfish and bullheads.....					33,329	3,295
Ciscoes:						
Fresh.....	3,159,135	173,810	923,986	39,171	7,361,794	333,736
Salted.....	519,726	23,574	500	23	2,621,018	118,554
Smoked.....					3,000	120
Muskellunge.....					145	15
Pike.....	8,020	776	800	80	21,174	2,031
Pike perch:						
Wall-eyed or yellow pike—						
Fresh.....	89,016	11,987	4,879	681	1,207,407	147,254
Salted.....					30	3
Rock bass.....					4,283	208
Sheepshead or drum.....	10,415	412			28,146	1,027
Sturgeon.....	8,409	1,837			13,735	2,987
Sturgeon caviar.....	281	789			508	1,284
Suckers:						
Fresh.....	995,552	39,453	175,248	7,116	3,049,569	123,107
Salted.....	2,815	94			3,815	144
Sunfish.....					1,650	68
Trout, lake:						
Fresh.....	3,580,969	306,044	1,536,851	127,374	7,188,617	647,208
Salted.....	545	38			9,203	822
Trout, steelhead.....	700	117			700	117
White bass.....	600	50			600	50
Whitefish:						
Common, fresh.....	2,839,868	298,594	242,262	24,361	4,102,906	450,706
Common, salted.....	1,945	201			5,295	531
Common, caviar.....					1,375	257
Menominee, fresh.....	76,687	3,876	1,230	110	124,374	6,177
Menominee, salted.....	25,298	1,933			45,315	3,133
Yellow perch:						
Fresh.....	309,599	21,557	3,000	235	1,239,348	86,198
Salted.....	1,725	81			1,725	81
Total.....	11,660,211	885,917	2,891,431	199,321	29,737,335	2,035,889

## FISHERIES OF WISCONSIN.

The fisheries of Wisconsin which were prosecuted in Lakes Michigan and Superior are given in detail in the following table:

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF WISCONSIN IN 1917, BY LAKES.

Items.	Lake Michigan.		Lake Superior.		Total.	
	<i>Number.</i>	<i>Value.</i>	<i>Number.</i>	<i>Value.</i>	<i>Number.</i>	<i>Value.</i>
<b>PERSONS ENGAGED.</b>						
On vessels fishing.....	584		74		658	
On vessels transporting.....	48				48	
In shore fisheries.....	647		134		781	
Shoresmen.....	258		164		422	
<b>Total.....</b>	<b>1,537</b>		<b>372</b>		<b>1,909</b>	
<b>INVESTMENT.</b>						
Vessels fishing:						
Steam.....	47	\$252,200	4	\$20,800	51	\$282,000
Tonnage.....	986		96		1,082	
Outfit.....		68,235		1,520		69,755
Gasoline.....	148	136,460	1	7,000	149	143,460
Tonnage.....	1,361		12		1,373	
Outfit.....		23,436		225		23,661
Vessels transporting:						
Gasoline.....	43	23,425			43	23,425
Tonnage.....	309				309	
Outfit.....		2,550				2,550
Sail and row boats.....	155	4,310	73	1,220	228	5,530
Power boats.....	125	37,450	52	23,150	177	60,600
Apparatus:						
Vessel fisheries—						
Gill nets.....	23,570	211,723	450	7,550	24,020	219,273
Lines.....		18,794		400		19,194
Shore fisheries—						
Pound nets and trap nets.....	321	117,550	48	8,450	369	126,000
Gill nets.....	19,379	49,316	966	12,860	20,345	62,176
Fyke nets.....	3,286	33,400			3,286	33,400
Seines.....	60	17,970			60	17,970
Lines.....		1,465		1,369		2,834
Crawfish pots.....	6,400	1,600			6,400	1,600
Shore and accessory property.....		405,161		46,140		451,301
Cash capital.....		109,300		14,500		123,800
<b>Total.....</b>		<b>1,514,345</b>		<b>154,184</b>		<b>1,668,529</b>
<b>PRODUCTS.</b>						
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Burbot.....	136,522	\$683			136,522	\$683
Carp, Asiatic.....	243,513	7,382			243,513	7,382
Catfish and bullheads.....	164,346	6,610			164,346	6,610
Ciscoes:						
Fresh.....	10,352,805	425,975	1,734,405	\$33,488	12,087,210	459,463
Salted.....	2,398,040	115,770	68,000	2,340	2,466,040	118,110
Pike.....	32,352	2,569	4,900	475	37,252	3,044
Pike perch (wall-eyed or yellow pike)	41,608	6,218	23,100	3,093	64,708	9,311
Rock bass.....	1,714	137			1,714	137
Sheepshead or drum.....	17,247	354			17,247	354
Suckers:						
Fresh.....	1,100,446	35,082	123,900	4,990	1,224,346	40,072
Salted.....	11,295	531	15,850	560	27,145	1,091
Trout, lake:						
Fresh.....	4,774,876	515,497	595,095	48,144	5,369,971	563,641
Salted.....	2,275	221			2,275	221
White bass.....	675	27			675	27
White fish:						
Common, fresh.....	167,830	19,096	42,855	4,297	210,685	23,393
Menominee, fresh.....	23,645	953	4,050	178	27,695	1,131
Menominee, salted.....	805	40			805	40
Yellow perch.....	1,877,459	8,904	2,000	121	1,879,459	9,025
Crawfish.....	80,495	4,427			80,495	4,427
<b>Total.....</b>	<b>21,427,948</b>	<b>1,150,476</b>	<b>2,614,155</b>	<b>97,686</b>	<b>24,042,103</b>	<b>1,248,162</b>

## FISHERIES OF NEW YORK.

The fisheries of New York in the Great Lakes are conducted in Lake Ontario and the St. Lawrence and Niagara Rivers, and also in two counties, Erie and Chautauqua, on Lake Erie. The number of persons engaged, investment, and products of these fisheries are given in detail in the following table:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF NEW YORK  
IN 1917, BY LAKES.

Items.	Lake Ontario. <sup>1</sup>		Lake Erie.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing.....	2		80		82	
On vessels transporting.....	2				2	
In shore fisheries.....	363		88		451	
Shoresmen.....	11		137		148	
<b>Total.....</b>	<b>378</b>		<b>305</b>		<b>683</b>	
<b>INVESTMENT.</b>						
Vessels fishing:						
Steam.....			11	\$79,000	11	\$79,000
Tonnage.....			236		236	
Outfit.....				10,230		10,230
Gasoline.....	1	\$1,200	4	7,500	5	8,700
Tonnage.....	8		30		38	
Outfit.....		20		1,160		1,180
Vessel transporting, gasoline.....	1	1,300			1	1,300
Tonnage.....	10				10	
Outfit.....		65				65
Sail and row boats.....	189	4,765	13	360	202	5,125
Power boats.....	79	17,130	31	18,675	110	35,805
Apparatus, vessel fisheries: Gillnets.....	3	40	7,470	53,777	7,473	53,817
Apparatus, shore fisheries:						
Pound nets and trap nets.....	353	21,460	30	2,820	383	24,280
Gillnets.....	162	15,135	3,322	26,451	3,484	41,586
Fykenets.....	334	4,374			334	4,374
Seines.....	12	610	8	240	20	850
Lines.....		1,174		698		1,872
Fishing machines.....	7	795			7	795
Other apparatus.....		6				6
Shore and accessory property.....		50,235		337,265		387,500
Cash capital.....		20,000		116,886		136,886
<b>Total.....</b>		<b>138,309</b>		<b>655,062</b>		<b>793,371</b>
<b>PRODUCTS.</b>						
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Bowfin.....	7,046	\$350			7,046	\$350
Burbot.....	61,760	2,388	15,265	\$245	77,025	2,633
Carp, Asiatic.....	41,472	2,173	29,508	1,570	70,980	3,743
Catfish and bullheads.....	47,934	5,935	695	81	48,629	6,016
Ciscoes:						
Fresh.....	460,363	39,991	2,043,360	133,085	2,503,723	173,076
Salted.....	8,909	1,051			8,909	1,051
Eels.....	43,007	3,402			43,007	3,402
Pike.....	16,191	2,149			16,191	2,149
Pike perch:						
Blue pike.....	45,730	4,784	19,644	1,669	65,374	6,453
Wall-eyed or yellow pike.....	2,590	458	5,798	719	8,388	1,177
Rock bass.....	7,525	463	100	5	7,625	468
Sauger.....			77,598	3,879	77,598	3,879
Sheepshead or drum.....	300	23	55	3	355	26
Sturgeon.....	51,141	12,063	22,139	5,147	73,280	17,210
Sturgeon caviar.....	544	1,232	1,018	2,045	1,562	3,277
Suckers.....	89,111	6,317	46,988	2,588	136,099	8,905
Sunfish.....	23,885	1,327			23,885	1,327
Trout.....	23,694	2,818	1,541	156	25,235	2,974
White bass.....			30	2	30	2
Whitefish.....	88,347	11,120	143,068	14,510	231,415	25,630
Yellow perch.....	34,839	2,819	20,041	1,654	54,880	4,473
<b>Total.....</b>	<b>1,054,388</b>	<b>100,863</b>	<b>2,426,848</b>	<b>167,358</b>	<b>3,481,236</b>	<b>268,221</b>

<sup>1</sup>Includes St. Lawrence and Niagara Rivers.

## FISHERIES OF LAKE OF THE WOODS, RAINY LAKE, AND LAKES KABETOGAMA AND LA CROIX.

The number of persons engaged in the fisheries of Lake of the Woods, Rainy Lake, and Lakes Kabetogama and La Croix, Minn., in 1917 was 195, of whom 9 were on transporting vessels, 165 in the shore or boat fisheries, and 21 shoresmen.

The investment amounted to \$177,210, which included 2 transporting vessels with their outfits, valued at \$15,960, 82 sail and power boats, valued at \$28,100; fishing apparatus to the value of \$44,800; shore and accessory property, valued at \$81,850; and cash capital utilized to the amount of \$6,500. The fishing apparatus included 185 pound nets, valued at \$36,250; 220 gill nets, valued at \$8,150; and 30 fyke nets, valued at \$400.

The products of the fisheries amounted to 2,167,169 pounds, valued at \$118,508, which was divided among the different forms of apparatus as follows: Pound nets, 1,576,829 pounds, value \$85,432; gill nets, 575,390 pounds, value \$32,366; and fyke nets, 14,950 pounds, value \$710. Among the principal species were pike perch, 706,279 pounds, valued at \$67,615; pike, 553,037 pounds, valued at \$22,109; ciscoes, 392,548 pounds, valued at \$12,770; suckers, 268,980 pounds, valued at \$3,584; whitefish, 96,185 pounds, valued at \$8,095; and sturgeon, 13,820 pounds, valued at \$1,659.

Following are given some comparative figures for Lake of the Woods for 1903 based on unpublished data and for 1917. In 1917 there were 100 men employed in the fisheries of this lake, an increase of 46 as compared with 1903. In 1903, the fishing apparatus consisted of 57 pound nets, valued at \$17,100, as compared with 100 pound nets, valued at \$15,000; 45 gill nets, valued at \$1,500; and 30 fyke nets, valued at \$400 in 1917. The products of the fisheries in 1903 amounted to 430,209 pounds, valued at \$17,954, and in 1917 to 1,098,744 pounds, valued at \$59,748, an increase of 668,535 pounds in quantity and of \$41,794 in value.

The table following shows the extent of the fisheries of Lake of the Woods, Rainy Lake, and Lakes Kabetogama and La Croix, Minn., in 1917.

## FISHERIES OF LAKE OF THE WOODS, RAINY LAKE, AND LAKES KABETOGAMA AND LA CROIX, MINN., 1917.

Items.	Lake of the Woods.		Rainy Lake and Lakes Kabetogama and La Croix.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels transporting.....	7		2		9	
In shore or boat fisheries.....	80		85		165	
Shoresmen.....	13		8		21	
Total.....	100		95		195	
<b>INVESTMENT.</b>						
Transporting vessels (steamers).....	1	\$8,300	1	\$1,500	2	\$9,800
Tonnage.....	20		9		29	
Value of outfit.....		5,760		400		6,160
Sail boats.....	3	800			3	800
Power boats.....	39	13,300	40	14,000	79	27,300
Pound nets.....	100	15,000	85	21,250	185	36,250
Gill nets.....	45	1,500	175	6,650	220	8,150
Fyke nets.....	30	400			30	400
Shore and accessory property.....		63,600		18,250		81,850
Cash capital.....		3,500		3,000		6,500
Total.....		112,160		65,050		177,210
<b>PRODUCTS BY APPARATUS.</b>						
<b>Pound nets:</b>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Bullheads.....	5,400	\$295			5,400	\$295
Burbot.....	50,500	303	16,600	\$250	67,100	553
Ciscoes ("Tullibee").....	22,048	440	262,500	9,100	284,548	9,540
Gold-eye.....	38,865	583			38,865	583
Pike.....	191,537	6,989	188,600	7,500	380,137	14,489
Pike perch (wall-eyed or yellow pike).....	335,279	30,475	200,000	20,000	535,279	50,475
Sturgeon.....	10,495	1,259	3,325	400	13,820	1,659
Suckers.....	160,180	2,119	30,000	375	190,180	2,494
Trout.....	130	9			130	9
Whitefish.....	45,135	3,985	15,000	1,200	60,135	5,185
Yellow perch.....	1,235	150			1,235	150
Total.....	860,804	46,607	716,025	38,825	1,576,829	85,432
<b>Gill nets:</b>						
Burbot.....	640	11			640	11
Ciscoes ("Tullibee").....	20,500	630	87,500	2,600	108,000	3,230
Gold-eye.....	11,500	230			11,500	230
Pike.....	75,500	3,750	94,400	3,750	169,900	7,500
Pike perch (wall-eyed or yellow pike).....	70,000	7,050	100,000	10,000	170,000	17,050
Suckers.....	43,800	650	30,000	375	73,800	1,025
Trout.....			2,500	200	2,500	200
Whitefish.....	1,050	110	35,000	2,800	36,050	2,910
Yellow perch.....			3,000	210	3,000	210
Total.....	222,990	12,431	352,400	19,935	575,390	32,366
<b>Fyke nets:</b>						
Bullheads.....	4,250	275			4,250	275
Crappie.....	100	10			100	10
Pike.....	3,000	120			3,000	120
Pike perch (wall-eyed or yellow pike).....	1,000	90			1,000	90
Suckers.....	5,000	65			5,000	65
Yellow perch.....	1,600	150			1,600	150
Total.....	14,950	710			14,950	710
<b>Grand total.....</b>	<b>1,098,744</b>	<b>59,748</b>	<b>1,068,425</b>	<b>58,760</b>	<b>2,167,169</b>	<b>118,508</b>

## FISHERIES OF THE GULF STATES IN 1918.

The information contained in this report applies to the commercial coast fisheries of the western coast of Florida, Alabama, Mississippi, Louisiana, and Texas, and is for the year 1918. The data were collected in 1919 by Winthrop A. Roberts and Rob Leon Greer, agents of this Bureau.

## EARLIER PUBLICATIONS.

Some of the earlier publications relating to the fisheries of the Gulf States and published in Washington, D. C., follow:

- Fisheries of the Gulf of Mexico, by Silas Stearns. The Fisheries and Fishery Industries of the United States, 1887, Section II, a Geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880, pp. 533-587.
- A Statistical Report on the Fisheries of the Gulf States, by J. W. Collins and H. M. Smith. Bulletin, U. S. Fish Commission, 1891, pp. 91-184.
- Report on the Coast Fisheries of Texas, by Charles H. Stevenson. Appendix, Report of Commissioner, U. S. Commission of Fish and Fisheries, 1889-1891, pp. 373-420, pls. 13-27.
- The Fish and Fisheries of the Coastal Waters of Florida. Transmitted to the United States Senate by the Commissioner of Fish and Fisheries, January 28, 1897. Senate Document 100, Fifty-fourth Congress, second session. See also pages 263-342, Appendix, Report of Commissioner, U. S. Commission of Fish and Fisheries, 1896.
- Statistics of the Fisheries of the Gulf States, by C. H. Townsend. Report of Commissioner, U. S. Commission of Fish and Fisheries, 1899, pp. 105-169.
- Statistics of the Fisheries of the Gulf States, 1902. Appendix, Report of Commissioner, U. S. Commission of Fish and Fisheries, 1903, pp. 411-481.
- Fisheries of the United States, 1908. Special Reports, Bureau of the Census, 1911.

## COMMON AND SCIENTIFIC NAMES OF FISHES OF GULF STATES.

To prevent misunderstanding from the use of the common names employed in the tables and discussions, the following list of common and scientific names of fishes is appended, the common name being the first given in every case. As the same common name is sometimes applied to more than one species of the same genus or species belonging to different genera, in such cases only the generic or family names are given, it being impossible to ascertain definitely the names of all the species represented in the catch. The names kingfish, whiting, sea mullet, sea mink, Virginia mullet, Carolina whiting, roundhead, hake, tom-cod, black mullet, etc., are applied to species of *Menticirrhus*. Most of these are used to designate other unrelated species, such as kingfish (*Scomberomorus regalis*) and whiting (*Merluccius bilinearis*), with resultant confusion. To avoid this confusion the Bureau has adopted the name king whiting for species of *Menticirrhus* in its reports, and suggests that the trade follow this practice in establishing a distinctive name for these important food fishes.

Amberfish.....	..... <i>Seriola</i> (species).
Angelfish.....	..... <i>Chaetodipterus faber</i> .
Barracuda.....	..... <i>Sphyrena</i> (species).
Black drum.....	..... <i>Pogonias cromis</i> .
Bluefish.....	..... <i>Pomatomus saltatrix</i> .
Blue runner or hardtail.....	..... <i>Caranx crysos</i> .
Bonito.....	..... <i>Sarda sarda</i> .
Catfish.....	{ <i>Felichthys marinus</i> .
	{ <i>Galeichthys felis</i> .
Cero and kingfish.....	{ <i>Scomberomorus cavalla</i> .
	{ <i>Scomberomorus regalis</i> .

Cowfish and "shellfish" .....	Ostraciidæ (species).
Crevallé .....	Caranx (species).
Croaker .....	<i>Micropogon undulatus</i> .
Elops or ten-pounder .....	<i>Elops saurus</i> .
Flounders .....	Pleuronectidæ (species).
Groupers .....	{ <i>Epinephelus</i> (species). <i>Mycteroperca</i> (species). <i>Garrupa nigrita</i> .
Grunts .....	Hæmulidæ (species).
Hogfish .....	<i>Lachnolaimus maximus</i> .
Jewfish .....	<i>Promicropus guttatus</i> .
King whiting .....	<i>Menticirrhus</i> (species).
Leather jacket or "turbot" .....	<i>Balistes carolinensis</i> .
Menhaden .....	<i>Brevoortia tyrannus</i> .
Moonfish .....	<i>Vomer setipinnis</i> .
Mullet .....	{ <i>Mugil cephalus</i> : <i>Mugil curema</i> .
Permit .....	<i>Trachinotus goodei</i> .
Pigfish .....	<i>Orthopristis chrysopterus</i> .
Pompano .....	{ <i>Trachinotus carolinus</i> . <i>Trachinotus</i> (other species). (See also permit.)
Porgies .....	{ <i>Calamus</i> (species). <i>Pagrus</i> (species).
Porkfish .....	<i>Anisotremus virginicus</i> .
Redfish or red drum .....	<i>Sciaenops ocellatus</i> .
Sailors choice .....	Applied indiscriminately to several species.
Scamp .....	<i>Mycteroperca phenax</i> .
Sea bass .....	<i>Centropristes striatus</i> .
Sea gar .....	<i>Tylosurus</i> (species).
Sergeantfish or snook .....	<i>Centropomus undecimalis</i> .
Sharks .....	All Selachii except Batoidei.
Sheepshead .....	<i>Archosargus probatocephalus</i> .
Snapper, mangrove .....	<i>Lutianus griseus</i> .
Snapper, mutton .....	<i>Lutianus analis</i> .
Snapper, red .....	<i>Lutianus blackfordi</i> .
Spanish mackerel .....	<i>Scomberomorus maculatus</i> .
Spot .....	<i>Leiostomus xanthurus</i> .
Squeteagies or "sea trout" .....	{ <i>Cynoscion regalis</i> . <i>Cynoscion nothus</i> . <i>Cynoscion nebulosus</i> .
Sturgeon .....	<i>Acipenser sturio</i> .
Tang .....	Teuthididæ (species).
Tarpon .....	<i>Tarpon atlanticus</i> .
Yellowtail .....	<i>Ocyurus chrysurus</i> .

## GENERAL STATISTICS.

The fisheries of the Gulf States in 1918 gave employment to 14,888 persons, of whom 1,731 were on vessels fishing, 297 on vessels transporting fishery products, 7,801 in shore fisheries, and 5,059 shoremen in wholesale fish establishments, shrimp and oyster canneries, and other branches of the fishery industries. The west coast of Florida had 5,161 persons employed in its fisheries; Alabama, 783; Mississippi, 2,867; Louisiana, 4,191; and Texas, 1,886. Compared with the returns for 1902, the year for which the last canvass was made by the Bureau, there has been a decrease in the number of persons employed in all of the States except Texas, the total decrease being 3,141, or 17.42 per cent. The largest decrease was 1,477, or 34 per cent, in Mississippi. The increase in Texas was 742 persons, or 64.86 per cent. In this connection it will be recalled that during

the year 1918 large numbers of persons entered the military branches of the Government or engaged in other war activities, such as ship building.

The total amount of capital invested in the fisheries of these States in 1918 was \$6,537,859. In Florida the investment was \$2,404,245; in Alabama, \$334,741; in Mississippi, \$1,433,585; in Louisiana, \$1,475,188; and in Texas, \$890,100. There has been an increase of \$1,830,399, or 38.88 per cent, in money invested in the fisheries of this region since 1902. The investment included 533 fishing and transporting vessels, valued at \$1,259,840, and having a net tonnage of 8,655 net tons and outfits valued at \$273,682; 6,642 boats, valued at \$1,175,017; fishing apparatus used by vessels and boats, valued at \$503,985; shore and accessory property to the value of \$2,669,135; and cash capital to the amount of \$656,200. The forms of fishing apparatus, arranged in order of value, are: Seines, 825, valued at \$201,390; gill nets, 2,092, valued at \$114,055; sponge apparatus to the value of \$71,145; trammel nets, 516, valued at \$44,910; tongs, 2,377, valued at \$15,506; otter trawls, 422, valued at \$13,755; lines to the value of \$13,534; stop nets, 136, valued at \$6,810; dredges, 198, valued at \$5,950; and other apparatus to the value of \$16,930. The use of the otter trawl, introduced in the shrimp fishery at Fernandina, Fla., about 1915, which is spreading rapidly along the Gulf coast, probably represents the most important change in apparatus since 1902.

The products of the fisheries in 1918 aggregated 130,923,583 pounds, valued at \$6,510,310. Of this quantity, the west coast of Florida produced 54,753,639 pounds, valued at \$3,420,363; Alabama, 5,609,219 pounds, valued at \$230,567; Mississippi, 20,592,089 pounds, valued at \$762,770; Louisiana, 24,953,876 pounds, valued at \$1,419,367; and Texas, 25,014,760 pounds, valued at \$677,243. The more important species taken in these States were black drum, 2,011,288 pounds, valued at \$49,140; catfish, 851,265 pounds, valued at \$40,072; croaker, 714,692 pounds, valued at \$43,446; groupers, 5,935,825 pounds, valued at \$235,406; menhaden, taken mostly in Texas, 14,392,920 pounds, valued at \$109,939; mullet, including roe, 28,641,364 pounds, valued at \$1,318,379; redfish, or red drum, 2,986,180 pounds, valued at \$175,109; red snapper, 9,429,802 pounds, valued at \$609,312; Spanish mackerel, 3,494,845 pounds, valued at \$251,197; squeteagues, or "sea trout," 4,960,738 pounds, valued at \$414,593; shrimp, green and dried, 27,142,999 pounds, valued at \$1,098,427; crabs, 821,244 pounds, valued at \$34,529; and oysters, 23,754,465 pounds, or 3,393,495 bushels, valued at \$1,106,725.

Compared with the Bureau's returns for 1902, there has been an increase in the products of the fisheries of 17,226,613 pounds, or 15.15 per cent, in the quantity and of \$3,016,114, or 86.31 per cent, in the value. Compared with the census returns for 1908, the increase amounts to 12,649,583 pounds, or 10.69 per cent, in quantity, and \$1,650,310, or 33.95 per cent, in value.

Following are comparative figures of some of the more important species taken in the fisheries of the Gulf States in 1902 and 1918 for which there have been long-established fisheries: Catch of mullet, in 1902, 27,233,322 pounds, in 1918, 28,641,364 pounds; pompano, including permit, in 1902, 548,344 pounds, in 1918, 271,555 pounds;

redfish, or red drum, in 1902, 2,607,881 pounds, in 1918, 2,986,280 pounds; salt-water sheepshead, in 1902, 1,974,815 pounds, in 1918, 1,558,514 pounds; snappers, in 1902, 13,995,660 pounds, in 1918, 9,547,901 pounds; squeteagues, or "sea trout," in 1902, 4,789,047 pounds, in 1918, 4,960,738 pounds; and oysters, in 1902, 34,115,935 pounds, in 1918, 23,754,465 pounds. The total for these species for 1902 was 85,265,004 pounds, and for 1918, 71,720,817 pounds, a decrease of 13,544,187 pounds. It will be noted that the falling off is confined largely to the oyster industry, the catch of other products changing but little. The falling off in the oyster catch was probably due chiefly to loss of men to war activities and to transportation difficulties.

In connection with the above comparisons and with the efforts of the Bureau and other agencies to increase the use of fishery products, particularly the neglected forms, the following comparative figures for these years are of interest: Catch of black drum, in 1902, 418,875 pounds, in 1918, 2,011,288 pounds; crevalles, including blue runner, in 1902, 100,105 pounds, in 1918, 507,005 pounds; cero and kingfish, in 1902, 152,700 pounds, in 1918, 465,860 pounds; groupers, in 1902, 1,112,258 pounds, in 1918, 5,935,825 pounds; menhaden, in 1902, 12,500 pounds, in 1918, 14,413,942 pounds; Spanish mackerel, in 1902, 1,583,891 pounds, in 1918, 3,494,845 pounds; and shrimp, in 1902, 12,366,915 pounds, in 1918, 27,142,999 pounds. The total for these species for 1902 was 15,747,244 pounds, and for 1918, 53,971,757 pounds, an increase of 38,224,513 pounds.

The following tables give the comparative statistics for various years from 1890 to 1918 for (1) five important fisheries which have been long established, and (2) five fisheries of less importance, showing their development and increase in recent years.

COMPARATIVE STATISTICS OF PRODUCTS OF CERTAIN FISHERIES OF THE GULF STATES, VARIOUS YEARS, 1890 TO 1918.

Year.	Mullet.	Redfish.	Snappers.	Squeteagues.	Oysters.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
1890.....	15,185,117	2,160,767	4,527,920	2,959,433	20,587,098
1897.....	15,351,886	2,257,914	6,221,909	3,091,103	16,657,138
1902.....	27,233,322	2,607,881	13,995,660	4,789,047	31,115,935
1908.....	18,853,000	1 3,028,000	12,819,000	4,090,000	44,403,000
1918.....	28,641,364	2,986,280	9,547,901	4,960,738	23,754,465

Year.	Black drum.	Crevalles. <sup>2</sup>	Groupers.	Spanish mackerel.	Shrimp.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
1890.....	136,053	430,499	427,781	700,459	7,451,350
1897.....	117,825	93,640	853,618	726,676	6,791,025
1902.....	418,875	100,105	1,112,258	1,583,891	12,366,910
1908.....		276,000	1,625,000	1,486,000	12,561,001
1918.....	2,011,288	507,005	5,935,825	3,494,845	27,142,999

<sup>1</sup> Probably includes some black drum, for which no separate figures are given.

<sup>2</sup> Includes blue runner.

The following tables contain statistics of the number of persons employed, the amount of capital invested, the quantity and value of the products of the fisheries of the Gulf States in 1918, and comparative statistics of the products of the fisheries for various years;

also a comparison of the extent of the fisheries in 1902 and 1918 and comparative statistics of the oyster industry for various years from 1880 to 1918:

## FISHERIES OF THE GULF STATES, 1918.

Items.	Florida (west coast only).		Alabama.		Mississippi.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing	623		85		601	
On vessels transporting	70		33		66	
In shore fisheries	3,600		365		673	
Shoresmen	868		300		1,527	
<b>Total</b>	<b>5,161</b>		<b>783</b>		<b>2,867</b>	
<b>INVESTMENT.</b>						
<b>Vessels fishing:</b>						
Gasoline	33	\$92,630	11	\$31,600	10	\$16,900
Tonnage	360		198		87	
Outfit		27,043		9,490		2,640
Sail	62	309,800	4	15,000	115	184,850
Tonnage	2,069		210		1,469	
Outfit		71,520		1,500		33,175
<b>Vessels transporting:</b>						
Gasoline	34	105,800	11	15,200	10	18,500
Tonnage	455		107		124	
Outfit		22,444		2,550		2,195
Sail	50	80,650	5	2,900	25	35,625
Tonnage	1,025		41		410	
Outfit				975		3,055
Boats, sail, row, etc	2,019	128,900	208	6,865	449	21,985
Boats, power	1,018	438,962	82	31,325	154	77,520
<b>Apparatus, vessel fisheries:</b>						
Seines	1	1,600			79	19,560
Trammel nets			8	600	8	800
Gill nets	6	120				
Lines		5,379		530		40
Other trawls	16	720	3	120	2	50
Tredges					171	5,100
Tongs	12	120	3	22	8	48
Sponge apparatus		210				
Other apparatus		2				
<b>Apparatus, shore fisheries:</b>						
Seines	163	61,175	3	600	19	4,710
Trammel nets	146	11,900	138	9,710	89	8,900
Gill nets	1,795	106,070	6	50		
Stop nets	136	6,840				
Lines		2,016		90		363
Other trawls	107	4,770	43	1,720	101	2,525
Tongs	284	2,616	224	1,680	365	1,825
Sponge apparatus		70,935				
Other apparatus		12,595		144		1,060
Shore and accessory property		619,987		178,170		786,109
Cash capital		219,350		23,900		206,050
<b>Total</b>		<b>2,404,245</b>		<b>334,741</b>		<b>1,433,585</b>
<b>PRODUCTS.</b>						
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Amberfish	11,100	\$413			900	\$45
Angelfish	20,825	798	6,900	\$278		
Barracuda	4,860	232				
Black drum	57,420	1,735	12,200	593	13,777	507
<b>Bluefish:</b>						
Fresh	246,168	17,411	8,750	275	2,566	190
Salted	12,240	915				
<b>Blue runner or hardtail:</b>						
Fresh	324,648	6,935	11,000	330		
Salted	65,490	2,734				
Bonito	50,955	2,015				
Catfish	51,427	3,126	40,663	902	16,108	682
Cero and kingfish	465,860	31,903				
Cowfish and "shellfish"	300	12				
Crevalle	105,927	3,800				
Croaker			93,500	3,252	40,600	1,917
<b>Elops, or ten-pounder:</b>						
Fresh	267,940	5,402				
Salted	9,883	334				
Flounders	37,381	2,089	38,607	2,300	37,865	3,030
Groupers	5,626,329	222,215	244,000	10,485	24,656	863
Grunts	87,349	3,618	2,700	59		

## FISHERIES OF THE GULF STATES, 1918—Continued.

Items.	Florida (west coast only).		Alabama.		Mississippi.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
PRODUCTS—continued.						
Hogfish.....	7,344	\$336				
Jewfish.....	69,844	2,704	2,000	\$75	8,800	\$288
King whiting.....	35,188	2,126	9,600	312	18,517	966
Leather jacket, or "turbot".....	7,756	357				
Menhaden:						
Fresh.....	263,530	6,779			11,050	80
Salted.....	21,022	669				
Moonfish.....	650	23				
Mullet:						
Fresh.....	22,569,736	973,129	1,693,520	67,540	1,229,948	46,801
Salted.....	2,453,930	177,974	6,000	275	209,498	15,632
Mullet roe:						
Fresh.....			10	3		
Salted.....	86,285	17,593			13,985	1,829
Permit.....	7,865	294				
Pigfish.....	6,596	250				
Pompano:						
Fresh.....	235,992	27,262	4,966	799	4,289	688
Salted.....	3,075	520				
Porpies.....	56,742	2,442			1,400	49
Porkfish.....	2,400	144				
Redfish or red drum:						
Fresh.....	937,490	38,068	23,250	1,127	115,685	8,135
Salted.....	7,321	366				
Sailors choice.....	21,132	809				
Scamp.....	300	10				
Sea bass.....	31,644	2,180	600	30	4,380	360
Sergeantfish or snook.....	73,745	2,568				
Sharks.....			600	17	400	12
Sheepshead.....	988,662	32,627	28,050	1,465	67,612	4,482
Snapper:						
Mangrove.....	103,999	4,359				
Mutton.....	14,100	564				
Red.....	7,230,168	455,640	798,400	49,075	98,232	6,877
Spanish mackerel:						
Fresh.....	3,408,701	244,026	4,284	277	11,531	966
Salted.....	27,200	1,505				
Spot.....	37,977	1,519	41,700	1,423	19,090	774
Squeteagues, or "sea trout":						
Fresh.....	1,630,686	145,534	138,630	6,611	356,070	28,874
Salted.....	31,625	3,772				
Sturgeon.....	4,915	620	2,938	125		
Sturgeon caviar and roe.....	12	12	60	45		
Tang.....	600	30				
Tarpon.....	1,800	180				
Yellowtail.....	31,735	1,537				
Shrimp: Green.....	3,250,468	81,408	1,265,612	38,828	9,147,445	319,595
Sea crawfish.....	322,015	16,064				
Crabs:						
Hard.....			95,850	3,292	216,025	5,607
Soft.....					9,000	2,275
Stone.....	24,500	2,600				
Terrapin.....	2,475	206	2,938	1,104	5,600	3,900
Turtles.....	65,370	4,429			337	20
Clams, hard.....	160,872	14,336				
Oysters:						
Market, public.....	2,602,446	121,049	651,126	22,690	7,503,209	259,414
Market, private.....	13,496	771	190,575	15,485	1,403,514	47,912
Seed, public.....			190,190	1,495		
Conch.....	2,000	100				
Sponges:						
Glove.....	2,022	245				
Grass.....	73,033	12,125				
Sheepswool.....	276,168	675,781				
Wire.....	9,324	2,817				
Yellow.....	91,641	34,187				
Total.....	54,753,639	3,420,363	5,609,219	230,567	20,592,089	762,770

## FISHERIES OF THE GULF STATES, 1918—Continued.

Items.	Louisiana.		Texas.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing.....	65		357		1,731	
On vessels transporting.....	128				297	
In shore fisheries.....	2,093		1,070		7,801	
Shoresmen.....	1,905		459		5,059	
Total.....	4,191		1,886		14,888	
<b>INVESTMENT.</b>						
Vessels fishing:						
Steam.....			2	\$50,000	2	\$850,000
Tonnage.....			217		217	
Outfit.....				14,800		14,800
Gasoline.....	16	\$36,700	30	50,085	100	227,915
Tonnage.....	137		357		1,139	
Outfit.....		6,875		17,050		63,098
Sail.....	14	16,570	43	85,190	238	611,410
Tonnage.....	151		761		4,663	
Outfit.....		1,200		42,745		150,140
Vessels transporting:						
Gasoline.....	52	98,440			107	237,940
Tonnage.....	351				1,067	
Outfit.....		13,605				40,794
Sail.....	6	13,400			86	132,575
Tonnage.....	93				1,569	
Outfit.....		820				4,850
Boats, sail, row, etc.....	1,072	39,040	790	68,020	4,538	264,810
Boats, power.....	690	311,100	160	51,300	2,104	910,207
Apparatus, vessel fisheries:						
Seines.....	14	3,920	33	9,745	127	34,825
Trammel nets.....			3	260	19	1,660
Gill nets.....			6	90	* 12	210
Lines.....		20		1,075		7,041
Otter trawls.....	1	25			22	915
Dredges.....	25	750	2	100	198	5,950
Tongs.....	27	207	93	476	143	873
Sponge apparatus.....						210
Other apparatus.....				1		3
Apparatus, shore fisheries:						
Seines.....	316	71,955	197	28,125	698	166,565
Trammel nets.....	62	5,475	62	7,175	497	43,250
Gill nets.....			279	7,725	2,080	113,845
Stop nets.....					136	6,810
Lines.....		1,102		2,889		6,490
Otter trawls.....	149	3,825			400	12,840
Tongs.....	1,031	6,459	330	2,053	2,234	14,633
Sponge apparatus.....						70,935
Other apparatus.....		1,579		1,548		16,927
Shore and accessory property.....		671,621		413,248		2,669,135
Cash capital.....		170,500		36,400		656,200
Total.....		1,475,188		890,100		6,537,859
<b>PRODUCTS.</b>						
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Amberfish.....					12,000	\$458
Angelfish.....	360	\$18	124	\$7	28,209	1,101
Barrauda.....					4,850	232
Black drum.....	54,455	1,911	1,873,436	44,394	2,011,288	49,140
Bluefish:						
Fresh.....			3,238	418	260,722	18,294
Salted.....					12,240	915
Blue runner or hardtail:						
Fresh.....					335,648	7,265
Salted.....					65,430	2,734
Bonito.....					50,955	2,045
Catfish.....	480,420	18,955	262,647	16,407	851,265	40,072
Cero and kingfish.....					465,860	31,903
Cowfish and "shellfish".....					300	12
Crevalle.....					105,927	3,800
Craker.....	383,035	28,862	197,557	9,415	714,692	43,446
Elops or ten-pounder:						
Fresh.....					267,940	5,402
Salted.....					9,883	334
Flounders.....	21,546	1,919	162,361	12,834	297,760	22,172
Groupers.....	20,000	1,000	20,840	843	5,935,825	235,406
Grunts.....			1,000	100	91,049	3,777

## FISHERIES OF THE GULF STATES, 1918—Continued.

Items.	Louisiana.		Texas.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
PRODUCTS—continued.						
Hogfish.....					7,344	\$336
Jewish.....			39,965	\$2,514	120,609	5,581
King whiting.....			35,974	3,328	99,279	6,732
Leather jacket or "turbot".....					7,756	357
Menhaden:						
Fresh.....			14,118,340	103,080	14,392,920	109,939
Salted.....					21,022	669
Moonfish.....					650	23
Mullet:						
Fresh.....	325,177	\$15,794	53,275	1,809	25,871,656	1,105,073
Salted.....					2,669,428	193,881
Mullet roe:						
Fresh.....					10	3
Salted.....					100,270	19,422
Permit.....					7,865	294
Pigfish.....					6,596	250
Pompano:						
Fresh.....	820	184	14,548	2,007	260,615	30,940
Salted.....					3,075	520
Porgies.....					58,142	2,491
Porkfish.....					2,400	144
Redfish or red drum:						
Fresh.....	565,899	46,945	1,336,535	80,468	2,978,859	174,743
Salted.....					7,321	366
Sailors choice.....					21,132	809
Scamp.....					300	10
Sea bass.....	15,100	1,216	6,625	350	58,349	4,136
Sea gar:						
Fresh.....			80,887	4,697	80,887	4,697
Dried.....	6,500	455			6,500	455
Sergeantfish or snook.....					73,745	2,568
Sharks.....	2,000	60			3,000	89
Sheepshead.....	276,528	22,044	197,662	12,642	1,558,514	73,260
Snapper:						
Mangrove.....					103,999	4,359
Mutton.....					14,100	564
Red.....	60,000	4,000	1,243,002	93,720	9,429,802	609,312
Spanish mackerel:						
Fresh.....	1,775	226	41,354	4,197	3,467,645	249,692
Salted.....					27,200	1,505
Spot.....	66,625	3,330			165,392	7,046
Squeteagues or "sea trout":						
Fresh.....	1,190,357	110,474	1,613,370	119,328	4,929,113	410,821
Salted.....					31,625	3,772
Sturgeon.....					7,853	745
Sturgeon caviar and roe.....					72	57
Tang.....					600	30
Tarpon.....					1,800	180
Yellowtail.....	2,200	110			33,935	1,647
Shrimp:						
Green.....	12,571,861	442,480	164,067	8,791	26,399,453	891,102
Dried.....	743,546	207,325			743,546	207,325
Sea crawfish.....					322,015	10,064
Squid.....	560	56			560	56
Crabs:						
Hard.....	281,925	9,908	193,244	10,672	1,787,044	29,479
Soft.....			700	175	2,970	2,450
Stone.....					24,500	2,600
Terrapin.....	23,006	7,578	2,850	990	37,269	13,778
Turtles.....	4,360	218	6,671	447	76,738	5,114
Clams, hard.....					3160,872	14,536
Oysters:						
Market, public.....	919,254	33,903	3,292,457	140,046	4,149,688	577,102
Market, private.....	6,936,167	460,396	52,031	3,564	8,595,783	528,128
Seed, public.....					190,190	1,495
Seed, private.....					2,000	100
Conch.....						
Sponges:						
Glove.....					2,022	245
Grass.....					73,033	12,125
Sheepswool.....					276,168	675,785
Wire.....					9,324	2,811
Yellow.....					91,641	34,187
Total.....	24,953,876	1,419,367	25,014,760	677,243	130,923,583	6,510,310

<sup>1</sup> 2,361,132 in number.<sup>2</sup> 29,100 in number.<sup>3</sup> 20,109 bushels.<sup>4</sup> 2,138,356 bushels.<sup>5</sup> 1,227,969 bushels.<sup>6</sup> 27,170 bushels.

COMPARATIVE STATISTICS OF PRODUCTS OF FISHERIES OF THE GULF STATES, VARIOUS YEARS, 1880 TO 1918.<sup>1</sup>

Years.	Florida (west coast only).		Alabama.		Mississippi.	
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
1880.....	8,376,335	\$564,819	3,541,500	\$119,275	788,500	\$22,540
1887.....					6,548,175	189,716
1888.....	19,597,084	802,282	1,633,589	75,560	7,883,010	231,712
1889.....	23,597,240	948,845	4,560,269	146,841	8,933,339	250,884
1890.....	27,418,562	1,064,139	4,776,968	154,871	8,131,401	245,699
1897.....	28,255,219	944,793	4,699,381	134,438	7,829,685	192,298
1902.....	48,120,019	1,462,166	9,351,447	266,682	23,426,965	553,220
1908.....	37,566,000	2,120,000	10,665,000	387,000	17,302,000	459,000
1918.....	54,753,639	3,420,363	5,609,219	230,567	20,592,089	762,770

Years.	Louisiana.		Texas.		Total.	
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
1880.....	6,996,000	\$392,610	3,858,875	\$128,300	23,561,210	\$1,227,544
1887.....	18,455,489	579,504	6,282,489	256,250		
1888.....	19,121,056	612,820	6,609,161	271,257	54,843,900	1,993,631
1889.....	20,947,239	621,048	7,357,800	297,258	65,395,887	2,264,876
1890.....	20,789,203	660,134	7,959,400	313,832	69,075,534	2,438,675
1897.....	17,401,788	713,587	7,174,550	286,610	65,360,623	2,271,726
1902.....	24,754,135	858,314	8,044,404	353,814	113,696,970	3,494,196
1908.....	42,302,000	1,448,000	10,439,000	446,000	118,274,000	4,860,000
1918.....	24,953,876	1,419,367	25,014,760	677,243	130,923,583	6,510,310

<sup>1</sup> The statistics for 1908 in this table are from data published by the Bureau of the Census.

COMPARATIVE STATISTICS OF EXTENT OF FISHERIES OF THE GULF STATES IN 1902 AND 1918.

States.	Persons engaged.				Capital invested.			
	1902		1918		1902		1918	
	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Per cent.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Per cent.</i>
Florida.....	6,416	5,161	-1,255	-19.56	\$1,945,320	\$2,404,245	\$458,925	23.59
Alabama.....	1,098	783	-315	-28.68	328,285	334,741	6,456	1.96
Mississippi.....	4,344	2,867	-1,477	-34.00	1,270,408	1,433,585	163,177	12.84
Louisiana.....	5,027	4,191	-836	-16.63	789,723	1,475,188	685,465	86.79
Texas.....	1,144	1,886	+742	+64.86	373,724	890,100	516,376	138.17
Total....	18,029	14,888	-3,141	-17.42	4,707,460	6,537,859	1,830,399	38.88

States.	Products.							
	Pounds.				Value.			
	1902		1918		1902		1918	
			<i>Increase or decrease.</i>				<i>Increase or decrease.</i>	
				<i>Per cent.</i>				<i>Per cent.</i>
Florida.....	48,120,019	54,753,639	+6,633,620	+13.78	\$1,462,166	\$3,420,363	+\$1,958,197	+133.92
Alabama.....	9,351,447	5,609,219	-3,742,228	-40.01	266,682	230,567	-36,115	-13.54
Mississippi.....	23,426,965	20,592,089	-2,834,876	-12.10	553,220	762,770	+209,550	+37.87
Louisiana.....	24,754,135	24,953,876	+199,741	+.80	858,314	1,419,367	+561,053	+65.36
Texas.....	8,044,404	25,014,760	+16,970,356	+210.95	353,814	677,243	+323,429	+91.41
Total	113,696,970	130,923,583	+17,226,613	+15.15	3,494,196	6,510,310	+3,016,114	+86.31

COMPARATIVE STATISTICS OF THE OYSTER INDUSTRY OF THE GULF STATES, VARIOUS YEARS, 1880 TO 1918.<sup>1</sup>

Years.	Florida.		Alabama.		Mississippi.	
	<i>Bushels.</i>	<i>Value.</i>	<i>Bushels.</i>	<i>Value.</i>	<i>Bushels.</i>	<i>Value.</i>
1880.....	58,600	\$10,950	104,500	\$14,950	25,000	\$10,000
1887.....	(2)		(2)		581,100	118,974
1888.....	181,445	44,448	76,125	32,174	767,205	157,463
1889.....	294,871	75,189	438,425	96,758	845,503	167,713
1890.....	371,081	93,692	481,070	107,812	806,478	166,672
1895.....	170,518	46,308	(2)		(2)	(2)
1897.....	179,715	50,258	255,053	60,207	629,713	110,964
1902.....	579,587	124,108	347,460	119,773	2,405,132	426,222
1908.....	538,000	187,000	590,400	172,940	1,067,600	295,340
1911.....	187,462	109,472	441,917	72,742	657,670	140,420
1918.....	373,706	121,820	147,413	39,670	3 1,272,389	307,326

Years.	Louisiana.		Texas.		Total.	
	<i>Bushels.</i>	<i>Value.</i>	<i>Bushels.</i>	<i>Value.</i>	<i>Bushels.</i>	<i>Value.</i>
1880.....	295,000	\$200,000	67,054	\$47,300	550,154	\$313,200
1887.....	678,227	215,163	256,199	88,275	(2)	(2)
1888.....	719,992	230,820	341,275	109,633	2,086,042	574,538
1889.....	835,520	269,057	360,600	111,400	2,774,919	720,117
1890.....	841,585	299,896	440,800	127,990	2,941,014	796,062
1895.....	(2)		(2)		(2)	(2)
1897.....	959,190	432,668	355,910	94,663	2,379,581	748,760
1902.....	1,198,413	493,227	343,113	100,359	4,873,705	1,263,689
1908.....	3,623,800	762,800	497,200	167,880	6,317,000	1,585,960
1911.....	4,504,402	1,022,723	434,690	131,609	6,226,141	1,476,966
1918.....	1,122,203	494,299	4 477,784	143,610	3,393,495	1,106,725

<sup>1</sup> The statistics for 1908 are from data published by the Bureau of the Census.

<sup>2</sup> Statistics not available.

<sup>3</sup> Includes 506,639 bushels, valued at \$118,328, from private beds in Louisiana and 188,514 bushels, valued at \$44,166, from public beds in Louisiana, all taken by Mississippi men.

<sup>4</sup> Includes 11,250 bushels, valued at \$3,000, taken from Louisiana public beds by Texas men.

## FISHERIES OF FLORIDA.

The statistics of the fisheries of Florida here presented are for the west or Gulf coast only. The fisheries of this part of Florida were more extensive than those of Alabama, Mississippi, and Louisiana combined. The number of persons employed was 5,161, of whom 623 were on vessels fishing, 70 on vessels transporting fishery products, 3,600 in the shore or boat fisheries, and 868 on shore in the wholesale fish establishments, in canneries, and other fishery industries.

The investment amounted to \$2,404,245, which includes 95 fishing vessels, valued at \$402,430, with a net tonnage of 2,429 tons, and outfits valued at \$98,563; 84 transporting vessels, valued at \$186,450, with a net tonnage of 1,480 tons, and outfits valued at \$22,444; 1,018 power boats, valued at \$438,962; 2,019 sail and other boats, valued at \$128,900; fishing apparatus employed on vessels to the value of \$8,151; fishing apparatus employed on boats to the value of \$279,008; shore and accessory property valued at \$619,987; and cash capital amounting to \$219,350.

The products amounted to 54,753,639 pounds, valued at \$3,420,363. This represents 41.82 per cent of the total quantity and 52.53 per cent of the total value of the products of the fisheries of the Gulf Coast States in 1918. Compared with 1902, there was an increase of 13.78 per cent in quantity and 133.92 per cent in value to the fishermen for the west coast of Florida. Among the products of special

importance were the following: Cero and kingfish, 465,860 pounds, valued at \$31,903; groupers, 5,626,329 pounds, valued at \$222,215; mullet, 25,109,951 pounds, valued at \$1,168,696; redfish or red drum, 937,490 pounds, valued at \$38,068; sheepshead, 988,662 pounds, valued at \$32,627; red snapper, 7,230,168 pounds, valued at \$455,640; Spanish mackerel, 3,435,901 pounds, valued at \$245,531; squeeteagues or "sea trout," 1,662,311 pounds, valued at \$149,306; shrimp, 3,250,468 pounds, valued at \$81,408; sea crawfish, 322,015 pounds, valued at \$16,064; oysters, 2,615,942 pounds, or 373,706 bushels, valued at \$121,820; and sponges, 452,188 pounds, valued at \$725,155.

## FISHERIES, BY COUNTIES.

The statistics as to the number of persons employed, investment, and products of the fisheries, by counties, of the west coast of Florida in 1918 are given in the following table:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES.

Items.	Bay County.		Calhoun County.		Citrus County.		De Soto County.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>								
On vessels fishing .....	20		2					
On vessels transporting .....							22	
In shore fisheries .....	335		20		130		274	
Shoresmen .....	26		6		17		72	
<b>Total.....</b>	<b>381</b>		<b>28</b>		<b>147</b>		<b>368</b>	
<b>INVESTMENT.</b>								
Vessels fishing:								
Gasoline .....	3	\$15,000	1	\$1,400				
Tonnage .....	63		7					
Outfit .....		7,323		50				
Vessels transporting:								
Gasoline .....							8	\$39,500
Tonnage .....							138	
Outfit .....								16,000
Boats, sail, row, etc .....	59	1,705	4	100	130	\$3,000	319	22,280
Boats, power .....	93	36,275	7	2,550	32	9,300	119	28,200
Apparatus, vessel fisheries:								
Lines .....		240						
Otter trawls .....			2	90				
Apparatus, shore fisheries:								
Seines .....	38	15,450	2	700			12	4,800
Gill nets .....	46	4,520	5	500	110	4,650	374	23,400
Stop nets .....							51	2,730
Lines .....		165				23		120
Tongs .....	13	104			8	56	4	36
Other apparatus .....		3						
Shore and accessory property .....		17,817		3,613		10,215		27,907
Cash capital .....		9,500		3,000		13,200		27,000
<b>Total.....</b>		<b>108,102</b>		<b>12,003</b>		<b>40,444</b>		<b>191,973</b>

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Bay County.		Calhoun County.		Citrus County.		De Soto County.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
PRODUCTS.								
Angelfish.....					310	\$14	5,256	\$186
Black drum.....	275	\$11			7,350	262	17,800	534
Bluefish:								
Fresh.....	72,243	4,305	23,468	\$1,367	490	40	37,908	3,411
Salted.....	12,240	915						
Blue runner or hardtail:							600	24
Fresh.....	165,315	2,482						
Salted.....	65,430	2,734						
Bonito.....	25,897	1,036						
Catfish.....							22,000	990
Cero and kingfish.....							3,011	240
Crevalle.....					590	25	41,287	1,391
Elops or ten-pounder:							4,280	134
Fresh.....	10,975	219						
Salted.....	3,810	152						
Flounders.....	2,504	126	1,150	56	200	8	3,112	95
Groupers.....	327,736	13,358					20,992	712
Grunts.....	870	35					2,373	84
Hogfish.....							2,286	84
Jewish.....	10,100	504					5,332	160
King whiting.....							2,481	215
Leather jacket or "turbot".....	3,206	160						
Menhaden:								
Fresh.....	13,325	299						
Salted.....	4,360	174						
Moonfish.....	350	14						
Mullet:								
Fresh.....	302,999	13,627	133,575	5,281	1,120,219	50,372	5,629,366	231,136
Salted.....	896,626	68,213	77,840	4,800				
Mullet roe, salted.....	28,207	5,125	3,500	670				
Permit.....							3,773	135
Pigfish.....	650	26	100	4			2,000	65
Pompano:								
Fresh.....	10,678	1,654	3,030	456	250	50	121,893	11,867
Salted.....	3,075	520						
Porgies.....	33,957	1,358						
Redfish or red drum:								
Fresh.....	8,109	329	1,747	65	41,091	1,940	243,533	8,760
Salted.....	7,321	306						
Sailors choice.....					300	12	9,831	313
Scamp.....	300	10						
Sergeantfish or snook.....							27,840	900
Sheepshead.....	7,856	317	2,800	111	37,940	1,777	300,142	10,250
Snapper:								
Mangrove.....	970	38			7,930	317	34,249	1,268
Red.....	564,139	38,225					12,000	840
Spanish mackerel:								
Fresh.....	483,734	38,366	19,094	1,201			278,355	19,664
Salted.....	25,050	1,333						
Spot.....	1,570	63	550	16			6,420	210
Squeteagues or "sea trout":								
Fresh.....	110,157	11,103	19,237	1,493	101,083	9,216	483,167	43,574
Salted.....	1,125	112			1,500	60	1,527	49
Yellowtail.....			15,741	354				
Shrimp.....					35,000	2,000	7,560	450
Oysters, market, public.....	11,760	630						
Total.....	3,216,919	207,939	302,732	15,874	1,354,253	66,093	7,330,374	337,741

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Escambia County.		Franklin County.		Hernando County.		Hillsborough County.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>								
On vessels fishing.....	339		75				57	
On vessels transporting.....							1	
In shore fisheries.....	152		254		8		63	
Shoresmen.....	79		533				10	
Total.....	570		892		8		131	
<b>INVESTMENT.</b>								
Vessels fishing:								
Gasoline.....	3	\$11,000	16	\$32,930			1	\$1,500
Tonnage.....	33		151				8	
Outfit.....		2,200		8,463				410
Sail.....	35	263,800	2	8,600			9	21,000
Tonnage.....	1,667		30				189	
Outfit.....		52,860		3,032				3,540
Vessels transporting:								
Gasoline.....							1	500
Tonnage.....							6	
Outfit.....								45
Boats, sail, row, etc.....	25	645	68	2,585	4	\$100	44	1,360
Boats, power.....	55	31,200	109	69,687	2	500	23	6,600
Apparatus, vessel fisheries:								
Lines.....		3,580		724				442
Other trawls.....				14				630
Tongs.....				12				120
Apparatus, shore fisheries:								
Seines.....	8	2,400	24	14,400			7	1,275
Gill nets.....	16	1,335	41	3,960	8	400	48	2,450
Trammel nets.....	29	2,900						
Stop nets.....							16	730
Other trawls.....	9	360	98	4,410				
Lines.....		150		198				20
Tongs.....	14	117	205	2,025				
Other apparatus.....				10				
Shore and accessory property.....		75,611		219,740		100		12,925
Cash capital.....		15,700		77,150				7,000
Total.....		463,858		448,664		1,100		59,827
<b>PRODUCTS.</b>								
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Amberfish.....	9,000	\$328	100	\$5				
Angelfish.....	1,700	74			50	\$2	485	\$20
Black drum.....	2,000	80	600	19			1,030	31
Bluefish, fresh.....	31,710	1,902	14,171	820			50	4
Blue runner or hardtail, fresh.....	52,130	1,302	7,500	200				
Bonito.....	22,000	880						
Catfish.....			27,156	2,040				
Crevalle.....	18,000	720			290	12	2,456	118
Elops or ten pounder, fresh.....	138,000	2,760	37,000	700				
Flounders.....	7,300	365	8,142	537			600	31
Groupers.....	3,120,294	123,214	743,022	32,855			192,181	7,783
Grunts.....			3,350	144				
Jewishfish.....	32,850	1,223	1,000	45				
King whiting.....	14,000	760	2,400	128			300	18
Leather jacket or "turbot".....	2,600	104						
Menhaden, fresh.....	194,270	4,856	5,758	120				
Mullet:								
Fresh.....	615,095	36,905	620,713	29,578	198,000	7,920	830,243	34,761
Salted.....			113,020	9,251				
Mullet roe, salted.....			5,025	1,134				
Pigfish.....	2,000	80					135	6
Pompano, fresh.....	9,703	1,455	877	111			2,070	306
Porgies.....	9,885	364	3,200	138				
Redfish or red drum, fresh.....	16,000	640	13,049	584	4,570	182	28,500	1,165
Sea bass.....			720	48				
Sergeantfish or snook.....							7,700	352
Sheepshead.....	17,000	680	1,250	56	1,950	78	4,300	175
Snapper:								
Mangrove.....					298	12	11,810	544
Red.....	4,661,984	286,434	655,716	43,409			353,247	22,868
Spanish mackerel, fresh.....	124,076	8,065	53,809	3,219				
Spot.....	7,500	330	1,250	29			1,800	86
Squeteagues or "sea trout," fresh.....	17,802	1,957	40,718	3,152	4,980	398	35,300	2,424
Sturgeon.....	2,250	270	1,215	60				
Yellowtail.....	8,000	320					2,200	112
Shrimp.....	28,526	1,711	3,206,201	79,343				
Turtles.....	5,000	250						
Oysters, market, public.....	53,536	3,824	2,387,021	107,112				
Total.....	9,224,211	481,853	7,953,983	314,837	210,138	8,604	1,474,427	70,804

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Jefferson County.		Lafayette County.		Lee County.		Levy County.	
	Number	Value.	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>								
On vessels transporting.....					19			
In shore fisheries.....	10		26		274		138	
Shoresmen.....					53		15	
Total.....	10		26		346		153	
<b>INVESTMENT.</b>								
Vessels transporting:								
Gasoline.....					9	\$37,000		
Tonnage.....					126			
Outfit.....						2,974		
Boats, sail, row, etc.....	10	\$200	26	\$545	240	7,520	109	\$3,060
Boats, power.....	5	500	1	900	114	18,850	43	19,350
Apparatus, shore fisheries:								
Seines.....					14	5,600		
Gill nets.....	10	400	26	1,040	304	15,800	101	3,815
Trammel nets.....							45	2,450
Lines.....						42		200
Tongs.....					3	12	10	70
Other apparatus.....								12,000
Shore and accessory property.....		200		250		108,502		17,267
Cash capital.....						12,000		6,000
Total.....		1,300		2,735		208,300		64,212
<b>PRODUCTS.</b>								
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....				5,909		\$202		\$90
Black drum.....				5,675		135		5,500
Bluefish, fresh.....				16,765		1,508		6,200
Blue runner or hardtail, fresh.....				300		12		57,530
Catfish.....				1,000		45		
Crevalle.....				27,849		906		3,200
Elops or ten pounder, fresh.....				1,000		30		
Flounders.....				1,258		39		2,150
Groupers.....				3,571		117		231,930
Grunts.....				798		27		17,250
Hogfish.....				833		27		
Jewfish.....				11,280		226		
King whiting.....				2,047		180		6,800
Menhaden, fresh.....								10,000
Mullet:								
Fresh.....	72,000	\$3,600	154,350	\$7,718	3,930,564	156,226	1,200,154	60,008
Salted.....	31,500	2,205	72,615	5,083			5,000	350
Mullet roe, salted.....	1,230	230	1,250	250			1,700	340
Permit.....					1,592	51		
Pigfish.....					311	10		
Pompano, fresh.....					32,557	3,689		2,365
Redfish or red drum, fresh.....	850	42	4,150	208	156,759	5,115	173,855	8,693
Sailors choice.....					2,273	73		500
Sea bass.....								29,924
Sergeantfish or snook.....					14,292	428		
Sheepshead.....	230	11	2,000	100	304,068	9,880	142,539	2,128
Snapper:								
Mangrove.....			900	45	7,879	258		1,600
Red.....								3,000
Spanish mackerel, fresh.....					57,971	4,056		23,950
Spot.....					7,667	250		5,000
Squeteagues or "sea trout," fresh.....	1,200	96	8,900	640	255,255	21,192		56,967
Sturgeon.....								1,450
Sturgeon caviar.....								12
Yellowtail.....					658	20		
Terrapin.....								2,475
Turtles.....								8,500
Clams, hard.....					159,272	13,936		
Oysters, market:								
Public.....					10,509	600		35,840
Private.....								13,496
Total.....	107,010	6,184	243,265	14,044	5,019,903	219,238	2,050,687	97,556

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Manatee County.		Monroe County.		Okaloosa County.		Pasco County.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED:</b>								
On vessels fishing.....			95					
On vessels transporting.....	2		10					
In shore fisheries.....	234		322		109		30	
Shoemen.....	26		31					
Total.....	262		458		109		30	
<b>INVESTMENT.</b>								
<b>Vessels fishing:</b>								
Gasoline.....			7	\$15,800				
Tonnage.....			74					
Outfit.....				3,500				
Sail.....			13	7,800				
Tonnage.....			121					
Outfit.....				9,360				
<b>Vessels transporting:</b>								
Gasoline.....	1	\$1,500	7	13,200				
Tonnage.....	8		104					
Outfit.....		150		1,250				
Boats, sail, row, etc.....	193	5,970	231	23,375	57	\$1,175	19	\$475
Boats, power.....	93	23,350	82	49,550	33	14,600	8	2,500
<b>Apparatus, vessel fisheries:</b>								
Seines.....			1	1,600				
Gill nets.....			6	120				
Dip nets.....			2	2				
Lines.....				43				
Sponge apparatus.....				210				
<b>Apparatus, shore fisheries:</b>								
Seines.....	32	9,025			7	2,800		
Gill nets.....	291	19,380	51	6,870	6	450	30	1,500
Trammel nets.....					25	2,500		
Stop nets.....	59	2,850						
Dip nets.....			20	20				
Lines.....		68		470				
Tongs.....	6	36						
Other apparatus.....		3		552				
Shore and accessory property.....		17,100		56,287		750		100
Cash capital.....		15,500		14,000				
Total.....		94,932		204,009		22,275		4,575
<b>PRODUCTS.</b>								
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Amberfish.....				2,000		\$80		
Angelfish.....	2,000	\$80		800		48		
Barracuda.....				4,860		232		
Black drum.....	14,890	357		500		10		250
Bluefish, fresh.....	10,184	951	16,614	1,540	12,958	778	550	\$44
Blue runner or hardtail, fresh.....			11,000	420	29,673	742		
Bonito.....				350	21	2,708	108	
Catfish.....						1,271	51	
Cero and kingfish.....	42,367	2,542	394,945	27,619				
Cowfish and "shellfish".....				300		12		
Crevalle.....	5,732	229	300	15	878	35	275	10
<b>Elops or ten-pounder:</b>								
Fresh.....	3,725	100			72,752	1,455		
Salted.....					6,073	182		
Flounders.....	2,930	118			600	30		
Groupers.....	24,280	961	54,144	2,889				
Grunts.....	7,287	219	30,300	1,698				
Hogfish.....	325	13	2,700	162				
Jewfish.....				9,000		540		
King whiting.....	3,945	234			3,215	183		
Leafy jacket or "turbot".....			1,500	75				
<b>Menhaden:</b>								
Fresh.....					40,177	1,004		
Salted.....					16,662	495		
Moonfish.....			300	9				
<b>Mullet:</b>								
Fresh.....	3,250,926	143,800	112,313	4,531	201,688	12,101	863,000	36,655
Salted.....					456,459	36,516		

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Manatee County.		Monroe County.		Okaloosa County.		Pasco County.	
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
PRODUCTS—continued.								
Permit.....	600	\$24	1,400	\$64				
Pigfish.....	1,400	59						
Pompano, fresh.....	28,343	3,665	545	191	8,909	\$1,336		
Porgies.....			9,700	582				
Porkfish.....			2,400	144				
Redfish or red drum, fresh.....	191,020	7,840	160	3	2,893	116	2,925	\$128
Sailors choice.....	1,028	41	2,200	110				
Sergeantfish or snook.....	15,913	578						
Sheepshead.....	133,850	5,566	300	12	3,701	148	875	35
Snapper:								
Mangrove.....	18,513	739	9,500	550			980	39
Mutton.....			14,100	564				
Red.....			9,000	630				
Spanish mackerel:								
Fresh.....	147,463	12,884	2,065,276	141,610	145,147	9,436		
Salted.....					2,150	172		
Spot.....	1,840	79			450	22		
Squeteagues or "sea trout":								
Fresh.....	182,338	17,686			51,450	5,163	8,635	691
Salted.....					30,500	3,660		
Tang.....			600	30				
Tarpon.....			1,800	180				
Yellowtail.....	5,350	226	12,500	750				
Sea crawfish.....			322,015	16,064				
Crabs, stone.....	2,000	100						
Turtles.....	1,600	400	49,250	3,398	1,920	96		
Clams, hard.....	875	75						
Oysters, market, public.....			2,000	100				
Conch.....								
Sponges:								
Glove.....			2,022	245				
Grass.....			28,963	3,311				
Sheepswool.....			55,281	73,012				
Yellow.....			21,477	5,809				
Total.....	4,100,724	199,166	3,752,355	290,170	1,092,514	73,840	877,240	37,602

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Pinellas County.		Santa Rosa County.		Taylor County.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing.....	55					
On vessels transporting.....	16					
In shore fisheries.....	942		32		45	
Total.....	993		32		45	
<b>INVESTMENT.</b>						
Vessels fishing:						
Gasoline.....	2	\$15,000				
Tonnage.....	24					
Outfit.....		5,067				
Sail.....	3	8,600				
Tonnage.....	62					
Outfit.....		2,728				
Vessels transporting:						
Gasoline.....	8	14,100				
Tonnage.....	73					
Outfit.....		2,025				
Sail.....	50	80,650				
Tonnage.....	1,025					
Boats, sail, row, etc.....	330	51,675	9	\$225	45	\$900
Boats, power.....	152	114,100	16	2,850	10	1,400
Apparatus, vessel fisheries, lines.....		350				
Apparatus, shore fisheries:						
Seines.....	12	3,400				
Gill nets.....	191	10,150			45	1,800
Trammel nets.....	16	1,600	9	1,000		
Stop nets.....	10	500				
Lines.....		590				
Tongs.....	1	5	20	155		
Sponge apparatus.....		70,935				
Other apparatus.....		8				
Shore and accessory property.....		46,128		150		1,150
Cash capital.....		16,500				300
Total.....		444,111		4,380		5,550
<b>PRODUCTS.</b>						
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....	2,365	\$75				
Bluefish, fresh.....	2,507	213				
Cero and kingfish.....	25,537	1,502				
Crevaille.....	4,020	131				
Elops or ten-pounder, fresh.....	208	4				
Flounders.....	3,535	158	300	\$30		
Groupers.....	908,179	32,049				
Grunts.....	25,121	894				
Hogfish.....	1,000	40	200	10		
Jewfish.....	282	6				
Leather jacket or "turbot".....	430	18				
Mullet:						
Fresh.....	2,598,083	103,546	120,000	6,000	285,850	\$13,227
Salted.....			9,000	720	133,120	9,317
Mullet roe, salted.....					5,975	925
Permit.....	500	20				
Pompano, fresh.....	14,772	2,216				
Redfish or red drum, fresh.....	27,959	1,293	1,000	50	8,150	410
Sailors choice.....	4,690	217				
Sea bass.....	1,090	40				
Sergeantfish or snook.....	8,000	310				
Sheepshead.....	18,456	860	1,800	90	1,955	98
Snapper:						
Mangrove.....	8,470	428				
Red.....	971,082	62,994				
Spanish mackerel, fresh.....	8,176	538				
Spot.....	1,580	69	1,500	75	350	17
Squeteagues or "sea trout," fresh.....	144,323	12,108	25,000	2,500	10,220	818
Crabs, stone.....	22,500	2,500				
Oysters, market, public.....	4,354	310	56,000	4,000		
Sponges:						
Grass.....	44,070	8,814				
Sheepswool.....	220,887	602,769				
Wire.....	9,324	2,817				
Yellow.....	70,164	28,378				
Total.....	5,151,504	865,317	214,800	13,475	445,620	24,812

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST  
OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Wakulla County.		Walton County.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing.....					623	
On vessels transporting.....					70	
In shore fisheries.....	169		3		3,600	
Shoresmen.....					868	
Total.....	169		3		5,161	
<b>INVESTMENT.</b>						
<b>Vessels fishing:</b>						
Gasoline.....					33	\$92,630
Tonnage.....					360	
Outfit.....						27,043
Sail.....					62	309,800
Tonnage.....					2,069	
Outfit.....						71,520
<b>Vessels transporting:</b>						
Gasoline.....					34	105,800
Tonnage.....					455	
Outfit.....						22,444
Sail.....					50	80,650
Tonnage.....					1,025	
Boats, sail, row, etc.....	96	\$1,980	1	\$25	2,019	128,900
Boats, power.....	20	6,500	1	200	1,018	438,962
<b>Apparatus, vessel fisheries:</b>						
Seines.....					1	1,600
Gill nets.....					6	120
Dip nets.....					2	2
Lines.....						5,379
Otter trawls.....					16	720
Tongs.....					12	120
Sponge apparatus.....						210
<b>Apparatus, shore fisheries:</b>						
Seines.....	6	1,200	1	125	163	61,175
Gill nets.....	92	3,650			1,795	106,070
Trammel nets.....	22	1,540			146	11,990
Stop nets.....					136	6,810
Otter trawls.....					107	4,770
Dip nets.....					20	20
Lines.....						2,046
Tongs.....					284	2,616
Sponge apparatus.....						70,935
Other apparatus.....						12,576
Shore and accessory property.....		4,175				619,987
Cash capital.....		2,500				219,350
Total.....		21,545		350		2,404,245
<b>PRODUCTS.</b>						
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Amberfish.....					11,100	\$413
Angelfish.....	150	\$7			20,825	798
Barracuda.....					4,860	232
Black drum.....	1,500	60			57,420	1,735
Bluefish.....						
Fresh.....	350	32			246,168	17,411
Salted.....					12,240	915
Blue runner or hardtail:						
Fresh.....	600	27			324,648	6,935
Salted.....					65,430	2,734
Bonito.....					50,955	2,045
Catfish.....					51,427	3,126
Cero and kingfish.....					465,860	31,903
Cowfish and "shellfish".....					300	12
Crevalle.....	1,050	48			105,927	3,800
Elops or ten-pounder:						
Fresh.....					267,940	5,402
Salted.....					9,883	334
Flounders.....	3,600	324			37,381	2,089
Groupers.....					5,626,329	222,215
Grunts.....					87,349	3,618
Hogfish.....					7,344	336
Jewfish.....					69,844	2,704
King whiting.....					35,188	2,126
Leather jacket or "turbot".....					7,756	357

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Wakulla County.		Walton County.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
PRODUCTS—continued.						
Menhaden:						
Fresh.....					263,530	\$6,779
Salted.....					21,022	669
Moonfish.....					650	23
Mullet:						
Fresh.....	321,598	\$15,597	9,000	\$540	22,569,736	973,129
Salted.....	658,750	41,519			2,453,930	177,974
Mullet roe, salted.....	39,398	8,919			86,285	17,593
Permit.....					7,865	294
Pigfish.....					6,596	250
Pompano:						
Fresh.....					235,992	27,262
Salted.....					3,075	520
Porgies.....					56,742	2,442
Porkfish.....					2,400	141
Redfish or red drum:						
Fresh.....	11,230	505			937,490	38,068
Salted.....					7,321	366
Sailors choice.....	400	18			21,132	809
Scamp.....					300	10
Sea bass.....					31,644	2,180
Sergeantfish or snook.....					73,745	2,568
Sheepshead.....	5,650	255			988,662	32,627
Snapper:						
Mangrove.....	900	41			103,999	4,359
Mutton.....					14,100	564
Red.....					7,230,168	455,640
Spanish mackerel:						
Fresh.....	750	68			3,408,701	244,026
Salted.....					27,200	1,565
Spot.....	500	23			37,977	1,519
Squeteagues or "sea trout":						
Fresh.....	71,854	6,466	3,000	300	1,630,686	145,534
Salted.....					31,625	3,772
Sturgeon.....					4,915	620
Sturgeon caviar.....					12	12
Tang.....					600	30
Tarpon.....					1,800	180
Yellowtail.....					31,735	1,537
Shrimp.....					3,250,468	81,408
Sea crawfish.....					322,015	16,064
Crabs, stone.....					124,500	2,600
Terrapin.....					2,475	206
Turtles.....	600	60	100	5	65,370	4,429
Clams, hard.....					2160,872	14,336
Oysters, market:						
Public.....					2,602,446	121,049
Private.....					413,496	771
Conch.....					2,000	100
Sponges:						
Glove.....					2,022	245
Grass.....					73,033	12,125
Sheepswool.....					276,168	675,781
Wire.....					9,324	2,817
Yellow.....					91,641	34,187
Total.....	1,118,880	73,969	12,100	845	54,753,639	3,420,363

<sup>1</sup> Represents 18,375 in number.<sup>2</sup> Represents 20,109 bushels.<sup>3</sup> Represents 371,778 bushels.<sup>4</sup> Represents 1,928 bushels.

## FISHERIES, BY APPARATUS.

In the vessel fisheries of western Florida, in which seven counties are represented, the forms of apparatus in use included haul seines, gill nets, otter trawls, lines, dip nets, sponge apparatus, and oyster tongs. The total yield from all forms of apparatus used on vessels was 10,941,646 pounds, valued at \$605,899. The catch with lines was 10,276,677 pounds, valued at \$546,040, of which 6,011,297 pounds, valued at \$373,124, were red snapper, and 4,162,160 pounds, valued at \$167,977, were groupers. The catch of shrimp with otter trawls, which are rapidly supplanting haul seines in this fishery, amounted to 343,219 pounds, with a value of \$8,701. Bluefish, mullet, pompano, and Spanish mackerel were taken with seines to the amount of 133,848 pounds, valued at \$9,374; oysters with tongs, 76,461 pounds, valued at \$4,822; sponges with sponge apparatus, 43,191 pounds, valued at \$32,952; turtles with gill nets, 40,250 pounds, valued at \$2,610, and sea crawfish with dip nets, 28,000 pounds, valued at \$1,400. Vessel operations with seines, gill nets, dip nets, and sponge apparatus were confined to Monroe County.

In the shore or boat fisheries, gill nets were the most productive form of apparatus, the catch amounting to 20,068,013 pounds, valued at \$1,009,315. Mullet was the principal species taken, amounting to 15,340,486 pounds, valued at \$674,949. The catch with seines was 8,535,648 pounds, valued at \$440,971. The mullet is again the principal species, other important species being Spanish mackerel, squeteagues, and sheephead.

As in 1902, the stop-net fisheries ranked third in quantity of products, the catch amounting to 3,632,397 pounds, valued at \$151,077. The principal species taken in this fishery were mullet, redfish, and sheephead. The catch with lines was 3,582,153 pounds, valued at \$195,560, the principal species taken by this apparatus being red snapper and groupers. The catch with otter trawls, confined to shrimp, was 2,907,249 pounds, valued at \$72,707; of oysters with tongs, 2,539,481 pounds, valued at \$116,998; with trammel nets made up of miscellaneous species, 1,499,550 pounds, valued at \$95,334; of sponges with sponge apparatus, 408,997 pounds, valued at \$692,203; of sea crawfish with dip nets, 283,915 pounds, valued at \$14,164; and with other minor apparatus, 354,590 pounds, valued at \$26,135. The total yield from all forms of apparatus used in the shore or boat fisheries was 43,811,993 pounds, valued at \$2,814,464.

The products of the vessel and shore or boat fisheries are shown separately by counties in the following tables:

YIELD OF VESSEL FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Bay.		Calhoun.		Escambia.		Franklin.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Otter trawls: Shrimp.....			15,741	\$354			327,478	\$8,347
<b>Lines:</b>								
Amberfish.....					9,000	\$328	100	5
Groupers.....	189,091	\$7,466			3,081,257	122,070	621,075	27,851
Grunts.....	870	35					3,350	144
Jewish.....	10,100	504			32,000	1,189	1,000	45
King whiting.....							300	12
Leatherjacket or "turbot".....					2,000	80		
Porgies.....	1,050	42			9,200	340	2,650	116
Scamp.....	300	10						
Sea bass.....							450	29
Snapper: Red.....	216,461	15,626			4,580,077	281,732	563,326	36,966
<b>Total.....</b>	<b>417,872</b>	<b>23,683</b>			<b>7,713,534</b>	<b>405,739</b>	<b>1,192,251</b>	<b>65,168</b>
<b>Tongs: Oysters, market, public.</b>							76,461	4,822
<b>Grand total.....</b>	<b>417,872</b>	<b>23,683</b>	<b>15,741</b>	<b>354</b>	<b>7,713,534</b>	<b>405,739</b>	<b>1,596,190</b>	<b>78,337</b>

Apparatus and species.	Hillsboro.		Monroe.		Pinellas.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Seines:</b>								
Bluefish.....			4,014	\$280			4,014	\$280
Mullet.....			7,313	511			7,313	511
Pompano.....			35	7			35	7
Spanish mackerel.....			122,486	8,576			122,486	8,576
<b>Total.....</b>			<b>133,848</b>	<b>9,374</b>			<b>133,848</b>	<b>9,374</b>
Gill nets: Turtles.....			40,250	2,610			40,250	2,610
Otter trawls: Shrimp.....							343,219	8,701
<b>Lines:</b>								
Amberfish.....							9,100	333
Cero and kingfish.....			28,750	1,976			28,750	1,976
Groupers.....	183,792	\$7,447	4,000	240	82,945	\$2,903	4,162,160	167,977
Grunts.....							4,220	179
Jewish.....							43,100	1,738
King whiting.....							300	12
Leatherjacket or "turbot".....							2,000	80
Porgies.....							12,900	498
Scamp.....							300	10
Sea bass.....							450	29
Snapper—								
Mutton.....			2,100	84			2,100	84
Red.....	344,797	22,277			306,636	16,523	6,011,297	373,124
<b>Total.....</b>	<b>528,589</b>	<b>29,724</b>	<b>34,850</b>	<b>2,300</b>	<b>389,581</b>	<b>19,426</b>	<b>10,276,677</b>	<b>546,040</b>
Dip nets: Sea crawfish.....			28,000	1,400			28,000	1,400
<b>Sponge apparatus:</b>								
Sponge—								
Glove.....			801	98			801	98
Grass.....			11,585	1,325			11,585	1,325
Sheepswool.....			22,213	29,205			22,213	29,205
Yellow.....			8,592	2,324			8,592	2,324
<b>Total.....</b>			<b>43,191</b>	<b>32,952</b>			<b>43,191</b>	<b>32,952</b>
<b>Tongs: Oysters, market, public.</b>							76,461	4,822
<b>Grand total.....</b>	<b>528,589</b>	<b>29,724</b>	<b>280,139</b>	<b>48,636</b>	<b>389,581</b>	<b>19,426</b>	<b>10,941,646</b>	<b>605,899</b>

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS,  
COUNTIES, AND SPECIES.

BY SEINES.

Species.	Bay.		Calhoun.		De Soto.		Escambia.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....							850	\$37
Black drum.....	275	\$11			5,200	\$156	1,000	40
Bluefish:								
Fresh.....	65,426	3,892	18,518	\$1,067				
Salted.....	12,240	915					31,710	1,902
Blue runner, or hardtail:								
Fresh.....	150,703	2,261					50,130	1,252
Salted.....	52,810	2,010						
Bonito.....	23,897	956					22,000	880
Catfish.....					17,600	792		
Crevalle.....					8,625	280	18,000	720
Elops, or ten-pounder:								
Fresh.....	10,225	204			1,000	33	138,000	2,760
Salted.....	3,810	152						
Flounders.....	679	34	1,000	50	3,112	95	4,000	200
Grunts.....					789	26		
Hogfish.....					1,250	40		
King whiting.....					612	54	12,000	640
Menhaden:								
Fresh.....	13,325	299					145,702	3,642
Salted.....	4,360	174						
Moonfish.....	350	14						
Mullet:								
Fresh.....	259,960	11,696	63,075	2,132	874,340	34,973	184,460	11,067
Salted.....	815,820	62,104	77,840	4,800				
Mullet roe, salted.....	25,468	4,642	3,500	670				
Permit.....					1,416	46		
Pigfish.....	650	26			1,250	40	1,000	40
Pompano:								
Fresh.....	10,628	1,645	2,080	313	20,466	2,255	5,000	750
Salted.....	3,075	520						
Redfish, or red drum:								
Fresh.....	7,439	301	1,747	65	21,551	700	8,000	320
Salted.....	7,321	366						
Sailors choice.....					6,000	180		
Sergeantfish, or snook.....					25,650	834		
Sheepshead.....	6,757	270	1,000	30	50,084	1,627	9,000	360
Snapper, mangrove.....	430	17			8,208	267		
Spanish mackerel:								
Fresh.....	392,718	31,136	8,494	511			36,798	2,392
Salted.....	23,650	1,263						
Spot.....	1,570	63	550	16	5,136	167	1,500	90
Squeteagues, or "sea trout".....	72,846	7,065	6,537	477	87,064	7,835	1,910	210
Yellowtail.....					1,125	33	8,000	320
Turtles.....							5,000	250
Total.....	1,966,432	132,036	184,341	10,131	1,140,478	50,433	684,060	27,872

## YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY SEINES—Continued.

Species.	Franklin.		Hillsborough.		Lee.		Manatee.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....					4,003	\$139	850	\$34
Black drum.....	600	\$19			4,625	115	13,890	312
Bluefish, fresh.....	14,171	820			7,602	684		
Blue runner, or hardtail, fresh.....	7,500	200			300	12		
Catfish.....					1,000	45		
Crevalle.....			200	\$10	17,972	584	1,932	77
Elops, or ten-pounder, fresh.....	37,000	700			500	15	1,800	48
Flounders.....			250	13	1,258	39	2,930	118
Groupers.....					3,571	117		
Grunts.....					798	27	2,500	75
Hogfish.....					833	27	325	13
King whiting.....	2,100	116			818	72	1,370	80
Menhaden, fresh.....	5,000	100						
Mullet:								
Fresh.....	355,469	15,996	85,350	4,289	1,423,513	56,945	524,648	23,182
Salted.....	20,000	2,000						
Mullet roe, salted.....	2,500	625						
Permit.....					1,402	45	360	14
Pigfish.....					311	10	900	39
Pompano, fresh.....	760	96			11,657	1,317	1,800	270
Redfish, or red drum, fresh.....	12,414	558	600	28	120,267	3,909	33,245	1,409
Sailors choice.....					2,273	73	778	31
Sergeantfish, or snook.....			3,150	172	14,292	428	15,913	578
Sheepshead.....	1,200	54	100	7	146,606	4,764	45,985	1,941
Snapper, mangrove.....			50	2	5,525	181	10,836	433
Spanish mackerel, fresh.....	53,809	3,219			8,753	612		
Spot.....	1,250	29	425	21	5,470	177	1,642	71
Squeteagues, or "sea trout".....	27,603	2,208	300	24	44,012	2,713	24,590	2,254
Yellowtail.....			2,200	112	565	17	5,350	226
Total.....	541,376	26,740	92,625	4,678	1,827,926	74,067	691,644	31,205

Species.	Okaloosa.		Pinellas.		Wakulla.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....			400	\$12		
Black drum.....	280	\$11				
Bluefish, fresh.....	12,858	772				
Blue runner, or hardtail, fresh.....	29,673	742				
Bonito.....	2,708	108				
Catfish.....	1,271	51				
Crevalle.....	478	19	400	16		
Elops, or ten-pounder:						
Fresh.....	72,752	1,455	208	4		
Salted.....	6,073	182				
Flounders.....	600	30	2,500	117		
Hogfish.....			500	20		
King whiting.....	3,215	183				
Menhaden:						
Fresh.....	40,177	1,004				
Salted.....	16,662	495				
Mullet:						
Fresh.....	145,438	8,726	365,329	15,439	75,000	\$4,500
Salted.....	99,959	7,996			295,000	20,650
Mullet roe, salted.....					33,300	7,500
Permit.....			250	10		
Pompano, fresh.....	8,909	1,336				
Redfish, or red drum, fresh.....	893	36	2,413	114		
Sailors choice.....			3,300	159		
Sergeantfish, or snook.....			8,000	310		
Sheepshead.....	1,901	76	1,556	75		
Snapper, mangrove.....			500	25		
Spanish mackerel, fresh.....	143,747	9,343				
Spot.....	450	22	1,380	59		
Squeteagues, or "sea trout".....	1,450	163	13,216	1,108		
Turtles.....	1,920	96				
Total.....	591,414	32,846	399,952	17,468	403,300	32,650

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918 BY APPARATUS,  
COUNTIES, AND SPECIES—Continued.

BY SEINES—Continued.

Species.	Walton.		Total.	
	Pounds.	Value.	Pounds.	Value.
Angelfish.....				\$222
Black drum.....			25,870	664
Bluefish:				
Fresh.....			150,285	9,137
Salted.....			12,240	915
Blue runner, or hardtail:				
Fresh.....			238,306	4,467
Salted.....			52,810	2,010
Bonito.....			48,605	1,944
Catfish.....			19,871	888
Crevalle.....			47,607	1,706
Elops, or ten-pounder:				
Fresh.....			261,485	5,219
Salted.....			9,883	334
Flounders.....			16,329	696
Groupers.....			3,571	117
Grunts.....			4,087	128
Hogfish.....			2,908	100
King whiting.....			20,115	1,145
Menhaden:				
Fresh.....			204,204	5,045
Salted.....			21,022	669
Moonfish.....			350	14
Mullet:				
Fresh.....	9,000	\$540	4,365,582	189,485
Salted.....			1,308,619	97,550
Mullet roe, salted.....			64,768	13,437
Permit.....			3,428	115
Pigfish.....			4,111	155
Pompano:				
Fresh.....			61,300	7,982
Salted.....			3,075	520
Redfish, or red drum:				
Fresh.....			208,569	7,440
Salted.....			7,321	366
Sailors choice.....			12,351	443
Sergeantfish, or snook.....			67,005	2,322
Sheepshead.....			264,189	9,204
Snapper, mangrove.....			25,549	925
Spanish mackerel:				
Fresh.....			644,319	47,213
Salted.....			23,650	1,263
Spot.....			19,373	715
Squeteagues, or "sea trout".....	3,000	300	282,528	25,357
Yellowtail.....			17,240	708
Turtles.....	100	5	7,020	351
Total.....	12,100	845	8,535,648	440,971

## BY TRAMMEL NETS.

Species.	Escambia County.		Levy County.		Okaloosa County.		Pinellas County.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....	850	\$37	200	\$10				
Black drum.....	1,000	40	5,500	225				
Bluefish.....			300	24	100	\$6		
Blue runner or hardtail.....	2,000	50						
Crevalle.....			1,050	52	400	16		
Flounders.....	3,300	165	825	66				
King whiting.....	2,000	120						
Mullet:								
Fresh.....	430,635	25,838			56,250	3,375		
Salted.....					318,000	25,440		
Permit.....							250	\$10
Pigfish.....	1,000	40						
Pompano.....	3,703	555	1,950	293			8,794	1,319
Redfish or red drum.....	8,000	320	121,916	6,095	2,000	80	1,555	70
Sailors choice.....			300	15				
Sheepshead.....	8,000	320	126,274	1,314	1,800	72	4,115	205
Snapper, mangrove.....			1,400	70				
Spanish mackerel.....	1,650	107			500	35		
Spot.....	6,000	240						
Squeteagues or "sea trout":								
Fresh.....	13,642	1,500			50,000	5,000	18,437	1,561
Salted.....					30,000	3,600		
Total.....	481,780	29,332	259,715	8,164	459,050	37,624	33,151	3,165

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS,  
COUNTIES, AND SPECIES—Continued.

BY TRAMMEL NETS—Continued.

Species.	Santa Rosa County.		Wakulla County.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....					1,050	\$47
Black drum.....			1,100	\$44	7,600	309
Bluefish.....					400	30
Blue runner or hardtail.....					2,000	50
Crevalle.....			250	12	1,700	80
Flounders.....	300	\$30	2,700	243	7,125	504
Hogfish.....	200	10			200	10
King whiting.....					2,000	120
Mullet:						
Fresh.....	120,000	6,000	33,800	1,521	640,685	36,734
Salted.....	9,000	720			327,000	26,160
Permit.....					250	10
Pigfish.....					1,000	40
Pompano.....					14,447	2,167
Redfish or red drum.....	1,000	50	7,120	320	141,591	6,935
Sailors choice.....			200	9	500	24
Sheepshead.....	1,800	90	2,725	123	144,714	2,124
Snapper, mangrove.....			500	23	1,900	93
Spanish mackerel.....			150	14	2,300	156
Spot.....	1,500	75			7,500	315
Squeteagues or "sea trout":						
Fresh.....	25,000	2,500	58,509	5,265	165,588	15,826
Salted.....					30,000	3,600
Total.....	158,800	9,475	107,054	7,574	1,499,550	95,334

## BY GILL NETS.

Species.	Bay.		Calhoun.		Citrus.		De Soto.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....					310	\$14		
Black drum.....					7,350	262		
Bluefish.....	6,817	\$413	4,950	\$300	490	40	37,908	\$3,411
Blue runner or hardtail:								
Fresh.....	14,612	221						
Salted.....	12,620	724					600	24
Bonito.....	2,000	80						
Catfish.....							4,400	198
Crevalle.....					590	25	10,321	348
Elops or ten-pounder.....	750	15					3,280	101
Flounders.....			150	6	200	8		
King whiting.....							1,352	116
Mullet:								
Fresh.....	43,039	1,931	70,500	3,149	1,120,219	50,372	3,136,602	129,892
Salted.....	80,806	6,109						
Mullet roe, salted.....	2,739	483						
Permit.....							1,182	44
Pigfish.....			100	4				
Pompano.....	50	9	950	143	250	50	101,221	9,585
Redfish or red drum.....	670	28			41,091	1,940	81,161	3,187
Sailors choice.....					300	12		
Sheepshead.....	1,099	47	1,800	81	36,590	1,724	83,407	2,959
Snapper, mangrove.....					7,930	317	14,533	551
Spanish mackerel:								
Fresh.....	91,016	7,230	11,500	690			278,355	19,664
Salted.....	1,400	70						
Spot.....							1,284	43
Squeteagues or "sea trout":								
Fresh.....	37,311	4,038	12,700	1,016	92,440	8,421	328,842	29,595
Salted.....	1,125	112						
Yellowtail.....							182	7
Total.....	296,054	21,510	102,650	5,389	1,307,760	63,185	4,084,630	199,725

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS,  
COUNTIES, AND SPECIES—Continued.

BY GILL NETS—Continued.

Species.	Escambia.		Franklin.		Hernando.		Hillsborough.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish					50	\$2	250	\$10
Bluefish							50	4
Catfish			2,850	\$112				
Crevalle					290	12	300	15
Flounders			4,142	217				
King whiting							300	18
Menhaden	48,508	\$1,214	758	20				
Mullet:								
Fresh			265,244	13,582	198,000	7,920	592,493	24,276
Salted			93,020	7,251				
Mullet roe, salted			2,525	509				
Pompano	1,000	150	117	15			2,070	306
Redfish or red drum			635	26	4,570	182	12,900	537
Sheepshead			50	2	1,950	78	2,250	92
Snapper, mangrove					298	12	7,560	345
Spanish mackerel, fresh	85,628	5,566						
Spot							875	43
Squeteagues or "sea trout," fresh	2,250	247	13,115	944	4,980	398	35,000	2,400
Sturgeon	2,250	270	1,215	60				
Total	139,696	7,447	383,671	22,738	210,138	8,604	654,048	28,046

Species.	Jefferson.		Lafayette.		Lee.		Levy.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish					1,906	\$63		
Black drum					1,050	20		
Bluefish					9,163	\$24	400	\$32
Crevalle					9,877	322		
Elops or ten-pounder					500	15		
Flounders							1,325	106
King whiting							1,229	108
Mullet:								
Fresh	72,000	\$3,600	154,350	\$7,718	2,507,051	99,281	1,200,154	60,008
Salted	31,500	2,205	72,615	5,083			5,000	350
Mullet roe, salted	1,230	230	1,250	250			1,700	340
Permit					190	6		
Pompano					20,900	2,372		
Redfish or red drum	850	42	4,150	208	36,492	1,206	42,389	2,120
Sailors choice							200	10
Sheepshead	230	11	2,000	100	157,462	5,116	14,265	714
Snapper, mangrove			900	45	2,354	77	200	10
Spanish mackerel, fresh					49,218	3,444	335	30
Spot					2,197	73		
Squeteagues or "sea trout," fresh	1,200	96	8,000	640	183,518	15,262	37,569	3,005
Sturgeon							1,450	290
Sturgeon, caviar							12	12
Yellowtail					93	3		
Turtles							8,500	620
Total	107,010	6,184	243,265	14,044	2,983,200	128,192	1,313,499	67,647

Species.	Manatee.		Monroe.		Okaloosa.		Pasco.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish	425	\$17						
Black drum			500	\$10				
Bluefish	10,184	951	12,000	1,200			550	\$44
Blue runner or hardtail, fresh			2,000	60				
Crevalle	1,200	48					275	10
Elops or ten-pounder	1,325	40						
King whiting	375	22						
Mullet:								
Fresh	1,810,423	79,811	105,000	4,020			863,000	36,655
Salted					38,500	\$3,080		
Permit	120	5						
Pompano	26,393	3,373	160	24				
Redfish or red drum	38,409	1,617	100	3			2,925	128
Sheepshead	28,813	1,252	300	12			875	35
Snapper, mangrove	6,147	245	1,000	40			980	39
Spanish mackerel:								
Fresh	147,463	12,884	1,938,890	135,722	900	58		
Salted					2,150	172		
Squeteagues or "sea trout":								
Fresh	135,068	13,270					8,635	691
Salted					500	60		
Turtles			9,000	788				
Total	2,206,345	113,537	2,068,950	141,879	42,050	3,370	877,240	37,602

## YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY GILL NETS—Continued.

Species.	Pinellas.		Taylor.		Wakulla.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....	365	\$15			150	\$7	3,456	\$128
Black drum.....					400	16	9,300	308
Bluefish.....	507	43			350	32	83,369	7,294
Blue runner or hardtail:								
Fresh.....					600	27	17,812	332
Salted.....							12,620	724
Bonito.....							2,000	80
Catfish.....							7,250	310
Crevalle.....	3,420	107			800	36	27,073	923
Elops or ten-pounder.....							5,855	171
Flounders.....	535	23			900	81	7,252	441
King whiting.....							3,256	264
Menhaden.....							49,326	1,234
Mullet:								
Fresh.....	1,863,935	71,511	285,850	\$13,227	212,798	9,576	14,500,658	616,529
Salted.....			133,120	9,317	303,750	20,869	818,311	54,264
Mullet roe, salted.....			5,975	925	6,098	1,419	21,517	4,156
Permit.....							1,492	55
Pigfish.....							100	4
Pompano.....	5,978	897					159,089	16,926
Redfish or red drum.....	13,000	614	8,150	410	4,110	185	291,602	12,433
Sailors choice.....					200	9	700	31
Sheepshead.....	3,447	160	1,955	98	2,925	132	339,418	12,613
Snapper, mangrove.....	5,400	265			400	18	47,702	1,904
Spanish mackerel:								
Fresh.....	8,176	538			600	54	2,612,081	185,880
Salted.....							3,550	242
Spot.....	200	10	350	17	500	23	5,406	209
Squeteagues or "sea trout":								
Fresh.....	88,698	7,476	10,220	818	13,345	1,201	1,012,891	89,518
Salted.....							1,625	172
Sturgeon.....							4,915	620
Sturgeon, caviar.....							12	12
Yellowtail.....							275	10
Turtles.....					600	60	18,100	1,468
Total.....	1,993,661	81,659	445,620	24,812	608,526	33,745	20,068,013	1,009,315

## BY STOP NETS.

Species.	De Soto.		Hillsborough.		Manatee.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....	5,256	\$186	235	\$10	725	\$29
Black drum.....	12,600	378	1,050	31	1,000	45
Crevalle.....	22,341	763	1,956	93	2,600	104
Elops or ten-pounder.....					600	12
Flounders.....			350	18		
Groupers.....	8,992	292				
Grunts.....	789	26			2,500	75
Hogfish.....	1,036	44				
King whiting.....	517	45			2,200	132
Mullet.....	1,618,424	66,271	152,400	6,196	915,855	40,807
Permit.....	1,175	45			120	5
Pigfish.....	750	25	135	6	500	20
Pompano.....	206	27			150	20
Redfish or red drum.....	119,701	4,029	15,000	600	119,366	4,814
Sailors choice.....	3,831	133			250	10
Sergeantfish or snook.....			4,550	180		
Sheepshead.....	150,151	5,004	1,950	76	59,052	2,373
Snapper, mangrove.....	1,618	55	4,200	197	1,530	61
Spot.....			500	22	198	8
Yellowtail.....	220	9				
Total.....	1,947,607	77,332	182,326	7,429	1,106,646	48,515

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS,  
COUNTIES, AND SPECIES—Continued.

## BY STOP NETS—Continued.

Species.	Pinellas.		Total.	
	Pounds.	Value.	Pounds.	Value.
Angelfish.....	1,600	\$48	7,816	\$273
Black drum.....	.....	.....	14,650	454
Crevalle.....	200	8	27,097	968
Elops or ten-pounder.....	.....	.....	600	12
Flourders.....	500	18	850	36
Groupers.....	.....	.....	8,992	292
Grunts.....	.....	.....	3,289	101
Hogfish.....	500	20	1,536	64
King whiting.....	.....	.....	2,717	177
Mullet.....	368,819	16,596	3,055,498	129,870
Permit.....	.....	.....	1,295	50
Pigfish.....	.....	.....	1,385	51
Pompano.....	.....	.....	356	47
Redfish or red drum.....	10,991	495	265,058	9,938
Sailors choice.....	1,300	53	5,381	201
Sergeantfish or snook.....	.....	.....	4,550	180
Sheepshead.....	9,338	420	220,491	7,873
Snapper, mangrove.....	2,570	138	9,918	451
Spot.....	.....	.....	698	30
Yellowtail.....	.....	.....	220	9
Total.....	395,818	17,801	3,632,397	151,077

## BY LINES.

Species.	Bay County.		Citrus County.		De Soto County.		Escambia County.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Cero and kingfish.....	.....	.....	.....	.....	3,011	\$240	.....	.....
Groupers.....	138,645	\$5,892	.....	.....	12,000	420	39,037	\$1,144
Grunts.....	.....	.....	.....	.....	795	32	.....	.....
Jewfish.....	.....	.....	.....	.....	5,332	160	850	34
Leather jacket or "turbot".....	3,206	160	.....	.....	.....	.....	600	24
Porgy.....	32,907	1,316	.....	.....	.....	.....	685	24
Redfish or red drum.....	.....	.....	.....	.....	21,120	844	.....	.....
Sergeantfish or snook.....	.....	.....	.....	.....	2,190	66	.....	.....
Sheepshead.....	.....	.....	1,350	\$53	16,500	660	.....	.....
Snapper:	.....	.....	.....	.....	.....	.....	.....	.....
Mangrove.....	540	21	.....	.....	9,890	395	.....	.....
Red.....	347,678	22,599	.....	.....	12,000	840	81,907	4,702
Squeteagues or "sea trout".....	.....	.....	8,643	795	67,261	6,144	.....	.....
Yellowtail.....	.....	.....	1,500	60	.....	.....	.....	.....
Total.....	522,976	29,988	11,493	908	150,099	9,801	123,079	5,928

Species.	Franklin County.		Hillsborough County.		Lee County.		Levy County.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Catfish.....	24,306	\$1,928	.....	.....	.....	.....	231,930	\$5,277
Groupers.....	121,947	5,004	8,389	\$336	.....	.....	17,250	517
Grunts.....	.....	.....	.....	.....	.....	.....	.....	.....
Jewfish.....	.....	.....	.....	.....	11,280	\$226	.....	.....
Porgy.....	550	22	.....	.....	.....	.....	.....	.....
Sea bass.....	270	19	.....	.....	.....	.....	29,824	2,087
Snapper, red.....	92,390	6,443	8,450	591	.....	.....	3,000	240
Squeteagues or "sea trout".....	.....	.....	.....	.....	27,725	2,217	.....	.....
Total.....	230,463	13,416	16,839	927	39,005	2,443	282,004	11,121

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY LINES—Continued.

Species.	Manatee County.		Monroe County.		Pinellas County.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Amberfish.....			2,000	\$80			2,000	\$80
Angelfish.....			800	48			800	48
Barracuda.....			1,500	30			1,500	30
Bluefish.....			600	60	2,000	\$170	2,600	230
Blue runner or hardtail.....			9,000	360			9,000	360
Bonito.....			350	21			350	21
Catfish.....							21,306	1,928
Cero and kingfish.....	42,367	\$2,542	366,195	25,643	25,537	1,502	437,110	29,927
Cowfish or "shellfish".....			300	12			300	12
Crovalle.....			300	15			300	15
Groupers.....	21,280	961	50,144	2,649	825,234	29,146	1,451,606	53,829
Grunts.....	2,287	69	20,300	1,698	25,121	894	75,753	3,200
Hogfish.....			2,700	162			2,700	162
Jewfish.....			9,000	540	282	6	26,744	966
Leather jacket or "turbot".....			1,500	75	450	18	5,756	277
Moonfish.....			300	9			300	9
Permit.....			1,400	64			1,400	64
Pompano.....			350	70			350	70
Porgy.....			9,700	582			43,842	1,944
Porkfish.....			2,400	144			2,400	144
Redfish or red drum.....							21,120	845
Sailors choice.....			2,200	110			2,200	110
Sea bass.....					1,000	40	31,094	2,146
Sergeantfish or snook.....							2,190	66
Sheepshead.....							17,850	713
Snapper:								
Mangrove.....			8,500	510			18,930	926
Mutton.....			12,000	480			12,000	480
Red.....			9,000	630	661,446	46,471	1,218,871	82,516
Spanish mackerel.....			3,900	312			3,900	312
Squeteagues or "sea trout".....	22,680	2,162			23,972	1,963	150,281	13,281
Tang.....			600	30			600	30
Yellowtail.....			12,500	750			14,000	810
Total.....	91,614	5,734	537,539	35,084	1,568,042	80,210	3,582,153	195,560

BY OTTER TRAWLS AND DIP NETS.

Apparatus and species.	Escambia.		Franklin.		Monroe.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Otter trawls: Shrimp.....	28,526	\$1,711	2,878,723	\$70,996			2,907,249	72,707
Dip nets: Sea crawfish.....					283,915	\$14,164	283,915	14,164
Total.....	28,526	1,711	2,878,723	70,996	283,915	14,164	3,191,164	86,871

BY TONGS.

Species.	Bay.		Citrus.		De Soto.		Escambia.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Oysters, market, public.....	11,760	\$630	35,000	\$2,000	7,560	\$450	53,536	\$3,824

Species.	Franklin.		Lee.		Levy.		Manatee.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Oysters, market:								
Public.....	2,310,560	\$102,290	10,500	\$600	35,840	\$2,048	875	\$75
Private.....					13,496	771		
Total.....	2,310,560	102,290	10,500	600	49,336	2,819	875	75

Species.	Pinellas.		Santa Rosa.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Oysters, market:						
Public.....	4,354	\$310	56,000	\$4,000	2,525,985	\$116,227
Private.....					13,496	771
Total.....	4,354	310	56,000	4,000	2,539,481	116,998

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS,  
COUNTIES, AND SPECIES—Continued.

## BY SPONGE APPARATUS.

Species.	Monroe County.		Pinellas County.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sponges:						
Glove.....	1,221	\$147			1,221	\$147
Grass.....	17,378	1,986	44,070	\$8,814	61,448	10,800
Sheepswool.....	33,068	43,807	220,887	602,769	253,955	646,576
Wire.....			9,324	2,817	9,324	2,817
Yellow.....	12,885	3,485	70,164	28,378	83,049	31,863
Total.....	64,552	49,425	344,445	642,778	408,997	692,203

## BY OTHER APPARATUS.

Species.	Bay County.		Franklin County.		Lee County.		Levy County.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....							1,600	\$80
Bluefish.....							5,500	440
Blue runner or hardtail.....							57,530	1,726
Crevalle.....							2,150	108
Flounders.....	1,825	\$92	4,000	\$320			6,800	408
King whiting.....							10,000	500
Menhaden.....							415	63
Pompano.....							9,550	478
Redfish or red drum.....							100	5
Sea bass.....							2,000	100
Sheepshead.....							23,615	1,889
Spanish mackerel.....							5,000	250
Spot.....							19,398	1,552
Squeteagues or "sea trout".....							2,475	206
Terrapin.....					159,272	\$13,936		
Clams, hard.....								
Total.....	1,825	92	4,000	320	159,272	13,936	146,133	7,805

Species.	Manatee County.		Monroe County.		Pinellas County.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....							1,600	\$80
Barracuda.....			3,360	\$202			3,360	202
Bluefish.....							5,500	440
Blue runner or hardtail.....							57,530	1,726
Crevalle.....							2,150	108
Flounders.....							5,825	412
King whiting.....							6,800	408
Menhaden.....							10,000	500
Pompano.....							415	63
Redfish or red drum.....							9,550	478
Sea bass.....							100	5
Sheepshead.....							2,000	100
Spanish mackerel.....							23,615	1,889
Spot.....							5,000	250
Squeteagues or "sea trout".....							19,398	1,552
Tarpon.....			1,800	180			1,800	180
Crabs, stone.....	2,000	\$100			22,500	\$2,500	24,500	2,600
Sea crawfish.....			10,100	500			10,100	500
Terrapin.....							2,475	206
Clams, hard.....	1,600	400					160,872	14,336
Conch.....			2,000	100			2,000	100
Total.....	3,600	500	17,260	982	22,500	2,500	354,590	26,135

## NOTES ON CERTAIN FISHERIES.

THE MULLET FISHERY.—In 1918 the catch of mullet constituted 45.85 per cent of the total quantity and 34.16 per cent of the total value of the fishery products of the west coast of Florida. Although the most important fishery of the Gulf States, its prosecution is confined largely to the west coast of Florida, 25,109,951 pounds, or 87.67 per cent of the total quantity, valued at \$1,168,696, or 88.64

per cent of the total value, being accredited to this State. Of the total catch on the west coast of Florida, 22,569,736 pounds, valued at \$973,129, was marketed fresh; 2,453,930 pounds, valued at \$177,974, salted; and 86,285 pounds, valued at \$17,593, represented salted roe. The apparatus of capture, arranged in the order of importance, as indicated by the catch taken, was as follows: Gill nets, 15,340,486 pounds; seines, 5,746,282 pounds; stop nets, 3,055,498 pounds; and trammel nets, 967,685 pounds.

The following table gives the yield of the mullet fishery of the west coast of Florida in various years from 1879 to 1918:

Items.	1879	1880	1889	1890	1895
Mullet:	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Fresh.....	1,058,083	.....	8,794,586	10,650,959	12,310,953
Salted.....	2,504,422	.....	2,728,785	2,968,254	5,714,134
Smoked.....	.....	.....	4,500	3,200	.....
Mullet roe:	.....	.....	.....	.....	.....
Fresh.....	.....	.....	.....	.....	2,150
Salted.....	6,662	.....	244,080	298,549	299,061
Total.....	3,569,167	2,028,250	11,771,951	13,920,962	18,326,298

Items.	1897	1902	<sup>a</sup> 1908	1918
Mullet:	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Fresh.....	11,639,615	22,223,685	<sup>b</sup> 16,008,000	22,569,736
Salted.....	2,503,703	2,589,190	.....	2,453,930
Smoked.....	.....	.....	.....	.....
Mullet roe:	.....	.....	.....	.....
Fresh.....	.....	.....	<sup>2</sup> 135,000	.....
Salted.....	143,999	134,887	.....	86,285
Total.....	14,287,317	24,947,762	16,143,000	25,109,951

<sup>a</sup> From data published by the Bureau of the Census.

<sup>b</sup> Includes fresh and salted.

**THE OYSTER FISHERY.**—The catch of oysters in 1918 on public grounds was 2,602,446 pounds, or 371,778 bushels, valued at \$121,049, and on private beds, 13,496 pounds, or 1,928 bushels, valued at \$771. The greater part of the catch, or 341,003 bushels, is credited to Franklin County. Compared with 1911, there has been an increase in the catch of 186,244 bushels, and in the value of \$12,348.

A summary of the catch of oysters on the west coast of Florida for various years from 1880 to 1918 is given in the table of comparative statistics of the oyster industry of the Gulf States on page 138.

**THE RED SNAPPER FISHERY.**—This fishery centers largely at Pensacola, the catch credited to Escambia County being 4,661,984 pounds, or 64.49 per cent of the catch of the west coast of Florida and 49.43 per cent of the catch of the entire Gulf coast. Of the other counties in which this fishery is of importance, Franklin is credited with 655,716 pounds, Bay with 564,139 pounds, and Hillsborough with 353,247 pounds. Compared with 1908, there has been a decrease in the catch of 428,832 pounds and an increase in the value of \$23,640. Those engaged in the industry experience considerable difficulty in supplying the demand for this highly prized fish, while the catch of groupers taken with the red snapper exceeds the demand. Reference has been made elsewhere in this report to the Bureau's efforts to increase the demand for groupers to supply markets for all that may be caught, as the future of the red-snapper fishery is, in a measure, dependent upon the accomplishment of this end.

The following summary shows the quantity and value of red snapper caught on the west coast of Florida in certain years:

Year.	Pounds.	Value.	Year.	Pounds.	Value.
1889.....	3,469,370	\$105,557	1902.....	8,074,066	\$237,428
1890.....	4,172,942	123,799	1903 <sup>1</sup> .....	7,659,000	432,000
1895.....	4,886,396	154,536	1918.....	7,230,168	455,640
1897.....	5,314,487	171,234			

<sup>1</sup> From data published by the Bureau of the Census.

**THE SPONGE FISHERY.**—The sponge fishery appears to be in a state of equilibrium between the natural supply and the catch, and if it can be so maintained no concern need be felt for the future. There is a superabundance of small sponges, attributed to the gradually returning productiveness of the beds in comparatively shallow water which was depleted by the spongers a number of years ago. If these small sponges were permitted an additional year's growth these formerly exhausted beds would yield a larger quantity, and, owing to the higher value of the larger sizes, a much greater financial return to the spongers.

As landed, sponges are strung on wire or twine in bunches,  $4\frac{5}{6}$  feet in length and of an average weight of 6 pounds to the bunch. The weights used in the statistical tables are those taken after the sponges have been beaten and dried before they are baled for shipment. For the different grades these are as follows: Glove, wire, and yellow, each  $1\frac{1}{2}$  pounds per bunch; grass and large wool,  $2\frac{1}{2}$  pounds per bunch; and small wool, 1 pound per bunch.

The following tables show the extent of the sponge fishery on the Gulf coast of Florida for certain years from 1880 to 1918, and the price per pound for certain years from 1895 to 1918:

Kinds.	1880		1889		1890		1895	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sheepswool.....							231,272	\$363,107
Yellow.....							29,509	11,798
Grass.....							21,387	5,464
Other.....							23,952	6,502
Total.....	207,000	\$200,750	316,559	\$381,087	366,772	\$438,682	306,120	386,871

Kinds.	1896		1897		1899		1900	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sheepswool.....	149,724	\$218,196	157,476	\$240,599	153,700	\$332,390	181,311	\$483,263
Yellow.....	23,655	9,318	32,362	13,082	55,800	16,205	74,466	44,045
Grass.....	41,617	11,508	128,622	29,188	76,900	14,319	143,112	33,263
Other.....	18,315	3,990	13,086	3,171	18,000	5,000	19,236	7,114
Total.....	236,311	273,012	331,546	286,040	304,400	367,914	418,125	567,685

Kinds.	1901		1902		1908 <sup>1</sup>		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sheepswool.....	202,673	\$422,561	133,518	\$297,727			276,168	\$675,781
Yellow.....	62,512	39,290	56,787	31,113			91,641	34,187
Grass.....	108,748	24,210	140,682	29,765			73,033	12,125
Other.....	21,627	6,679	15,902	5,817			11,346	3,062
Total.....	395,500	492,740	346,889	364,422	622,000	\$545,000	452,188	725,155

<sup>1</sup> From data published by the Bureau of Census.

Kinds.	Average price per pound.								
	1895	1896	1897	1899	1900	1901	1902	1908 <sup>1</sup>	1918
Sheepswool.....	\$1.57	\$1.66	\$1.53	\$2.16	\$2.67	\$2.08	\$2.23	.....	\$2.44
Yellow.....	.39	.40	.40	.29	.59	.63	.55	.....	.37
Grass.....	.26	.26	.23	.19	.23	.22	.21	.....	.16
Other.....	.27	.22	.24	.28	.37	.31	.37	.....	.27
Average.....	1.26	1.16	.86	1.21	1.36	1.25	1.05	\$0.87	1.60

<sup>1</sup> From data published by the Bureau of the Census.

#### WHOLESALE FISHERY TRADE AND CANNING INDUSTRY.

In 1918 there were 77 wholesale fishery establishments on the west coast of Florida handling fresh and salt fish and oysters, valued at \$250,877, with a cash capital amounting to \$157,650, in which 455 persons were engaged and \$240,030 paid in wages. There were in addition 7 establishments, valued at \$300,510, engaged in canning shrimp, oysters, etc., and the preparation of by-products. The number of persons employed in these establishments was 451, and the wages paid amounted to \$123,803.

The following table shows the extent of the canning industry, including by-products, on the west coast of Florida in 1918:

#### SHRIMP AND OYSTER CANNING INDUSTRY, INCLUDING BY-PRODUCTS, ON THE WEST COAST OF FLORIDA IN 1918.

Items.	Number.	Value.	Items.	Number.	Value.
Establishments.....	7	\$300,510	.PRODUCTS—continued.		
Cash capital.....		61,700		Oysters, canned:	
Persons engaged.....	451		No. 1—5 ounces..... cans..	391,056	\$40,972
Wages paid.....		123,803	Clams, fish, and turtles,		
			.....cans and bottles..	795,600	100,996
			By-products.....pounds..	446,746	15,611
.PRODUCTS.					
Shrimp, canned:					
No. 1—4½ ounces..... cans..	1,922,912	208,423			
No. 1—5 ounces.....do.....	973,008	101,355			
No. 1½—8½ ounces.....do....	83,280	15,420			
Total.....	2,979,200	325,198			

#### FISHERIES OF ALABAMA.

The coastal fisheries of Alabama are less extensive than those of the other Gulf States. In 1918 the number of persons employed in the fisheries of this State was 783, of whom 85 were on fishing vessels, 33 on vessels transporting fishery products, 365 in the shore and boat fisheries, and 300 shoresmen in the wholesale fish establishments and other fishery industries. Compared with 1902, there was a decrease of 315 men, or 28.68 per cent.

The total investment in the fisheries of the State amounted to \$334,741, as compared with \$328,285 in 1902, representing an increase of 1.96 per cent. The items making up this total included 15 fishing vessels, valued with their outfit at \$57,590; 16 transporting vessels, with a value, including outfit, of \$21,625; 290 power, sail, and row-boats, valued at \$38,190; fishing apparatus in the vessel and shore

fisheries valued at \$15,266; shore and accessory property with a value of \$178,170; and working cash capital amounting to \$23,900.

The products in 1918 amounted to 5,609,219 pounds, with a value of \$230,567. Compared with 1902 there was a decrease of 40.01 per cent in the quantity and 13.54 per cent in the value of the products. The species of chief importance were as follows: Mullet, 1,699,530 pounds, valued at \$67,818; shrimp, 1,265,612 pounds, valued at \$38,828; oysters, 1,031,891 pounds, or 147,413 bushels, valued at \$39,670; and red snapper, 798,400 pounds, valued at \$49,075.

## FISHERIES, BY COUNTIES.

The following table gives, by counties, the number of persons employed, investment, and products of the fisheries of Alabama in 1918:

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF ALABAMA IN 1918, BY COUNTIES.

Items.	Baldwin.		Mobile.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing.....	85		85		85	
On vessels transporting.....	15		18		33	
In shore fisheries.....	117		218		365	
Shoresmen.....	12		288		300	
Total.....	144		639		783	
<b>INVESTMENT.</b>						
Vessels fishing:						
Gasoline.....			11	\$31,600	11	\$31,600
Tonnage.....			198		198	
Outfit.....				9,490		9,490
Sail.....			4	15,000	4	15,000
Tonnage.....			210		210	
Outfit.....				1,500		1,500
Vessels transporting:						
Gasoline.....	6	\$10,800	5	4,400	11	15,200
Tonnage.....	60		47		107	
Outfit.....		1,375		1,175		2,550
Sail.....	1	1,000	4	1,900	5	2,900
Tonnage.....	10		31		41	
Outfit.....		223		750		957
Sail and row boats.....	90	2,060	118	4,805	208	6,885
Power boats.....	8	2,475	74	28,850	82	31,265
Apparatus, vessel fisheries:						
Trammel nets.....			8	600	8	600
Lines.....				530		530
Otter trawls.....			3	120	3	120
Tongs.....			3	22	3	22
Apparatus, shore fisheries:						
Seines.....	1	500	2	100	3	600
Trammel nets.....	91	6,700	47	3,010	138	9,710
Gill nets.....	6	50			6	50
Otter trawls.....			43	1,720	43	1,720
Lines.....		50		40		90
Tongs.....	24	180	200	1,500	224	1,680
Minor apparatus.....		47		97		144
Shore and accessory property.....		885		177,285		178,170
Cash capital.....		800		23,100		23,900
Total.....		27,147		307,594		334,741
<b>PRODUCTS.</b>						
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....	3,450	\$103	3,450	\$175	6,900	\$278
Black drum.....	8,775	417	3,425	176	12,200	593
Bluefish.....	5,000	155	3,750	120	8,750	275
Blue runner or hardtail.....	1,000	30	10,000	300	11,000	330
Catfish.....	25,760	573	14,903	329	40,663	902
Croaker.....	55,800	2,036	37,700	1,216	93,500	3,252
Flounders.....	14,357	1,146	24,250	1,154	38,607	2,300
Groupers.....			244,000	10,485	244,000	10,485
Grunts.....	600	7	2,100	42	2,700	59
Jewishfish.....			2,000	75	2,000	75
King whiting.....	5,000	144	4,600	168	9,600	312
Mullet:						
Fresh.....	859,500	33,390	834,020	34,150	1,693,520	67,540
Salted.....	5,000	225	1,000	50	6,000	275
Roe.....			10	3	10	3
Pompano.....	1,341	184	3,625	615	4,966	799

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF ALABAMA IN 1918, BY COUNTIES—Continued.

Items.	Baldwin.		Mobile.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
PRODUCTS—continued.						
Redfish or red drum	16,650	\$755	6,600	\$372	23,250	\$1,127
Sea bass			600	30	600	30
Sharks	400	12	200	5	600	17
Sheepshead	15,400	725	12,650	740	28,050	1,465
Snapper, red			798,400	49,075	798,400	49,075
Spanish mackerel	1,934	112	2,350	165	4,284	277
Spot	21,300	822	20,400	601	41,700	1,423
Sturgeon	2,938	125			2,938	125
Sturgeon roe	60	45			60	45
Squeteagues or "sea trout"	36,875	1,746	101,755	4,865	138,630	6,611
Shrimp			1,265,612	38,828	1,265,612	38,828
Crabs, hard	25,800	965	70,050	2,327	195,850	3,292
Terrapin	763	224	2,175	880	2,938	1,104
Oysters:						
Market, public	15,750	775	635,376	21,915	651,126	22,690
Market, private	27,300	1,900	163,275	13,585	190,575	15,485
Seed, public	180,600	1,290	9,590	205	190,190	1,495
Total	1,331,353	47,916	4,277,866	182,651	5,609,219	230,567

<sup>1</sup> Represents 287,550 in number.  
<sup>2</sup> Represents 93,018 bushels.

<sup>3</sup> Represents 27,225 bushels.  
<sup>4</sup> Represents 27,170 bushels.

FISHERIES, BY APPARATUS.

The total yield of all forms of apparatus employed in the vessel fisheries, which included lines, trammel nets, otter trawls, and tongs, amounted to 1,335,173 pounds, valued at \$75,963. The greater part of this total consisted of red snapper and groupers taken with lines.

In the shore or boat fisheries the catch amounted to 4,204,596 pounds, valued at \$152,300. The most productive form of apparatus was the trammel net, the catch consisting of various species, chiefly mullet, amounting to 1,704,540 pounds, valued at \$63,815. Otter trawls used in the capture of shrimp ranked second, with a catch of 1,224,574 pounds, valued at \$37,616, and tongs used for taking oysters third, with a catch of 1,000,391 pounds, or 142,913 bushels, valued at \$38,695.

The following tables give the products of the vessel and shore fisheries, by counties, in 1918:

YIELD OF VESSEL FISHERIES OF ALABAMA IN 1918, BY APPARATUS AND SPECIES.<sup>1</sup>

Species.	Lines.		Trammel nets.		Other trawls.		Tongs.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Angelfish			1,200	\$120					1,200	\$120
Black drum			300	15					300	15
Croaker			9,000	420					9,000	420
Flounders			250	20					250	20
Groupers	244,000	\$10,485							244,000	10,485
Jewfish	2,000	75							2,000	75
King whiting			1,500	75					1,500	75
Mullet:										
Fresh			180,020	10,800					180,020	10,800
Salted			1,000	50					1,000	50
Roe			10	3					10	3
Pompano			1,860	450					1,860	450
Redfish or red drum			600	60					600	60
Sharks			300	15					300	15
Sheepshead			1,300	128					1,300	128
Snapper, red	798,400	49,075							798,400	49,075
Spanish mackerel			600	65					600	65
Spot			2,100	105					2,100	105
Spot										
Squeteagues or "sea trout"			18,255	1,815					18,255	1,815
Shrimp					41,038	\$1,212			41,038	1,212
Oysters, market, public							31,500	\$975	31,500	975
Total	1,044,400	59,635	218,235	14,141	41,038	1,212	31,500	975	1,335,173	75,963

<sup>1</sup> Vessel fisheries were conducted only in Mobile County in 1918.

## YIELD OF SHORE FISHERIES OF ALABAMA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Baldwin.		Mobile.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Seines:</b>						
Angelfish.....	1,000	\$30	900	\$18	1,900	\$48
Black drum.....	5,000	225	375	20	5,375	245
Bluefish.....	5,000	155	3,750	120	8,750	275
Blue runner or hardtail.....	1,000	30	10,000	300	11,000	330
Catfish.....	3,330	60	2,000	28	5,330	88
Croaker.....	10,000	350	600	12	10,600	362
Flounders.....	750	35	625	32	1,375	67
Grunts.....	100	3	100	2	200	5
King whiting.....	1,000	28			1,000	28
Mullet.....			12,000	360	12,000	360
Pompano.....	1,000	145	1,125	90	2,125	235
Redfish or red drum.....	3,750	170	3,750	210	7,500	380
Sharks.....			200	5	200	5
Sheepshead.....	2,500	115	625	35	3,125	150
Spanish mackerel.....	1,250	70	1,500	84	2,750	154
Spot.....	2,500	95	300	6	2,800	101
Squeteagues or "sea trout".....	6,900	225	6,250	350	13,150	575
<b>Total.....</b>	<b>45,080</b>	<b>1,736</b>	<b>44,100</b>	<b>1,672</b>	<b>89,180</b>	<b>3,408</b>
<b>Trammel nets:</b>						
Angelfish.....	2,450	73	1,350	37	3,800	110
Black drum.....	3,775	192	2,750	141	6,525	333
Catfish.....	21,930	504	12,503	287	34,433	791
Croaker.....	45,800	1,686	28,000	780	73,800	2,466
Flounders.....	1,807	91	2,125	97	3,932	188
Grunts.....	500	14	2,000	40	2,500	54
King whiting.....	2,000	56	600	18	2,600	74
Mullet—						
Fresh.....	858,000	32,940	617,000	22,190	1,475,000	55,130
Salted.....	5,000	225			5,000	225
Pompano.....	341	39	700	75	1,041	114
Redfish or red drum.....	5,400	245	2,250	102	7,650	347
Sharks.....	400	12			400	12
Sheepshead.....	12,900	610	10,625	571	23,525	1,181
Spanish mackerel.....	684	42	250	16	934	58
Spot.....	18,800	727	18,000	490	36,800	1,217
Squeteagues or "sea trout".....	15,725	1,021	10,875	494	26,600	1,515
<b>Total.....</b>	<b>995,512</b>	<b>38,477</b>	<b>709,028</b>	<b>25,338</b>	<b>1,704,540</b>	<b>63,815</b>
<b>Gill nets:</b>						
Sturgeon.....	2,938	125			2,938	125
Sturgeon roe.....	60	45			60	45
<b>Total.....</b>	<b>2,998</b>	<b>170</b>			<b>2,998</b>	<b>170</b>
<b>Lines:</b>						
Catfish.....	500	9	400	14	900	23
King whiting.....	2,000	60	2,500	75	4,500	135
Redfish or red drum.....	7,500	340			7,500	340
Sea bass.....			600	30	600	30
Squeteagues or "sea trout".....	14,250	500	66,250	2,200	80,500	2,700
Crabs, hard.....	25,800	965	300	8	26,100	973
<b>Total.....</b>	<b>50,050</b>	<b>1,874</b>	<b>70,050</b>	<b>2,327</b>	<b>120,100</b>	<b>4,201</b>
<b>Otter trawls: Shrimp.....</b>			<b>1,224,574</b>	<b>37,616</b>	<b>1,224,574</b>	<b>37,616</b>
<b>Tongs:</b>						
Oysters—						
Market, public.....	15,750	775	603,876	20,940	619,626	21,715
Market, private.....	27,300	1,900	163,275	13,585	190,575	15,485
Seed, public.....	180,600	1,290	9,590	205	190,190	1,495
<b>Total.....</b>	<b>223,650</b>	<b>3,965</b>	<b>776,741</b>	<b>34,730</b>	<b>1,000,391</b>	<b>38,695</b>
<b>Minor apparatus:</b>						
Croakers.....			100	4	100	4
Flounders.....	11,800	1,020	21,250	1,005	33,050	2,025
Mullet.....	1,500	450	25,000	800	26,500	1,250
Sheepshead.....			100	6	100	6
Squeteagues or "sea trout".....			125	6	125	6
Terrapin.....	763	224	2,175	880	2,938	1,104
<b>Total.....</b>	<b>14,063</b>	<b>1,694</b>	<b>48,750</b>	<b>2,701</b>	<b>62,813</b>	<b>4,395</b>
<b>Grand total.....</b>	<b>1,331,353</b>	<b>47,916</b>	<b>2,873,243</b>	<b>104,384</b>	<b>4,204,596</b>	<b>152,300</b>

WHOLESALE FISHERY TRADE.

In 1918 there were 16 wholesale fish establishments, including 2 engaged in the canning of shrimp and oysters and 1 in crushing oyster shells, valued at \$175,850, with a cash or working capital of \$23,900, employing 296 persons, to whom wages were paid amounting to \$69,676. The output of canned shrimp and oysters and crushed oyster shells is included in the wholesale table for Mississippi.

FISHERIES OF MISSISSIPPI.

In 1918 Mississippi ranked fourth in quantity of fishery products taken and third in the value of the products. The number of persons engaged on fishing and transporting vessels was 667; in the shore fisheries, 673; and in the wholesale establishments, canneries, and other industries, 1,527, representing a total of 2,867.

The investment amounted to \$1,433,585, which includes 160 fishing and transporting vessels, valued at \$255,875, with a net tonnage of 2,090 tons and outfits valued at \$41,065; 603 power and other boats, valued at \$99,505; fishing apparatus employed on vessels to the value of \$25,598; fishing apparatus employed on boats to the value of \$19,383; shore and accessory property valued at \$786,109; and cash capital amounting to \$206,050.

The products amounted to 20,592,089 pounds, valued at \$762,770, a decrease of 2,834,876 pounds, or 12.10 per cent, in quantity and an increase of 209,550, or 37.87 per cent, in value as compared with 1902. The catch of shrimp was 9,147,445 pounds, with a value of \$319,595; oysters, 8,906,723 pounds, or 1,272,389 bushels, valued at \$307,326; mullet, 1,453,431 pounds, valued at \$64,262; sque-teagues or "sea trout," 356,070 pounds, valued at \$28,874; crabs, 225,025 pounds, valued at \$7,882; and redfish, 115,685 pounds, valued at \$8,135.

FISHERIES, BY COUNTIES.

The following table shows, by counties, the number of persons employed, the number and value of vessels, boats, and apparatus used, the amount of capital invested, and the quantity and value of the products of the fisheries in 1918:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MISSISSIPPI IN 1918, BY COUNTIES.

Items.	Hancock County.		Harrison County.		Jackson County.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>								
On vessels fishing.....	35		549		17		601	
On vessels transporting.....			66				66	
In shore fisheries.....	63		444		166		673	
Shoresmen.....	154		1,334		39		1,527	
<b>Total.....</b>	<b>252</b>		<b>2,393</b>		<b>222</b>		<b>2,867</b>	
<b>INVESTMENT.</b>								
<b>Vessels fishing:</b>								
Gasoline.....			6	\$9,300	4	\$7,600	10	\$16,900
Tonnage.....			53		34		87	
Outfit.....				1,565		1,075		2,640
Sail.....	7	\$11,400	108	173,450			115	184,850
Tonnage.....	113		1,356				1,469	
Outfit.....		2,400		30,775				33,175

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MISSISSIPPI  
IN 1918, BY COUNTIES—Continued.

Items.	Hancock County.		Harrison County.		Jackson County.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
INVESTMENT—continued.								
Vessels transporting:								
Gasoline.....			10	\$18,500			10	\$18,500
Tonnage.....			124				124	
Outfit.....				2,195				2,195
Sail.....			25	35,625			25	35,625
Tonnage.....			410				410	
Outfit.....				3,055				3,055
Sail and row boats.....	75	\$2,580	264	15,365	110	\$4,040	449	21,985
Power boats.....			115	58,870	39	18,650	154	77,520
Apparatus, vessel fisher- ies:								
Trammel nets.....			2	200	6	600	8	800
Seines.....	7	1,960	72	17,600			79	19,560
Other trawls.....			2	50			2	50
Lines.....						40		40
Dredges.....	10	300	161	4,800			171	5,100
Tongs.....			8	48			8	48
Apparatus, shore fisher- ies:								
Trammel nets.....	12	1,200	43	4,300	34	3,400	89	8,900
Seines.....			15	3,560	4	1,150	19	4,710
Other trawls.....			95	2,375	6	150	101	2,525
Lines.....		80		135		148		363
Tongs.....	45	225	231	1,155	89	445	365	1,825
Other apparatus.....		1		999		60		1,060
Shore and accessory property.....		118,168		642,911		25,030		786,109
Cash capital.....		23,100		166,150		16,800		206,050
Total.....		161,414		1,192,983		79,188		1,433,585
PRODUCTS.								
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....			600	\$30	300	\$15	900	\$45
Black drum.....	500	\$20	8,760	263	4,517	224	13,777	507
Bluefish.....			500	40	2,066	150	2,566	190
Catfish.....			9,220	337	6,888	345	16,108	682
Croaker.....	5,200	312	23,000	1,135	12,400	470	40,600	1,917
Flounders.....	2,790	279	19,780	1,581	15,295	1,170	37,865	3,030
Groupers.....					24,656	863	24,656	863
Jewfish.....					8,800	288	8,800	288
King whiting.....	4,000	240	9,100	455	5,417	271	18,517	966
Menhaden.....			11,050	80			11,050	80
Mullet:								
Fresh.....	140,000	8,400	199,835	6,596	890,113	31,805	1,229,948	46,801
Salted.....			112,649	7,885	96,849	7,747	209,498	15,632
Mullet roe, salted.....			9,430	964	4,555	865	13,985	1,829
Pompano.....			480	79	3,809	609	4,289	688
Porgies.....					1,400	49	1,400	49
Redfish or red drum.....	12,000	960	37,636	2,676	66,049	4,499	115,685	8,135
Sea bass.....	250	30	2,560	209	1,570	121	4,380	360
Sharks.....			400	12			400	12
Sheepshead.....	7,250	725	9,665	705	50,694	3,052	67,612	4,482
Snapper, red.....					98,232	6,877	98,232	6,877
Spanish mackerel.....	1,250	125	9,037	741	1,244	100	11,531	966
Spot.....	4,000	200	11,945	431	3,145	143	19,090	774
Squeteagues or "sea trout".....	132,000	13,240	104,748	7,405	119,322	8,229	356,070	28,874
Shrimp.....	644,800	22,668	8,404,000	293,295	98,645	3,732	9,147,445	319,595
Crabs:								
Hard.....	25,000	1,500	151,025	3,307	40,000	800	1216,025	5,607
Soft.....			9,000	2,275			29,000	2,275
Terrapin.....	600	450	3,000	1,950	2,000	1,500	5,600	3,900
Turtles.....			337	20			337	20
Oysters, market:								
Public, from Missis- sippi beds.....	751,653	26,168	3,116,379	110,959	88,704	3,959	3,956,736	141,086
Public, from Louisi- ana beds.....			3,546,473	118,328			3,546,473	118,328
Private, from Missis- sippi beds.....			63,532	2,836	20,384	910	83,916	3,746
Private, from Louisi- ana beds.....	311,682	10,389	1,007,916	33,777			1,319,598	44,166
Total.....	2,042,975	85,606	16,882,060	598,371	1,667,054	78,793	20,592,089	762,770

<sup>1</sup> Represents 648,075 in number.<sup>2</sup> Represents 27,000 in number.<sup>3</sup> Represents 565,248 bushels.<sup>4</sup> Represents 506,639 bushels.<sup>5</sup> Represents 11,988 bushels.<sup>6</sup> Represents 188,514 bushels.

FISHERIES, BY APPARATUS.

The catch of all forms of apparatus employed in the vessel fisheries in 1918 amounted to 13,613,605 pounds, valued at \$464,404. The catch of oysters with dredges and tongs amounted to 7,633,983 pounds, or 1,090,569 bushels, valued at \$251,011; shrimp, with seines and otter trawls, 5,677,200 pounds, valued at \$198,402; various species with trammel nets, 184,407 pounds, with a value of \$7,879; and red snapper, groupers, jewfish, and porgies, with lines, 118,015 pounds, valued at \$7,112.

The products of the shore or boat fisheries amounted to 6,978,484 pounds, valued at \$298,366. The largest quantity was taken with otter trawls, recently introduced in the fishery for shrimp, amounting to 3,248,070 pounds, valued at \$113,309. The catch of oysters with tongs, which ranked second, was 1,272,740 pounds, or 181,820 bushels, valued at \$56,315. Various species were taken with trammel nets, amounting to 1,108,094 pounds, valued at \$60,876; with seines, amounting to 921,199 pounds, valued at \$44,000; with lines, 345,943 pounds, valued at \$15,353; and with minor appliances, amounting to 82,438 pounds, valued at \$8,513.

The following tables give the products of the vessel and shore fisheries in 1918, by counties, apparatus, and species:

YIELD OF VESSEL FISHERIES OF MISSISSIPPI IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Hancock County.		Harrison County.		Jackson County.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Trammel nets:</b>								
Angelfish.....					100	\$5	100	\$5
Black drum.....			560	\$17	571	27	1,131	44
Bluefish.....					200	14	200	14
Croaker.....			500	25	1,950	67	2,450	92
Flounders.....			150	12	2,500	175	2,650	187
King whiting.....					976	49	976	49
Mullet.....			14,500	450	125,552	4,294	140,052	4,744
Redfish or red drum.....			8,000	560	8,318	582	16,318	1,142
Sea bass.....					200	16	200	16
Sheepshead.....					5,277	370	5,277	370
Spot.....					1,000	36	1,000	36
Squeteagues or "sea trout" <sup>77</sup> .....			3,500	350	10,553	830	14,053	1,180
Total.....			27,210	1,414	157,197	6,465	184,407	7,879
<b>Seines: Shrimp.....</b>	644,800	\$22,568	4,982,400	174,084			5,627,200	196,652
<b>Lines:</b>								
Groupers.....					23,063	807	23,063	807
Jewfish.....					8,000	260	8,000	260
Porgies.....					1,200	42	1,200	42
Snapper, red.....					85,752	6,003	85,752	6,003
Total.....					118,015	7,112	118,015	7,112
<b>Otter trawls: Shrimp.....</b>			50,000	1,750			50,000	1,750
<b>Dredges:</b>								
Oysters, market—								
Public, from Mississippi beds.....	653,121	21,770	2,339,841	76,744			2,992,962	98,514
Public, from Louisiana beds.....			3,261,573	105,891			3,261,573	105,891
Private, from Louisiana beds.....	311,682	10,389	1,001,616	33,402			1,313,298	43,791
Total.....	964,803	32,159	6,603,030	216,037			7,567,833	248,196
<b>Tongs:</b>								
Oysters, market—								
Public, from Mississippi beds.....			3,150	190			3,150	190
Public, from Louisiana beds.....			56,700	2,250			56,700	2,250
Private, from Louisiana beds.....			6,300	375			6,300	375
Total.....			66,150	2,815			66,150	2,815
<b>Grand total.....</b>	1,609,603	\$4,727	11,728,790	396,100	275,212	13,577	13,613,605	464,404

## YIELD OF SHORE FISHERIES OF MISSISSIPPI IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Hancock County.		Harrison County.		Jackson County.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Trammel nets:</b>								
Angelfish.....			300	\$15	100	\$5	400	\$20
Black drum.....	500	\$20	8,000	240	2,798	140	11,298	400
Bluefish.....			500	40	300	24	800	64
Catfish.....			5,220	182	200	10	5,420	192
Croaker.....	4,000	240	5,700	285	8,350	298	18,050	823
Flounders.....	540	54	1,700	136	1,795	131	4,035	321
King whiting.....			3,300	165	2,815	142	6,115	307
Mullet—								
Fresh.....	140,000	8,400	125,060	4,007	411,674	15,135	676,734	27,542
Salted.....			10,000	700			10,000	700
Pompano.....			350	58	90	14	440	72
Redfish or red drum.....	12,000	960	24,350	1,704	45,182	3,156	81,532	5,820
Sea bass.....			1,010	75	380	26	1,390	101
Sheepshead.....	6,000	600	6,300	441	41,790	2,459	54,090	3,500
Spanish mackerel.....			2,990	299	100	8	3,090	307
Spot.....	4,000	200	5,700	203	2,145	107	11,845	510
Squeteagues or "sea trout".....	88,000	8,800	59,616	4,328	72,639	5,119	220,255	18,247
Terrapin.....	600	450			2,000	1,500	2,600	1,950
<b>Total.....</b>	<b>255,640</b>	<b>19,724</b>	<b>260,096</b>	<b>12,878</b>	<b>592,358</b>	<b>28,274</b>	<b>1,108,094</b>	<b>60,876</b>
<b>Seines:</b>								
Angelfish.....			200	10	100	5	300	15
Black drum.....			100	3	1,148	57	1,248	60
Bluefish.....					1,566	112	1,566	112
Catfish.....			3,000	105	810	41	3,810	146
Croaker.....			8,500	425	300	15	8,800	440
Flounders.....			1,350	108	1,400	102	2,750	210
King whiting.....			1,400	70	1,626	80	3,026	150
Menhaden.....			10,000	60			10,000	60
Mullet—								
Fresh.....			42,275	1,419	348,887	12,216	391,162	13,635
Salted.....			102,649	7,185	96,849	7,747	199,498	14,932
Mullet roe, salted.....			9,430	964	4,555	865	13,985	1,829
Pompano.....			50	8	3,669	587	3,719	595
Redfish or red drum.....			2,486	188	11,749	713	14,235	901
Sea bass.....			150	10	90	7	240	17
Sheepshead.....			1,568	120	3,427	207	4,995	327
Spanish mackerel.....			5,430	395	1,044	84	6,474	479
Spot.....			5,145	173			5,145	173
Squeteagues or "sea trout".....			11,043	765	19,203	1,379	30,246	2,144
Shrimp.....			220,000	7,775			220,000	7,775
<b>Total.....</b>			<b>424,776</b>	<b>19,783</b>	<b>496,423</b>	<b>24,217</b>	<b>921,199</b>	<b>44,000</b>
<b>Lines:</b>								
Catfish.....			800	40	5,878	294	6,678	324
Croaker.....	1,200	72	6,800	335	1,800	90	9,800	497
Flounders.....			1,260	116	600	42	1,860	158
Groupers.....					1,593	56	1,593	56
Jewfish.....					800	28	800	28
King whiting.....	4,000	240	3,800	190			7,800	430
Pompano.....					50	8	50	8
Porgy.....					200	7	200	7
Redfish or red drum.....			300	24	800	48	1,100	72
Sea bass.....	250	30	900	84	900	72	2,050	186
Sheepshead.....	1,250	125	850	68	200	16	2,300	209
Snapper, red.....					12,480	874	12,480	874
Spanish mackerel.....	1,250	125	130	13	100	8	1,480	146
Spot.....			600	30			600	30
Squeteagues or "sea trout".....	44,000	4,400	20,200	1,370	16,927	901	81,127	6,711
Crabs, hard.....	25,000	1,500	151,025	3,307	40,000	800	216,025	5,607
<b>Total.....</b>	<b>76,950</b>	<b>6,532</b>	<b>186,665</b>	<b>5,577</b>	<b>82,328</b>	<b>3,244</b>	<b>345,943</b>	<b>15,353</b>
<b>Otter trawls: Shrimp.....</b>			<b>3,151,600</b>	<b>109,686</b>	<b>96,470</b>	<b>3,623</b>	<b>3,248,070</b>	<b>113,309</b>
<b>Other apparatus:</b>								
Angelfish.....			100	5			100	5
Black drum.....			100	3			100	3
Catfish.....			200	10			200	10
Croaker.....			1,500	65			1,500	65
Flounders.....	2,250	225	15,320	1,209	9,000	720	26,570	2,151
King whiting.....			600	30			600	30
Menhaden.....			1,050	20			1,050	20
Mullet.....			18,000	720	4,000	160	22,000	880
Pompano.....			80	13			80	13
Redfish or red drum.....			2,500	200			2,500	200
Sea bass.....			500	40			500	40
Sharks.....			400	12			400	12

## YIELD OF SHORE FISHERIES OF MISSISSIPPI IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Hancock County.		Harrison County.		Jackson County.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Other apparatus—Continued.								
Sheepshead			950	\$76			950	\$76
Spanish mackerel			487	34			487	34
Spot			500	25			500	25
Squeteagues or "sea trout"			10,389	592			10,389	592
Shrimp					2,175	\$109	2,175	109
Crabs, soft			9,000	2,275			9,000	2,275
Terrapin			3,000	1,950			3,000	1,950
Turtles			337	20			337	20
Total	2,250	\$225	65,013	7,299	15,175	989	82,438	8,513
Tongs:								
Oysters, market—								
Public, from Mississippi beds	98,532	4,398	773,388	34,025	88,704	3,959	960,624	42,382
Public, from Louisiana beds			228,200	10,187			228,200	10,187
Private, from Mississippi beds			63,532	2,836	20,384	910	83,916	3,746
Total	98,532	4,398	1,065,120	47,048	109,088	4,869	1,272,740	56,315
Grand total	433,372	30,879	5,153,270	202,271	1,391,842	65,216	6,978,484	298,366

## WHOLESALE FISHERY TRADE.

There were 29 wholesale fresh-fish establishments in the State in 1918, valued at \$59,065, with a cash capital amounting to \$31,250, in which 455 persons were engaged and \$47,290 paid in wages. In addition to these, there were 21 establishments engaged in canning shrimp and oysters, valued at \$723,094, with a cash capital amounting to \$174,800. The number of persons engaged in the canning industry was 1,382 and the wages paid amounted to \$307,560.

To avoid the disclosure of individual enterprise, the output of canned shrimp and oysters and crushed oyster shells in Alabama has been included in the following table, containing statistics of the canning industry and preparation of by-products for Mississippi:

## OYSTER AND SHRIMP CANNING INDUSTRY, INCLUDING BY-PRODUCTS, IN MISSISSIPPI IN 1918.

Items.	Number.	Value.	Items.	Number.	Value.
Establishments	21	\$723,094	Shrimp canned:		
Cash capital		174,800	No. 1	2 6,550,344	\$521,484
Persons engaged	1,382		No. 1 <sup>1</sup>	2 449,568	99,872
Wages paid		307,560	Total	6,999,912	621,356
PRODUCTS.			Miscellaneous products	40,800	14,800
Oysters canned:			Crushed oyster shells (poultry food)	3 5,320,000	22,080
3 ounces	34,632	3,207	Other products	311,000	8,580
4 ounces	946,896	95,678			
5 ounces	4,004,664	437,628			
6 ounces	29,880	4,188			
8 ounces	1 917,448	174,391			
10 ounces	401,472	84,379			
12 ounces	3,840	960			
Total	6,338,832	800,431			

<sup>1</sup> Includes pack of one firm in Alabama.<sup>2</sup> Includes pack of two firms in Alabama.<sup>3</sup> Includes output of one firm in Alabama.

## FISHERIES OF LOUISIANA.

Louisiana ranked second among the Gulf States in 1918 in the number of persons engaged, in the investment, and in the value of its fishery products. There were 65 persons employed on fishing vessels, 128 on vessels transporting fishery products, 2,093 in the shore or boat fisheries, and 1,905 on shore in fresh-fish establishments, canneries, etc., totaling 4,191 persons engaged in the fisheries, compared with 5,027 persons in 1902. The decrease was largely in the shore fisheries.

There were 88 fishing and transporting vessels, representing a net tonnage of 765 tons, with a value, including their outfit, of \$187,610, and 1,762 power, sail, and row boats, valued at \$350,140. The value of the fishing apparatus used in the vessel and shore fisheries amounted to \$95,317; the value of the shore and accessory property to \$671,621, and the cash capital to \$170,500, representing a total investment in the fisheries of the State of \$1,475,188, an increase of \$685,465, or 86.79 per cent, as compared with 1902.

The products of the fisheries in 1918 aggregated 24,953,876 pounds, valued at \$1,419,367. Compared with 1902, there was an increase in the quantity of 199,741 pounds, or 0.80 per cent, and \$561,053, or 65.36 per cent, in the value of the products. Among the species of importance mention may be made of the following: Shrimp, 13,315,407 pounds, valued at \$649,805; oysters, 7,855,421 pounds, or 1,122,203 bushels, valued at \$494,299; squeteagues or "sea trout," 1,190,357 pounds, valued at \$110,474; redfish or red drum, 565,899 pounds, valued at \$46,945; catfish, 480,420 pounds, valued at \$18,955; and croaker, 383,035 pounds, valued at \$28,862.

## FISHERIES, BY PARISHES OR COUNTIES.

The number of persons employed, the number and value of vessels, boats, and fishing apparatus used, the amount of capital invested, and the quantity and value of the products of the fisheries of Louisiana in 1918 are shown, by counties, in the following table:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF LOUISIANA  
IN 1918, BY COUNTIES.

Items.	Calcasieu.		Cameron.		Jefferson.		Jefferson Davis.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>								
On vessels transporting.....	2		2		4			
In shore fisheries.....	3		15		488		4	
Shoresmen.....					318			
Total.....	5		17		810		4	
<b>INVESTMENT.</b>								
<b>Vessels transporting:</b>								
Gasoline.....					2	\$5,000		
Tonnage.....					12			
Outfit.....						500		
Sail.....	1	\$500	1	\$600				
Tonnage.....	6		8					
Outfit.....		50		70				
Sail and row boats.....	1	30	9	250	97	2,680	1	\$30
Power boats.....	1	500	2	400	137	86,600	1	500
<b>Apparatus, shore fisheries:</b>								
Seines.....	1	200	1	125	49	17,040	1	500
Trammel nets.....					6	450		
Lines.....						72		
Otter trawls.....					69	1,725		
Tongs.....			7	35	60	270		
Minor apparatus.....						4		
Shore and accessory property.....				100		122,615		
Cash capital.....						40,300		
Total.....		1,280		1,600		277,256		1,030
<b>PRODUCTS.</b>								
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Black drum.....	500	\$25	1,000	\$49	11,300	\$429	400	\$20
Catfish.....	1,800	90	21,400	1,070	43,263	1,408	1,200	60
Croaker.....					45,699	3,446		
Flounders.....					9,800	786		
Mullet.....					74,411	3,725		
Pompano.....					610	147		
Redfish or red drum.....	3,200	156	4,400	352	54,778	4,382	3,200	255
Sea bass.....					6,600	528		
Sharls.....					2,000	60		
Sheepshead.....	2,600	208	2,600	208	20,443	1,685	2,200	176
Spanish mackerel.....					860	129		
Spot.....					18,590	929		
Squeteagues, or "sea trout".....	4,600	460	5,600	560	198,529	17,152	4,100	410
Yellowtail.....					2,000	100		
Shrimp, green.....					6,724,614	236,881		
Squid.....					560	56		
Crabs, hard.....					52,350	2,617		
Terrapin.....					18,000	6,000		
Turtles.....					4,360	218		
<b>Oysters, market:</b>								
Public.....			98,406	7,029				
Private.....					677,124	40,305		
Total.....	12,700	939	133,406	9,268	7,968,882	320,983	11,100	922

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF LOUISIANA  
IN 1918, BY COUNTIES—Continued.

Items.	Lafourche.		Orleans.		Plaquemines.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing	5		24		3	
On vessels transporting	14		52		4	
In shore fisheries	284		177		296	
Shoresmen	166		522		194	
Total	469		775		497	
<b>INVESTMENT.</b>						
Vessels fishing:						
Gasoline	1	\$2,000	5	\$10,300	1	\$4,000
Tonnage	8		28		5	
Outfit		475		2,000		1,100
Sail			14	16,570		
Tonnage			151			
Outfit				1,200		
Vessels transporting:						
Gasoline	7	9,250	17	42,190	1	4,000
Tonnage	43		144		9	
Outfit		1,405		6,750		300
Sail			3	11,700	1	600
Tonnage			70		9	
Outfit				600		100
Sail and row boats	160	5,500	138	3,960	290	15,705
Power boats	98	27,400	38	13,850	124	57,700
Apparatus, vessel fisheries:						
Seines			12	3,360		
Otter trawls	1	25				
Dredges			15	450		
Tongs	5	35	19	148	3	24
Apparatus, shore fisheries:						
Seines	33	9,740	30	3,100	16	5,200
Trammel nets					16	1,475
Cast nets			115	1,150		
Lines				490		180
Otter trawls	48	1,300			12	300
Tongs	150	750			230	1,323
Minor apparatus				425		
Shore and accessory property		27,507		229,370		67,058
Cash capital		8,500		55,500		20,700
Total		93,887		403,113		179,765
<b>PRODUCTS.</b>						
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angel fish			360	\$18		
Black drum	5,300	\$159	2,800	83	4,600	\$138
Catfish	39,243	1,177	9,200	370	20,050	796
Croaker	71,085	4,975	147,700	11,536	42,850	2,774
Flounders	1,200	708	2,500	245	1,250	115
Groupers			20,000	1,000		
Mullet	70,716	3,535	39,600	1,880		
Redfish or red drum	74,066	5,925	50,750	4,052	74,270	5,935
Sea bass	8,100	648	400	40		
Sheepshead	36,868	2,947	34,260	2,663	44,540	3,463
Snapper, red			60,000	4,000		
Spanish mackerel					625	62
Spot	26,985	1,349	2,750	137		
Squeteagues or "sea trout"	100,443	8,038	188,970	18,258	162,450	13,189
Yellowtail	200	10				
Shrimp:						
Green	2,526,907	82,057	947,340	36,282	1,301,000	45,326
Dried					18,375	5,145
Crabs, hard			111,875	3,256	56,000	1,490
Oysters, market:						
Public				88,200	42,000	2,500
Private	908,340	59,425	577,500	20,900	2,819,852	166,151
Total	3,959,453	170,353	2,284,205	108,650	4,587,862	246,994

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF LOUISIANA  
IN 1918, BY COUNTIES—Continued.

Items.	St. Bernard.		St. Mary.		St. Tammany.	
	<i>Number.</i>	<i>Value.</i>	<i>Number.</i>	<i>Value.</i>	<i>Number.</i>	<i>Value.</i>
<b>PERSONS ENGAGED.</b>						
On vessels fishing.....			29			
On vessels transporting.....			28			
In shore fisheries.....	177		165		4	
Shoresmen.....			122			
<b>Total.....</b>	<b>177</b>		<b>314</b>		<b>4</b>	
<b>INVESTMENT.</b>						
<b>Vessels fishing:</b>						
Gasoline.....			8	\$15,400		
Tonnage.....			86			
Outfit.....				2,800		
<b>Vessels transporting:</b>						
Gasoline.....			11	20,500		
Tonnage.....			101			
Outfit.....				2,400		
Sail and row boats.....	81	\$2,330	45	1,125	1	\$30
Power boats.....	65	24,600	54	25,850	1	500
<b>Apparatus, vessel fisheries:</b>						
Seines.....			2	560		
Lines.....				20		
Dredges.....			8	240		
<b>Apparatus, shore fisheries:</b>						
Seines.....	13	5,500	5	500	1	200
Trammel nets.....	26	2,500				
Lines.....		70		220		
Other trawls.....	12	300				
Tongs.....	40	200	150	1,200		
Shore and accessory property.....		1,400		31,874		
Cash capital.....				8,000		
<b>Total.....</b>		<b>36,900</b>		<b>110,779</b>		<b>730</b>
<b>PRODUCTS.</b>						
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Black drum.....	13,450	\$403	600	\$30		
Catfish.....	23,960	1,088	203,468	8,163		
Croaker.....	42,440	3,446	2,400	216	9,000	\$720
Flounders.....	2,596	245				
Mullet.....	97,800	4,890	1,500	75	3,200	160
Pompano.....	100	20				
Redfish or red drum.....	109,220	8,737	3,600	324	3,800	304
Sheepshead.....	29,610	2,392	3,000	270	3,500	280
Spanish mackerel.....	290	35				
Spot.....	18,300	915				
Squeteagues, or "sea trout".....	173,000	18,011	17,900	1,973	12,000	1,200
<b>Shrimp:</b>						
Green.....	500,000	19,610			6,000	300
Dried.....			50,000	12,500		
Crabs, hard.....	46,700	2,335	15,000	300		
<b>Oysters, market:</b>						
Public.....	690,648	20,444				
Private.....	249,879	7,431	307,545	17,988		
<b>Total.....</b>	<b>1,997,993</b>	<b>90,002</b>	<b>605,013</b>	<b>41,839</b>	<b>37,500</b>	<b>2,964</b>

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF LOUISIANA  
IN 1918, BY COUNTIES—Continued.

Items.	Terrebonne.		Vermilion. <sup>1</sup>		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing.....	4				65	
On vessels transporting.....	16		6		128	
In shore fisheries.....	396		84		2,093	
Shoresmen.....	583				1,905	
Total.....	999		90		4,191	
<b>INVESTMENT.</b>						
Vessels fishing:						
Gasoline.....	1	\$5,000			16	\$36,700
Tonnage.....	10				137	
Outfit.....		500				6,875
Sail.....					14	16,570
Tonnage.....					154	
Outfit.....						1,200
Vessels transporting:						
Gasoline.....	8	14,000	3	\$3,500	52	98,440
Tonnage.....	46		26		381	
Outfit.....		1,735		425		13,605
Sail.....					6	13,400
Tonnage.....					93	
Outfit.....						820
Sail and row boats.....	225	6,750	24	650	1,072	39,040
Power boats.....	142	67,500	27	5,700	690	311,100
Apparatus, vessel fisheries:						
Seines.....					14	3,920
Lines.....						20
Other trawls.....					1	25
Dredges.....	2	60			25	750
Tongs.....					27	207
Apparatus, shore fisheries:						
Seines.....	151	28,050	15	1,800	316	71,955
Trammel nets.....	14	1,050			62	5,475
Cast nets.....					115	1,150
Lines.....		50				1,102
Other trawls.....	8	200			149	3,825
Tongs.....	355	2,485	39	196	1,031	6,459
Minor apparatus.....						429
Shore and accessory property.....		191,397		300		671,621
Cash capital.....		37,500				170,500
Total.....		356,277		12,371		1,475,188
<b>PRODUCTS.</b>						
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angel fish.....					360	\$18
Black drum.....	9,505	\$475	2,000	\$100	54,455	1,911
Catfish.....	110,786	4,431	6,050	302	480,420	18,955
Croaker.....	16,370	1,309	5,500	440	383,035	28,862
Flounders.....	3,950	395	250	25	21,546	1,919
Garfish, dried.....	6,500	455			6,500	455
Groupers.....					20,000	1,000
Mullet.....	36,925	1,477	1,025	52	325,177	15,794
Pompano.....	110	17			820	184
Redfish or red drum.....	175,315	15,778	9,300	744	565,899	46,945
Sea bass.....					15,100	1,216
Sharks.....					2,000	60
Sheepshead.....	90,157	7,212	6,750	540	276,528	22,044
Snapper, red.....					60,000	4,000
Spanish mackerel.....					1,775	226
Spot.....					66,625	3,330
Squeteagues, or "sea trout".....	285,515	27,768	37,250	3,455	1,190,357	110,474
Yellow-tail.....					2,200	110
Shrimp:						
Green.....	566,000	22,024			12,571,861	442,480
Dried.....	665,171	312,180	10,000	3,500	743,546	207,325
Squid.....					560	56
Crabs, hard.....					2 281,925	9,908
Terrapin.....	5,406	1,578			23,406	7,578
Turtles.....					4,360	218
Oysters, market:						
Public.....					3 919,254	33,903
Private.....	1,207,122	141,203	98,805	6,993	4 6,936,167	460,396
Total.....	3,178,832	410,302	176,930	16,151	24,953,876	1,419,367

<sup>1</sup> Includes Iberia Parish.<sup>2</sup> 93,975 in number.<sup>3</sup> 131,322 bushels.<sup>4</sup> 990,881 bushels. In addition to the oysters shown above, 695,153 bushels, valued at \$162,494, were taken by Mississippi men from Louisiana beds, and 11,250 bushels, valued at \$3,000, were taken by Texas men from Louisiana beds.

FISHERIES, BY APPARATUS.

The different forms of apparatus used in the vessel fisheries of Louisiana, in the order of their importance, based on the value of the catch, were: Seines, with 783,740 pounds of shrimp, valued at \$39,702; dredges, with 888,594 pounds of oysters, valued at \$35,605; tongs, with 372,750 pounds of oysters, valued at \$19,712; lines, with 42,000 pounds of catfish, valued at \$1,680; and otter trawls, with 18,500 pounds of shrimp, valued at \$740. The total catch of the vessel fisheries amounted to 2,105,584 pounds, valued at \$97,439.

The total yield of the shore or boat fisheries amounted to 22,848,292 pounds, valued at \$1,321,928. Seines were the most productive form of apparatus used, the catch amounting to 9,600,274 pounds, valued at \$601,843. The catch with tongs amounted to 6,594,077 pounds, valued at \$438,982; with otter trawls, 5,381,428 pounds, valued at \$198,653; with lines, 699,128 pounds, valued at \$43,140; with trammel nets, 293,050 pounds, valued at \$23,473; with cast nets, 125,500 pounds, valued at \$5,075; and with minor apparatus, 154,835 pounds, valued at \$10,762.

The products of the vessel and shore fisheries of Louisiana in 1918 are shown in the following tables, by counties, apparatus, and species:

YIELD OF VESSEL FISHERIES OF LOUISIANA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Lafourche.		Orleans.		Plaquemines.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Seines: Shrimp, green.....			733,740	\$27,202		
Otter trawls: Shrimp, green.....	18,500	\$740				
Dredges:						
Oysters, market—						
Public.....			46,200	1,430		
Private.....			420,000	14,000		
Total.....			466,200	15,430		
Tongs:						
Oysters, market—						
Public.....			42,000	2,500	42,000	\$2,500
Private.....	68,250	4,062	157,500	6,900	63,000	3,750
Total.....	68,250	4,062	199,500	9,400	105,000	6,250
Grand total.....	86,750	4,802	1,399,440	52,032	105,000	6,250

Apparatus and species.	St. Mary.		Terrebonne.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Seines:						
Shrimp—						
Green.....					733,740	\$27,202
Dried.....	50,000	\$12,500			50,000	12,500
Total.....	50,000	12,500			783,740	39,702
Otter trawls: Shrimp, green.....					18,500	740
Lines: Catfish.....	42,000	1,680			42,000	1,680
Dredges:						
Oysters, market—						
Public.....					46,200	1,430
Private.....	307,545	17,988	114,849	\$2,187	842,394	34,175
Total.....	307,545	17,988	114,849	2,187	888,594	35,605
Tongs:						
Oysters, market—						
Public.....					84,000	5,000
Private.....					288,750	14,712
Total.....					372,750	19,712
Grand total.....	399,545	32,168	114,849	2,187	2,105,584	97,439

## YIELD OF SHORE FISHERIES OF LOUISIANA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Calcasieu.		Cameron.		Jefferson.		Jefferson Davis.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Seines:</b>								
Black drum.....	500	\$25	750	\$37	14,300	\$429	400	\$20
Catfish.....	1,800	90	1,400	70	40,763	1,308	1,200	60
Croaker.....					39,490	3,024		
Flounders.....					1,100	88		
Mullet.....					70,311	3,520		
Pompano.....					500	137		
Redfish or red drum.....	3,200	156	3,400	272	48,778	3,902	3,200	256
Sea bass.....					6,600	528		
Sharks.....					2,000	60		
Sheepshead.....	2,600	208	2,100	168	18,643	1,511	2,200	176
Spanish mackerel.....					800	120		
Spot.....					18,390	919		
Squeteagues or "sea trout".....	4,600	460	4,100	410	177,529	15,052	4,100	410
Yellowtail.....					2,000	100		
Shrimp, green.....					2,928,452	103,169		
Squid.....					500	56		
<b>Total.....</b>	<b>12,700</b>	<b>939</b>	<b>11,750</b>	<b>957</b>	<b>3,370,276</b>	<b>133,953</b>	<b>11,100</b>	<b>922</b>
<b>Trammel nets:</b>								
Catfish.....					1,500	60		
Croaker.....					5,000	350		
Mullet.....					4,100	205		
Redfish or red drum.....					4,500	360		
Sheepshead.....					900	72		
Spanish mackerel.....					60	9		
Spot.....					200	10		
Squeteagues or "sea trout".....					12,000	1,200		
<b>Total.....</b>					<b>28,260</b>	<b>2,266</b>		
<b>Otter trawls: Shrimp, green.....</b>					<b>3,796,162</b>	<b>133,712</b>		
<b>Lines:</b>								
Black drum.....			250	12				
Catfish.....			20,000	1,000	1,000	40		
Croaker.....					1,200	72		
Flounders.....					100	10		
Pompano.....					50	10		
Redfish or red drum.....			1,000	80	1,500	120		
Sheepshead.....			500	40	900	72		
Squeteagues or "sea trout".....			1,500	150	9,000	900		
Crabs, hard.....					52,350	2,617		
<b>Total.....</b>			<b>23,250</b>	<b>1,282</b>	<b>66,100</b>	<b>3,841</b>		
<b>Minor apparatus:</b>								
Flounders.....					8,600	688		
Turtles.....					4,360	218		
Terrapin.....					18,000	6,000		
<b>Total.....</b>					<b>30,960</b>	<b>6,906</b>		
<b>Tongs:</b>								
Oysters, market—								
Public.....			98,406	7,029				
Private.....					677,124	40,305		
<b>Total.....</b>			<b>98,406</b>	<b>7,029</b>	<b>677,124</b>	<b>40,305</b>		
<b>Grand total.....</b>	<b>12,700</b>	<b>939</b>	<b>133,406</b>	<b>9,268</b>	<b>7,968,882</b>	<b>320,983</b>	<b>11,100</b>	<b>922</b>

## YIELD OF SHORE FISHERIES OF LOUISIANA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Lafourche.		Orleans.		Plaquemines.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Seines:</b>						
Angelfish.....			360	\$18		
Black drum.....	5,300	\$159	2,200	65	4,500	\$135
Catfish.....	39,243	1,177	8,100	325	13,500	540
Croaker.....	71,085	4,975	58,100	4,448	34,820	2,245
Flounders.....	1,200	108	950	95	1,250	115
Mullet.....	70,716	3,535	39,600	1,880		
Redfish or red drum.....	74,066	5,925	33,300	2,664	65,525	5,236
Sea bass.....	8,100	648	400	40		
Sheepshead.....	36,868	2,947	28,070	2,235	39,520	3,062
Spanish mackerel.....					350	35
Spot.....	26,985	1,349	2,750	137		
Squeteagues or "sea trout".....	100,443	8,038	92,170	8,482	121,350	10,645
Yellowtail.....	200	10				
<b>Shrimp—</b>						
Green.....	1,437,391	47,264	76,100	3,405	1,274,750	44,278
Dried.....					18,375	5,145
<b>Total.....</b>	<b>1,871,597</b>	<b>76,135</b>	<b>342,100</b>	<b>23,794</b>	<b>1,573,910</b>	<b>71,439</b>
<b>Trammel nets:</b>						
Black drum.....					100	3
Catfish.....					6,550	256
Croaker.....					8,030	526
Red fish or red drum.....					8,745	699
Sheepshead.....					5,020	401
Spanish mackerel.....					275	27
Squeteagues or "sea trout".....					41,100	2,544
<b>Total.....</b>					<b>69,820</b>	<b>4,456</b>
<b>Otter trawls: Shrimp, green.....</b>	<b>1,071,016</b>	<b>34,053</b>			<b>26,250</b>	<b>1,048</b>
<b>Cast nets: Shrimp.....</b>			<b>125,500</b>	<b>5,075</b>		
<b>Lines:</b>						
Black drum.....			600	18		
Catfish.....			1,100	45		
Croaker.....			89,600	7,088		
Flounders.....			1,550	150		
Groupers.....			20,000	1,000		
Red fish or red drum.....			17,450	1,388		
Sheepshead.....			6,190	428		
Snapper, red.....			60,000	4,000		
Squeteagues or "sea trout".....			96,800	9,776		
Crabs, hard.....					56,000	1,400
<b>Total.....</b>			<b>293,290</b>	<b>23,893</b>	<b>56,000</b>	<b>1,400</b>
<b>Minor apparatus:</b>						
Crabs, hard.....			111,875	3,256		
Shrimp.....			12,000	600		
<b>Total.....</b>			<b>123,875</b>	<b>3,856</b>		
<b>Tongs: Oysters, market, private.....</b>	<b>930,090</b>	<b>53,363</b>			<b>2,756,852</b>	<b>162,401</b>
<b>Grand total.....</b>	<b>3,872,703</b>	<b>165,551</b>	<b>884,765</b>	<b>56,618</b>	<b>4,482,862</b>	<b>240,744</b>

## YIELD OF SHORE FISHERIES OF LOUISIANA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	St. Bernard.		St. Mary.		St. Tammany.	
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
<b>Seines:</b>						
Black drum.....	13, 152	\$394	600	\$30		
Catfish.....	21, 960	1, 008	2, 400	120		
Croaker.....	33, 845	2, 707	2, 400	216	9, 000	\$720
Flounders.....	2, 096	197				
Mullet.....	74, 700	3, 735	1, 500	75	3, 200	160
Pompano.....	100	20				
Red fish or red drum.....	74, 743	5, 979	3, 600	324	3, 800	304
Sheepshead.....	26, 600	2, 128	3, 000	270	3, 500	280
Spanish mackerel.....	150	18				
Spot.....	16, 300	815				
Squeteagues or "sea trout".....	110, 400	11, 665	17, 900	1, 973	12, 000	1, 200
Shrimp, green.....	122, 000	6, 110			6, 000	300
Total.....	496, 046	34, 776	31, 400	3, 008	37, 500	2, 964
<b>Trammel nets:</b>						
Black drum.....	298	9				
Catfish.....	2, 000	80				
Croaker.....	6, 095	489				
Flounders.....	500	48				
Mullet.....	23, 100	1, 155				
Red fish or red drum.....	33, 877	2, 710				
Sheepshead.....	2, 110	174				
Spanish mackerel.....	90	10				
Spot.....	2, 000	100				
Squeteagues or "sea trout".....	57, 000	5, 730				
Total.....	127, 070	10, 505				
<b>Otter trawls: Shrimp, green.....</b>	378, 000	13, 500				
<b>Lines:</b>						
Catfish.....			159, 068	6, 363		
Croaker.....	2, 500	250				
Red fish or red drum.....	600	48				
Sheepshead.....	900	90				
Spanish mackerel.....	50	7				
Squeteagues or "sea trout".....	5, 600	616				
Crabs, hard.....	46, 700	2, 335	15, 000	300		
Total.....	56, 350	3, 346	174, 068	6, 663		
<b>Tongs:</b>						
Oysters, market—						
Public.....	690, 648	20, 444				
Private.....	249, 879	7, 431				
Total.....	940, 527	27, 875				
<b>Grand total.....</b>	1, 997, 993	90, 002	205, 468	9, 671	37, 500	2, 964

## YIELD OF SHORE FISHERIES OF LOUISIANA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Terrebonne.		Vermilion.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Seines:</b>						
Angel fish.....					360	\$18
Black drum.....	7,385	\$369	2,000	\$100	51,087	1,763
Catfish.....	110,786	4,431	6,050	302	247,202	9,431
Croaker.....	14,770	1,181	5,500	440	269,010	19,959
Flounders.....	500	50	250	25	7,346	678
Garfish, dried.....	5,300	371			5,300	371
Mullet.....	36,925	1,477	1,025	52	297,977	14,434
Pompano.....	110	17			770	174
Red fish or red drum.....	147,715	13,294	9,300	744	470,627	39,056
Sea bass.....					15,100	1,216
Sharks.....					2,000	60
Sheepshead.....	73,857	5,908	6,750	540	243,708	19,463
Spanish mackerel.....					1,300	173
Spot.....					64,425	3,220
Squeteagues or "sea trout".....	239,815	23,258	37,250	3,455	921,657	85,048
Yellowtail.....					2,200	110
Shrimp—						
Green.....	506,000	19,634			6,350,693	224,210
Dried.....	615,171	172,180	10,000	3,500	643,546	180,825
Squid.....					560	56
Terrapin.....	5,406	1,578			5,406	1,578
<b>Total.....</b>	<b>1,763,740</b>	<b>243,798</b>	<b>78,125</b>	<b>9,158</b>	<b>9,600,274</b>	<b>601,843</b>
<b>Trammel nets:</b>						
Black drum.....					398	12
Catfish.....					10,050	396
Croaker.....	1,600	128			20,725	1,493
Flounders.....					500	48
Mullet.....					27,200	1,360
Red fish or red drum.....	21,000	1,890			68,122	5,659
Sheepshead.....	12,100	968			20,130	1,615
Spanish mackerel.....					425	46
Spot.....					2,200	110
Squeteagues or "sea trout".....	33,200	3,260			143,300	12,734
<b>Total.....</b>	<b>67,900</b>	<b>6,246</b>			<b>293,050</b>	<b>23,473</b>
<b>Otter trawls:</b>						
Shrimp—						
Green.....	60,000	2,340			5,331,428	184,653
Dried.....	50,000	14,000			50,000	14,000
<b>Total.....</b>	<b>110,000</b>	<b>16,340</b>			<b>5,381,428</b>	<b>198,653</b>
<b>Cast nets: Shrimp.....</b>					<b>125,500</b>	<b>5,075</b>
<b>Lines:</b>						
Black drum.....	2,120	106			2,970	136
Catfish.....					181,168	7,448
Croaker.....					93,300	7,440
Flounders.....	3,450	345			5,100	505
Garfish, dried.....	1,200	84			1,200	84
Groupers.....					20,000	1,000
Pompano.....					50	40
Red fish or red drum.....	6,600	594			27,150	2,230
Sheepshead.....	4,200	336			12,690	966
Snapper, red.....					60,000	4,000
Spanish mackerel.....					50	7
Squeteagues or "sea trout".....	12,500	1,250			125,400	12,692
Crabs, hard.....					170,050	6,652
<b>Total.....</b>	<b>30,070</b>	<b>2,715</b>			<b>699,128</b>	<b>43,140</b>
<b>Minor apparatus:</b>						
Flounders.....					8,600	688
Crabs, hard.....					111,875	3,256
Shrimp.....					12,000	600
Turtles.....					4,360	218
Terrapin.....					18,000	6,000
<b>Total.....</b>					<b>151,835</b>	<b>10,762</b>
<b>Tongs:</b>						
Oysters, market—						
Public.....					789,054	27,473
Private.....	1,092,273	139,016	98,805	6,993	5,805,023	411,500
<b>Total.....</b>	<b>1,092,273</b>	<b>139,016</b>	<b>98,805</b>	<b>6,993</b>	<b>6,594,077</b>	<b>438,983</b>
<b>Grand total.....</b>	<b>3,063,983</b>	<b>408,115</b>	<b>176,930</b>	<b>16,151</b>	<b>22,848,292</b>	<b>1,321,928</b>

Includes the catch of several men living in Iberia County.

## WHOLESALE FISHERY TRADE.

There were 35 wholesale establishments in the State of Louisiana in 1918 engaged in handling fresh fish or oysters. The total number of persons employed in these establishments was 622; the amount of wages paid during the year was \$224,552; the investment, \$168,183; and the cash capital utilized \$52,500. Besides these, there were 23 establishments engaged in the canning of shrimp and oysters and in the preparation of by-products, valued at \$486,838, using cash capital amounting to \$118,000; and employing 1,193 persons, to whom \$145,687 were paid in wages during the year. These establishments were distributed as follows: In Jefferson Parish, 9; in Lafourche Parish, 3; in Orleans Parish, 4; in Plaquemines Parish, 3; and in Terrebonne Parish, 4.

The following table contains the statistics of the canning industry and preparation of by-products for Louisiana in 1918:

## OYSTER AND SHRIMP CANNING INDUSTRY, INCLUDING BY-PRODUCTS, IN LOUISIANA IN 1918.

Items.	Number.	Value.	Items.	Number.	Value.
Establishments.....	23	\$486,838	PRODUCTS—continued.		
Cash capital.....		118,000	Shrimp, canned:		
Persons engaged.....	1,193		No. 1.....cans.	4,686,000	\$504,043
Wages paid.....		145,687	No. 1½.....do.	399,744	86,912
PRODUCTS.			Total.....	5,085,744	590,955
Oysters, canned:			Shrimp:		
3 ounces.....cans.	24,048	2,505	Dried.....pounds.	603,259	194,388
4 ounces.....do.	157,152	16,719	Bran.....do.	460,000	10,145
5 ounces.....do.	1,754,408	81,936	Crushed oyster shells (poultry food).....pounds.		
6 ounces.....do.	172,704	24,705		2,698,000	39,097
8 ounces.....do.	33,336	7,081			
10 ounces.....do.	51,696	11,615			
12 ounces.....do.	33,168	9,360			
Total.....	1,226,512	153,921			

<sup>1</sup> Includes a small quantity of 5½-ounce cans put up by a Texas firm.

<sup>2</sup> Includes output of two firms in Texas.

## FISHERIES OF TEXAS.

In 1918 Texas ranked second among the Gulf States in the quantity of fishery products and fourth in the number of persons engaged, investment, and value of the products. Compared with 1902, there has been an increase in the number of persons engaged of 742, or 64.86 per cent; in the investment an increase of \$516,376, or 138.17 per cent; in the quantity of products an increase of 16,970,356 pounds, or 210.95 per cent; and in their value an increase of \$323,429, or 91.41 per cent. The number of persons employed in 1918 on fishing vessels was 357, in the shore and boat fisheries 1,070, and on shore in wholesale establishments 459, totaling 1,886.

The number of fishing vessels was 75, with a total net tonnage of 1,335 tons, valued, with their outfit, at \$259,870; the number of boats was 950, valued at \$119,320. The value of the fishing apparatus used in the vessel and shore fisheries amounted to \$61,262, the value of the shore and accessory property amounted to \$413,248, and the working cash capital to \$36,400, representing a total investment of \$890,100.

The total yield of the fisheries of Texas was 25,014,760 pounds, valued at \$677,243. The quantities and values of the principal species were: Black drum, 1,873,436 pounds, valued at \$44,394; menhaden, 14,118,340 pounds, valued at \$103,080; redfish or red

drum, 1,336,535 pounds, valued at \$80,468; red snapper, 1,243,002 pounds, valued at \$93,720; squeteagues or "sea trout," 1,613,370 pounds, valued at \$119,328; and oysters, 3,344,488 pounds, or 477,784 bushels, valued at \$143,610.

FISHERIES, BY COUNTIES.

The following table gives, by counties, the number of persons engaged, the investment, and the products of the fisheries of Texas in 1918:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF TEXAS IN 1918, BY COUNTIES.

Items.	Aransas County.		Brazoria County.		Calhoun County.		Cameron County.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>								
On vessels fishing.....	6				63			
In shore fisheries.....	150		8		72		112	
Shoemen.....	13				128		21	
Total.....	169		8		263		133	
<b>INVESTMENT.</b>								
<b>Vessels fishing:</b>								
Gasoline.....					11	\$9,800		
Tonnage.....					86			
Outfit.....						4,350		
Sail.....	1	\$3,100			16	10,420		
Tonnage.....	21				116			
Outfit.....		2,000				3,885		
Boats, sail, row, etc.....	160	14,380	4	\$50	103	9,395	32	\$8,730
Boats, power.....	7	3,200	4	800	8	3,200		
<b>Apparatus, vessel fisheries:</b>								
Seines.....					12	2,100		
Trammel nets.....					1	100		
Gill nets.....					6	90		
Lines.....		100						
Dredges.....					2	100		
Tongs.....					48	182		
<b>Apparatus, shore fisheries:</b>								
Seines.....	32	3,500			17	1,900	28	5,600
Trammel nets.....	20	2,575	4	300	20	2,150		
Gill nets.....	180	5,175			70	750		
Cast nets.....					11	40	5	17
Fyke nets.....			4	300				
Lines.....		25				245		
Spears.....	27	20			20	14		
Tongs.....	80	400			56	385		
Minor apparatus.....		30						
Shore and accessory property.....		25,025		100		44,275		14,450
Cash capital.....		3,200				5,000		3,100
Total.....		62,730		1,550		98,231		31,847
<b>PRODUCTS.</b>								
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Black drum.....	119,000	\$4,608			60,589	\$2,915	1,083,486	\$10,835
Bluefish.....	1,000	150			538	63		
Catfish.....	31,800	1,118			58,766	3,397	10,000	300
Croaker.....	30,375	1,155			15,818	734	15,000	525
Flounders.....	18,775	1,300			6,873	609	4,500	180
Jewish.....							3,000	120
King whiting.....	565	38			3,496	331		
Mullet.....	11,625	448			9,000	418	10,000	100
Pompano.....	4,375	525			3,467	443	300	18
Redfish or red drum.....	119,250	8,415	11,875	\$950	150,959	13,207	722,324	28,892
<b>Sea:</b>								
Bass.....							5,000	200
Gar.....	12,500	875			4,124	402	40,000	1,600
Sheepshead.....	18,750	873			20,938	1,718	20,000	800
Snapper, red.....	85,000	8,500						
Spanish mackerel.....	5,000	415				85		
Squeteagues or "sea trout".....	228,369	22,895	13,750	1,100	186,366	19,120	722,324	28,892
Shrimp.....					3,500	260	1,500	50
Crabs, hard.....	384	11			360	11		
Turtles.....	431	13						
<b>Oysters, market:</b>								
Public.....	334,243	15,280			1,207,612	50,860	105	27
Private.....	10,500	480			10,500	523		
Total.....	1,031,942	67,099	25,625	2,050	1,743,556	93,095	2,637,539	72,539

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF TEXAS IN 1918, BY COUNTIES—Continued.

Items.	Chambers County.		Galveston County.		Harris County.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing .....			177		4	
In shore fisheries .....	45		202		100	
Shoresmen .....	4		60		15	
Total .....	49		439		119	
<b>INVESTMENT.</b>						
Vessels, fishing:						
Gasoline .....			9	\$32,050	2	\$1,000
Tonnage .....			188		13	
Outfit .....				9,000		450
Sail .....			11			
Tonnage .....			528			
Outfit .....				32,225		
Boats, sail, row, etc .....	30	\$450	91	1,670	91	2,035
Boats, power .....	15	3,000	66	20,100	17	5,100
Apparatus, vessel fisheries:						
Seines .....			5	2,300	1	75
Lines .....				940		
Tongs .....			8	52		
Minor apparatus .....				1		
Apparatus, shore fisheries:						
Seines .....	9	900	8	1,835	15	1,800
Trammel nets .....			11	1,350		
Cast nets .....			10	35		
Lines .....		800		555		519
Spears .....			25	20		
Tongs .....			70	455	12	78
Minor apparatus .....		670		4		
Shore and accessory property .....		500		148,905		8,525
Cash capital .....		500		9,000		1,400
Total .....		6,820		322,097		20,982
<b>PRODUCTS.</b>						
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish .....					124	\$7
Black drum .....	400	\$20	7,750	\$507	8,875	1,251
Catfish .....	68,100	5,448	16,080	1,011	25,370	1,365
Croaker .....	300	18	18,750	1,203	5,837	464
Flournders .....	500	43	7,425	990	1,535	178
Groupers .....			20,840	843		
Grunts .....			1,000	100		
Jewfish .....			27,340	1,534		
King whiting .....			21,000	2,138	2,950	391
Menhaden .....			4,574,340	31,500		
Mullet .....	600	12	2,500	92	11,300	429
Pompano .....			1,780	398	364	68
Redfish or red drum .....	1,000	60	26,625	3,265	28,725	3,791
Sheepshead .....	200	14	12,625	1,273	11,850	1,000
Snapper, red .....			1,146,002	83,720		
Spanish mackerel .....			3,750	710	244	37
Squeteagues or "sea trout" .....	1,500	125	32,125	4,245	41,175	6,170
Shrimp .....			9,000	719	2,000	175
Crabs:						
Hard .....			35,000	2,650	157,500	8,000
Soft .....					700	175
Terrapin .....					1,350	540
Oysters, market:						
Public .....			454,230	18,520	118,811	5,657
Private .....			26,250	2,350		
Total .....	72,600	5,740	6,444,412	157,049	418,710	29,693

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF TEXAS IN 1918, BY COUNTIES—Continued.

Items.	Jefferson County.		Matagorda County.		Nueces County.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing.....	54		31		22	
In shore fisheries.....	45		122		167	
Shoemen.....	42		128		41	
Total.....	141		281		230	
<b>INVESTMENT.</b>						
<b>Vessels fishing:</b>						
Steam.....	2	\$50,000				
Tonnage.....	217					
Outfit.....		14,800				
Gasoline.....	1	2,000	7	\$5,235		
Tonnage.....	12		58			
Outfit.....		800		2,450		
Sail.....			10	6,000	5	\$4,170
Tonnage.....			60		36	
Outfit.....				3,075		1,610
Boats, sail, row, etc.....	28	705	105	11,405	116	18,300
Boats, power.....	10	3,900	19	8,700	1	1,000
<b>Apparatus, vessel fisheries:</b>						
Seines.....	2	2,400	5	1,250	8	1,620
Trammel nets.....			2	160		
Lines.....		25		10		
Tongs.....			31	203	6	39
<b>Apparatus, shore fisheries:</b>						
Seines.....	7	750	14	2,900	60	8,140
Trammel nets.....			6	675		
Gill nets.....			10	100	13	1,100
Cast nets.....	2	7			100	300
Lines.....		50		155		500
Spears.....			25	15	25	25
Tongs.....	4	25	104	685		
Minor apparatus.....						6
Shore and accessory property.....		74,893		36,550		58,775
Cash capital.....		3,000		4,400		5,900
Total.....		153,330		83,968		101,485
<b>PRODUCTS.</b>						
	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>	<i>Pounds.</i>	<i>Value.</i>
Black drum.....	2,200	\$193	68,614	\$3,230	514,972	\$20,473
Bluefish.....			500	55		
Catfish.....	9,470	682	35,001	2,556	3,760	150
Croaker.....	3,125	290	81,052	3,796	25,000	1,000
Flournders.....	1,102	136	27,251	2,266	81,000	6,000
Jewfish.....	4,000	360	625	50	5,000	450
King whiting.....	600	60	5,813	275	1,000	40
Menhaden.....	9,544,000	71,580				
Mullet.....	1,000	60	4,375	135	1,875	45
Pompano.....			812	100	3,250	430
Redfish or red drum.....	11,800	1,590	71,500	5,990	170,477	12,110
<b>Sea:</b>						
Bass.....	1,625	150				
Gar.....			4,063	327	19,500	1,430
Sheepshead.....	7,375	749	24,124	1,975	70,500	3,450
Snapper, red.....	12,000	1,500				
Spanish mackerel.....			1,250	150	25,360	2,545
Squeteagues or "sea trout".....	8,250	1,150	101,461	10,895	235,650	19,961
Shrimp.....	2,500	265		72	145,000	7,250
Terrapin.....	1,000	350		100		
Turtles.....	2,000	120	240	14	4,000	300
<b>Oysters, market:</b>						
Public.....	39,375	1,500	1,058,120	44,383	40,586	2,319
Private.....			4,781	209		
Total.....	9,651,422	80,735	1,490,649	76,578	1,346,930	77,953

## PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF TEXAS IN 1918, BY COUNTIES—Continued.

Items.	Orange County.		San Patricio County.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
<b>PERSONS ENGAGED.</b>						
On vessels fishing.....					357	
In shore fisheries.....	12		35		1,070	
Shoresmen.....			7		459	
Total.....	12		42		1,886	
<b>INVESTMENT.</b>						
Vessels fishing:						
Steam.....					2	\$50,000
Tonnage.....					217	
Outfit.....						14,800
Gasoline.....					30	50,085
Tonnage.....					357	
Outfit.....						17,050
Sail.....					43	85,190
Tonnage.....					761	
Outfit.....						42,745
Boats, sail, row, etc.....	9	\$690	21	\$210	790	68,020
Boats, power.....	5	1,250	8	1,050	160	51,300
Apparatus, vessel fisheries:						
Seines.....					33	9,745
Trammel nets.....					3	260
Gill nets.....					6	90
Lines.....						1,075
Dredges.....					2	100
Tongs.....					93	476
Minor apparatus.....						1
Apparatus, shore fisheries:						
Seines.....	4	500	3	300	197	28,125
Trammel nets.....	1	125			62	7,175
Gill nets.....			6	600	279	7,725
Cast nets.....			10	35	138	434
Fyke nets.....					4	300
Lines.....		10		30		2,889
Spears.....			14	10		104
Tongs.....	4	25			330	2,053
Minor apparatus.....						710
Shore and accessory property.....		100		1,150		413,248
Cash capital.....				900		36,400
Total.....		2,700		4,285		890,100
<b>PRODUCTS.</b>						
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish.....					124	\$7
Black drum.....	1,250	\$110	6,300	\$252	1,873,436	44,394
Bluefish.....			1,200	150	3,238	418
Catfish.....	2,800	305	1,500	75	262,647	16,407
Croaker.....	2,300	230			197,557	9,415
Flounders.....	400	47	13,000	1,085	162,361	12,834
Groupers.....					20,840	843
Grunts.....					1,000	100
Jewfish.....					39,965	2,514
King whiting.....	550	55			35,974	3,328
Menhaden.....					14,118,340	103,080
Mullet.....	1,000	70			53,275	1,809
Pompano.....			200	25	14,548	2,007
Redfish or red drum.....	3,800	560	18,200	1,638	1,336,535	80,468
Sea:						
Bass.....					6,625	350
Gar.....			700	63	80,887	4,697
Sheepshead.....	4,500	450	6,800	340	197,662	12,642
Snapper, red.....					1,243,002	93,720
Spanish mackerel.....			5,100	255	41,354	4,197
Squeteagues or "sea trout".....	3,400	500	39,000	4,275	1,613,370	119,328
Shrimp.....					164,067	8,791
Crabs:						
Hard.....					193,244	10,672
Soft.....					2700	175
Terrapin.....					2,850	990
Turtles.....					6,671	447
Oysters, market:						
Public.....	39,375	1,500			3,292,457	140,046
Private.....					452,031	3,564
Total.....	59,375	3,827	92,000	8,158	25,014,760	677,243

1 Represents 579,732 in number.

2 Represents 2,100 in number.

3 Represents 470,351 bushels and includes 11,250 bushels, valued at \$3,000, taken from Louisiana beds.

4 Represents 7,433 bushels.

## FISHERIES, BY APPARATUS.

The catch of all forms of apparatus used in the vessel fisheries amounted to 17,084,241 pounds, with a value of \$278,409; in the shore or boat fisheries it amounted to 7,930,519 pounds, valued at \$398,834. The catch in the vessel and shore fisheries with seines was 18,930,250 pounds, valued at \$325,732; with trammel nets, 424,920 pounds, with a value of \$34,773; with gill nets, 165,830 pounds, valued at \$14,570; with lines, 1,869,716 pounds, valued at \$140,260; and with tongs, 2,980,922 pounds, valued at \$128,214. Various other forms of apparatus, such as dredges, cast nets, fyke nets, spears, etc., were employed, but the catch was relatively unimportant.

The products of the vessel and shore fisheries of Texas, by counties, in 1918 are shown in the following tables:

YIELD OF VESSEL FISHERIES OF TEXAS IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Aransas.		Calhoun.		Galveston.		Harris.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Seines:</b>								
Bluefish.....			63	\$7				
Black drum.....			9,588	483	1,750	\$107		
Catfish.....			6,445	368	2,745	35	400	\$20
Croaker.....			5,334	245	2,125	130	400	42
Flounders.....			959	89	125	15	100	11
King whiting.....			875	48	1,500	138	200	34
Menhaden.....					4,574,340	31,500		
Mullet.....			917	41			800	28
Pompano.....			875	113	280	41	25	4
Redfish or red drum.....			23,571	2,017	3,375	380	1,700	221
Sea gar.....			1,459	140				
Sheepshead.....			7,084	540	2,000	183	600	35
Spanish mackerel.....			500	65	500	72	20	3
Squeteagues or "sea trout".....			22,225	2,280	3,625	425	1,800	270
Shrimp.....					1,000	79		
Total.....			79,865	6,436	4,591,365	33,105	6,045	668
<b>Trammel nets:</b>								
Black drum.....			1,500	70				
Catfish.....			16	1				
Croaker.....			37	2				
Mullet.....			313	15				
Redfish or red drum.....			2,706	230				
Sheepshead.....			162	13				
Squeteagues or "sea trout".....			5,295	545				
Total.....			10,029	876				
<b>Gill nets:</b>								
Black drum.....			750	40				
Redfish or red drum.....			1,750	165				
Squeteagues or "sea trout".....			3,750	385				
Total.....			6,250	590				
<b>Lines:</b>								
Groupers.....					20,840	\$43		
Jewfish.....					21,340	874		
Snapper, red.....	85,000	\$8,500			1,146,002	83,720		
Total.....	85,000	8,500			1,188,182	85,437		
<b>Dredges: Oysters, market, public.....</b>			315,000	12,000				
<b>Tongs: Oysters, market, public.....</b>			654,031	27,835	73,500	3,220		
<b>Minor apparatus: Flounders.....</b>					800	125		
<b>Grand total.....</b>	85,000	8,500	1,065,175	47,737	5,853,847	121,887	6,045	668

## YIELD OF VESSEL FISHERIES OF TEXAS IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Jefferson.		Matagorda.		Nueces.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Seines:</b>								
Bluefish.....			250	\$27			313	\$34
Black drum.....			18,035	850	50,000	\$1,875	79,343	3,315
Catfish.....			7,633	525	675	25	15,898	973
Croaker.....			17,761	832	2,750	110	28,370	1,359
Flounders.....			1,738	148	3,364	215	6,286	478
King whiting.....			1,600	76			4,175	296
Menhaden.....	9,544,000	\$71,580					14,118,340	103,080
Mullet.....			562	27	370	10	2,649	106
Pompano.....			406	50	114	13	1,700	221
Redfish or red drum.....			20,875	1,717	9,167	550	58,688	4,885
Sea gar.....			1,938	155	1,435	90	4,832	385
Sheepshead.....			7,937	642	2,750	130	20,371	1,530
Spanish mackerel.....			625	75	88	10	1,733	225
Squeteagues or "sea trout".....			27,543	2,932	14,665	1,100	69,858	7,007
Shrimp.....			283	36			1,283	115
Terrapin.....			250	50			250	50
Turtles.....			120	7			120	7
<b>Total.....</b>	<b>9,544,000</b>	<b>71,580</b>	<b>107,556</b>	<b>8,149</b>	<b>85,378</b>	<b>4,128</b>	<b>14,414,209</b>	<b>124,066</b>
<b>Trammel nets:</b>								
Black drum.....			625	30			2,125	100
Catfish.....			1,920	130			1,936	131
Croaker.....			406	19			443	21
King whiting.....			375	18			375	18
Mullet.....							313	15
Redfish or red drum.....			1,125	98			3,831	328
Sheepshead.....							162	13
Squeteagues or "sea trout".....			1,750	195			7,045	740
<b>Total.....</b>			<b>6,201</b>	<b>490</b>			<b>16,230</b>	<b>1,366</b>
<b>Gill nets:</b>								
Black drum.....							750	40
Redfish or red drum.....							1,750	165
Squeteagues or "sea trout".....							3,750	385
<b>Total.....</b>							<b>6,250</b>	<b>590</b>
<b>Lines:</b>								
Catfish.....			1,670	110			1,670	110
Groupers.....							20,840	843
Jewfish.....	4,000	360					25,340	1,234
Snapper, red.....	12,000	1,500					1,243,002	93,720
<b>Total.....</b>	<b>16,000</b>	<b>1,860</b>	<b>1,670</b>	<b>110</b>			<b>1,290,852</b>	<b>95,907</b>
<b>Dredges: Oysters, market, public.....</b>							315,000	12,000
<b>Tongs: Oysters, market, public.....</b>			302,869	12,700	10,500	600	1,040,900	44,355
<b>Minor apparatus: Flounders.....</b>							800	125
<b>Grand total.....</b>	<b>9,560,000</b>	<b>73,440</b>	<b>418,296</b>	<b>21,449</b>	<b>95,878</b>	<b>4,728</b>	<b>17,084,241</b>	<b>278,409</b>

## YIELD OF SHORE FISHERIES OF TEXAS IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Aransas.		Brazoria.		Calhoun.		Cameron.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Seines:</b>								
Black drum	88,750	\$3,450			20,037	\$972	1,083,486	\$10,835
Bluefish	1,000	150			125	14		
Catfish	19,300	675			5,300	306	10,000	300
Croaker	27,625	1,050			5,979	276	15,000	525
Flounders	5,650	400			1,604	138	4,500	180
Jewish							3,000	120
King whiting	565	38			1,156	96		
Mullet	8,750	335			2,646	122	10,000	100
Pompano	4,375	525			1,625	209	300	18
Redfish or red drum	86,250	6,100			46,114	3,953	722,324	28,892
Sea—								
Bass							5,000	200
Gar	10,000	700			2,603	257	40,000	1,600
Sheepshead	15,625	725			6,479	540	20,000	800
Spanish mackerel	2,500	200			119	16		
Squeteagues or "sea trout"	142,115	15,550			44,581	4,625	722,324	28,892
<b>Total</b>	<b>412,505</b>	<b>29,898</b>			<b>138,368</b>	<b>11,524</b>	<b>2,635,934</b>	<b>72,462</b>
<b>Trammel nets:</b>								
Bluefish					350	42		
Black drum	28,125	1,075			28,619	1,345		
Catfish	5,000	175			3,390	192		
Croaker	2,750	105			3,278	156		
Flounders					1,185	97		
King whiting					1,187	90		
Mullet	2,875	113			5,124	240		
Pompano						87		
Redfish or red drum	20,000	1,400	10,000	\$800	66,818	5,978		
Sea gar	2,500	175			62	5		
Sheepshead	3,125	148			7,213	625		
Spanish mackerel					31	4		
Squeteagues or "sea trout"	41,629	3,500	11,250	900	91,515	9,375		
<b>Total</b>	<b>106,004</b>	<b>6,691</b>	<b>21,250</b>	<b>1,700</b>	<b>209,460</b>	<b>18,236</b>		
<b>Gill nets:</b>								
Black drum	2,125	83						
Catfish	7,500	268			1,085	65		
Croaker					1,190	55		
King whiting					278	97		
Pompano					279	34		
Redfish or red drum	10,500	745			5,250	440		
Squeteagues or "sea trout"	33,750	2,900			8,750	855		
<b>Total</b>	<b>53,875</b>	<b>3,996</b>			<b>16,832</b>	<b>1,546</b>		
<b>Cast nets: Shrimp</b>					3,500	260	1,500	50
<b>Fyke nets:</b>								
Redfish or red drum			1,875	150				
Squeteagues or "sea trout"			2,500	200				
<b>Total</b>			<b>4,375</b>	<b>350</b>				
<b>Lines:</b>								
Black drum					125	5		
Catfish					42,530	2,465		
Redfish or red drum	2,500	170			4,750	424		
Spanish mackerel	2,500	215						
Squeteagues or "sea trout"	10,875	945			10,250	1,055		
Crabs, hard	384	11			360	11		
<b>Total</b>	<b>16,259</b>	<b>1,341</b>			<b>58,015</b>	<b>3,990</b>		
<b>Spears: Flounders</b>	13,125	900			3,125	285		
<b>Minor apparatus:</b>								
Turtles	431	13					105	27
Oysters, market, public							105	27
<b>Total</b>	<b>431</b>	<b>13</b>					<b>105</b>	<b>27</b>
<b>Tongs:</b>								
Oysters, market—								
Public	334,243	15,280			238,581	11,025		
Private	10,500	480			10,500	525		
<b>Total</b>	<b>344,743</b>	<b>15,760</b>			<b>249,081</b>	<b>11,550</b>		
<b>Grand total</b>	<b>946,942</b>	<b>58,599</b>	<b>25,625</b>	<b>2,050</b>	<b>678,381</b>	<b>47,361</b>	<b>2,637,539</b>	<b>72,539</b>

## YIELD OF SHORE FISHERIES OF TEXAS IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Chambers.		Galveston.		Harris.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Seines:</b>						
Angel fish .....					124	\$7
Black drum .....	400	\$20	3,125	\$200	8,250	1,205
Catfish .....	100	8	1,670	80	5,000	265
Croaker .....	300	18	7,500	480	5,125	398
Flounders .....	500	43	500	64	1,125	131
King whiting .....			6,000	500	2,750	357
Mullet .....	600	12	1,000	45	10,500	401
Pompano .....			100	19	339	64
Redfish or red drum .....	1,000	60	8,750	1,050	19,525	2,570
Sheepshead .....	200	14	2,500	250	9,375	805
Spanish mackerel .....			125	19	224	34
Squeteagues or "sea trout" .....	1,500	125	10,000	1,280	20,625	3,100
Shrimp .....					2,000	175
Terrapin .....					1,350	540
<b>Total .....</b>	<b>4,600</b>	<b>300</b>	<b>41,270</b>	<b>3,987</b>	<b>86,312</b>	<b>10,052</b>
<b>Trammel nets:</b>						
Black drum .....			1,875	120		
Catfish .....			335	16		
Croaker .....			8,750	560		
Flounders .....			250	32		
King whiting .....			6,250	625		
Mullet .....			1,500	47		
Pompano .....			200	38		
Redfish or red drum .....			10,625	1,275		
Sheepshead .....			3,125	315		
Spanish mackerel .....			125	19		
Squeteagues or "sea trout" .....			11,250	1,440		
<b>Total .....</b>			<b>44,285</b>	<b>4,487</b>		
<b>Cast nets: Shrimp .....</b>			<b>8,000</b>	<b>640</b>		
<b>Lines:</b>						
Black drum .....			1,000	80	625	46
Catfish .....	68,000	5,440	13,330	880	19,970	1,080
Croaker .....			375	33	312	24
Flounders .....			750	114	310	36
Grunts .....			1,000	100		
Jewfish .....			6,000	660		
King whiting .....			7,250	875		
Pompano .....			1,200	300		
Redfish or red drum .....			3,875	560	7,500	1,000
Sheepshead .....			1,250	150	1,875	160
Spanish mackerel .....			5,000	600		
Squeteagues or "sea trout" .....			7,250	1,100	18,750	2,800
Crabs, hard .....			32,000	2,400	157,500	8,000
<b>Total .....</b>	<b>68,000</b>	<b>5,440</b>	<b>78,280</b>	<b>7,852</b>	<b>206,842</b>	<b>13,146</b>
<b>Spears:</b>						
Flounders .....			5,000	640		
Sheepshead .....			3,750	375		
<b>Total .....</b>			<b>8,750</b>	<b>1,015</b>		
<b>Minor apparatus:</b>						
Crabs—						
Hard .....			3,000	250		
Soft .....					700	175
Oysters, market, private .....			18,375	1,650		
<b>Total .....</b>			<b>21,375</b>	<b>1,900</b>	<b>700</b>	<b>175</b>
<b>Tongs:</b>						
Oysters, market—						
Public .....			380,730	15,300	118,811	5,657
Private .....			7,875	700		
<b>Total .....</b>			<b>388,605</b>	<b>16,000</b>	<b>118,811</b>	<b>5,657</b>
<b>Grand total .....</b>	<b>72,600</b>	<b>5,740</b>	<b>590,565</b>	<b>35,881</b>	<b>412,665</b>	<b>29,030</b>

## YIELD OF SHORE FISHERIES OF TEXAS IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Jefferson.		Matagorda.		Nueces.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Seines:</b>						
Black drum.....	1,500	\$132	46,829	\$2,200	461,972	\$18,478
Bluefish.....			250	28		
Catfish.....	2,800	237	13,100	895	3,085	125
Croaker.....	3,000	280	60,729	2,843	22,250	890
Flounders.....	537	63	4,138	352	27,636	1,785
King whiting.....	600	60	3,400	160	1,000	40
Mullet.....	1,000	60	563	27	1,505	35
Pompano.....			406	50	3,136	417
Redfish or red drum.....	5,500	750	36,625	3,083	146,710	10,330
Sea—						
Bass.....	1,625	150				
Gar.....			2,125	172	18,065	1,340
Sheepshead.....	6,250	625	15,812	1,303	22,750	1,070
Spanish mackerel.....			625	75	272	35
Squeteagues or "sea trout".....	5,125	700	59,043	6,383	172,985	14,061
Shrimp.....	1,500	185	284	36	5,000	250
Terrapin.....	1,000	350	250	50		
Turtles.....	2,000	120	120	7	1,000	150
Total.....	32,437	3,712	244,299	17,664	887,366	49,006
<b>Trammel nets:</b>						
Black drum.....			2,500	120		
Catfish.....			335	20		
Croaker.....			1,656	79		
Flounders.....			125	11		
King whiting.....			375	18		
Mullet.....			3,250	81		
Redfish or red drum.....			4,875	395		
Sheepshead.....			375	30		
Squeteagues or "sea trout".....			9,250	955		
Total.....			22,741	1,709		
<b>Gill nets:</b>						
Black drum.....					3,000	120
Catfish.....			335	21		
Croaker.....			500	23		
King whiting.....			63	3		
Redfish or red drum.....			1,000	86	9,600	780
Squeteagues or "sea trout".....			1,375	150	43,000	4,250
Total.....			3,273	283	55,600	5,150
<b>Cast nets: Shrimp.....</b>	1,000	80			140,000	7,000
<b>Lines:</b>						
Black drum.....	700	61	625	30		
Catfish.....	6,670	445	10,008	855		
Croaker.....	125	10				
Flounders.....	565	73				
Jewfish.....			625	50	5,000	450
Redfish or red drum.....	6,300	840	7,000	611	5,000	450
Sheepshead.....	1,125	124			45,000	2,250
Spanish mackerel.....					25,000	2,500
Squeteagues or "sea trout".....	3,125	450	2,500	280	5,000	550
Total.....	18,610	2,003	20,758	1,826	85,000	6,200
<b>Spears: Flounders.....</b>			21,250	1,755	50,000	4,000
<b>Minor apparatus:</b>						
Turtles.....					3,000	150
Oysters, market, public.....					30,086	1,719
Total.....					33,086	1,869
<b>Tongs:</b>						
Oysters, market—						
Public.....	39,375	1,500	755,251	31,683		
Private.....			4,781	209		
Total.....	39,375	1,500	760,032	31,892		
<b>Grand total.....</b>	91,422	7,295	1,072,353	55,129	1,251,052	73,225

## YIELD OF SHORE FISHERIES OF TEXAS IN 1918 BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Orange.		San Patricio.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Seines:</b>						
Angel fish.....					124	\$7
Black drum.....	1,000	\$88	5,300	\$212	1,720,649	37,792
Bluefish.....			200	30	1,575	222
Catfish.....	1,000	110	500	25	61,855	3,026
Croaker.....	1,500	150			149,008	6,910
Flounders.....	250	30	1,000	85	47,440	3,271
Jewfish.....					3,000	120
King whiting.....	400	40			15,871	1,291
Mullet.....	1,000	70			37,564	1,207
Pompano.....			200	25	10,481	1,327
Redfish or red drum.....	2,400	350	7,200	648	1,082,398	57,786
Sea—						
Bass.....					6,625	350
Gar.....			700	63	73,493	4,132
Sheepshead.....	3,000	300	800	40	102,791	6,472
Spanish mackerel.....			100	5	3,965	384
Squeteagues or "sea trout".....	2,400	350	4,000	440	1,184,698	75,506
Shrimp.....					8,784	646
Terrapin.....					2,600	940
Turtles.....					3,120	277
<b>Total.....</b>	<b>12,950</b>	<b>1,488</b>	<b>20,000</b>	<b>1,573</b>	<b>4,516,041</b>	<b>201,666</b>
<b>Trammel nets:</b>						
Bluefish.....					350	42
Black drum.....	250	22			61,369	2,682
Catfish.....	300	30			9,360	433
Croaker.....	800	80			17,234	980
Flounders.....	150	17			1,710	157
King whiting.....	150	15			7,962	748
Mullet.....					12,749	481
Pompano.....					888	125
Redfish or red drum.....	800	120			113,118	9,968
Sea gar.....					2,562	180
Sheepshead.....	1,500	150			15,338	1,268
Spanish mackerel.....					156	23
Squeteagues or "sea trout".....	1,000	150			165,894	16,320
<b>Total.....</b>	<b>4,950</b>	<b>584</b>			<b>408,690</b>	<b>33,407</b>
<b>Gill nets:</b>						
Black drum.....			1,000	40	6,125	243
Bluefish.....			1,000	120	1,000	120
Catfish.....					8,920	354
Croaker.....					1,690	78
King whiting.....					341	100
Pompano.....					279	34
Redfish or red drum.....			8,000	720	34,350	2,771
Sheepshead.....			1,000	50	1,000	50
Squeteagues or "sea trout".....			19,000	2,075	105,875	10,230
<b>Total.....</b>			<b>30,000</b>	<b>3,005</b>	<b>159,580</b>	<b>13,980</b>
<b>Cast nets:</b>						
Spanish mackerel.....			5,000	250	5,000	250
Shrimp.....					154,000	8,030
<b>Total.....</b>			<b>5,000</b>	<b>250</b>	<b>159,000</b>	<b>8,280</b>
<b>Fyke nets:</b>						
Redfish or red drum.....					1,875	150
Squeteagues or "sea trout".....					2,500	200
<b>Total.....</b>					<b>4,375</b>	<b>350</b>
<b>Lines:</b>						
Black drum.....					3,075	222
Catfish.....	1,500	165	1,000	50	163,008	11,880
Croaker.....					812	67
Flounders.....					1,625	223
Grunts.....					1,000	100
Jewfish.....					11,625	1,160
King whiting.....					7,250	875
Pompano.....					1,200	300
Redfish or red drum.....	600	90	3,000	270	40,525	4,415
Sheepshead.....			5,000	250	54,250	2,934
Spanish mackerel.....					30,500	3,315
Squeteagues or "sea trout".....			16,000	1,760	73,750	8,940
Crabs, hard.....					190,244	10,422
<b>Total.....</b>	<b>2,100</b>	<b>255</b>	<b>25,000</b>	<b>2,330</b>	<b>578,864</b>	<b>44,353</b>

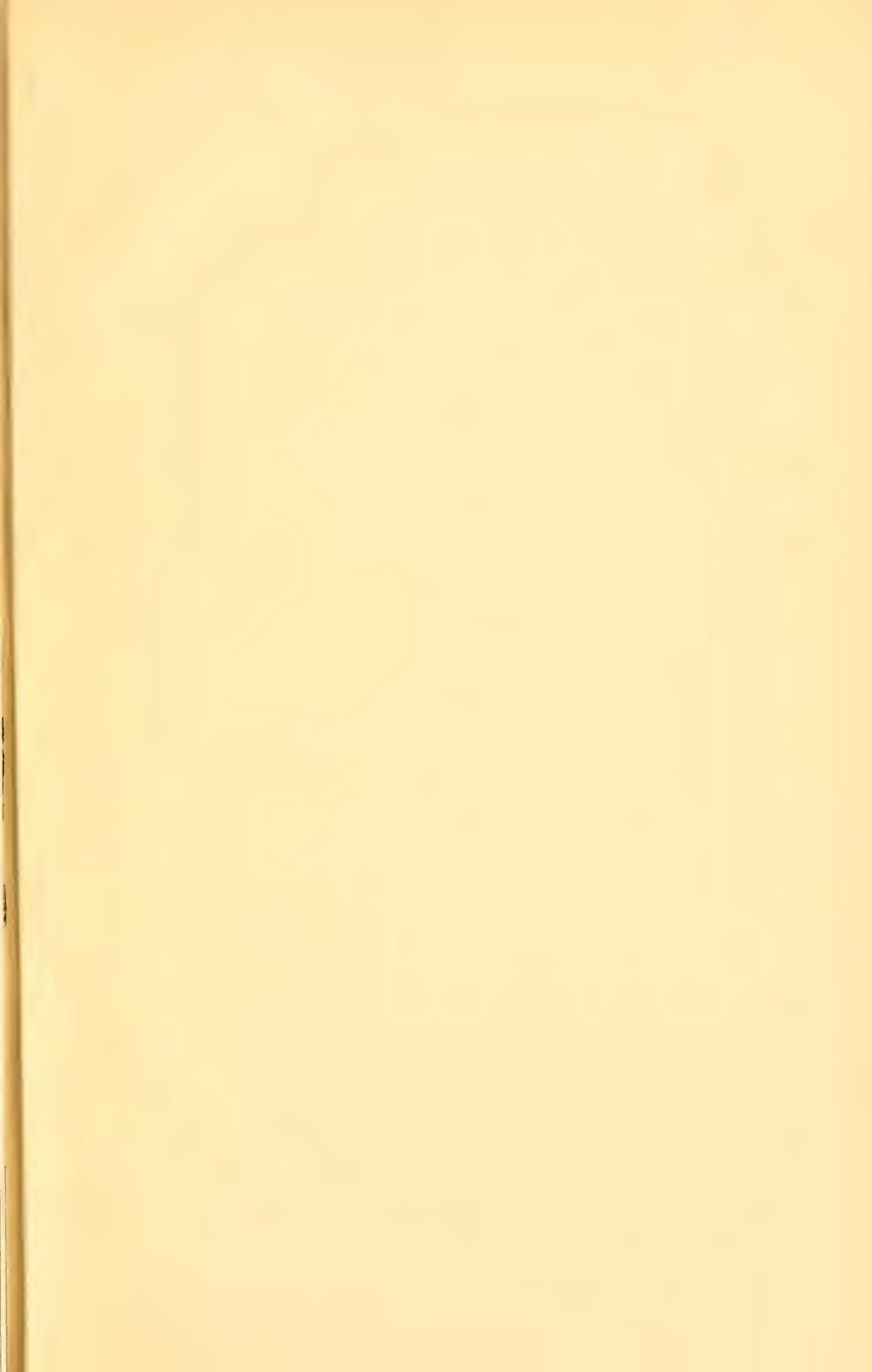
## YIELD OF SHORE FISHERIES OF TEXAS IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

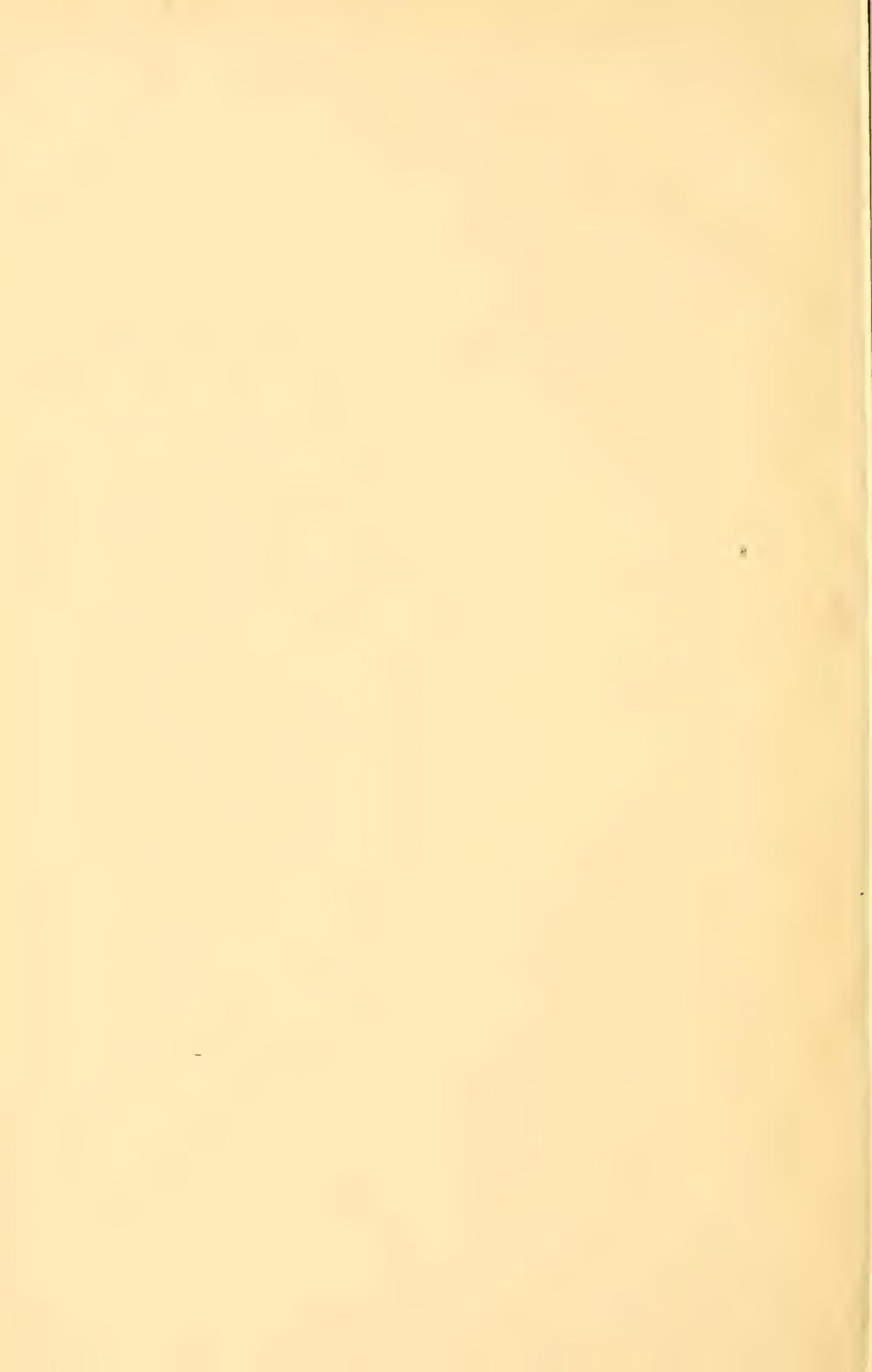
Apparatus and species.	Orange.		San Patricio.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<b>Spears:</b>						
Flounders.....			12,000	\$1,000	104,500	\$8,580
Sheepshead.....					3,750	375
Total.....			12,000	1,000	108,250	8,955
<b>Minor apparatus:</b>						
Crabs—						
Hard.....					3,000	250
Soft.....					700	175
Turtles.....					3,431	163
Oysters, market—						
Public.....					30,191	1,746
Private.....					18,375	1,650
Total.....					55,697	3,984
<b>Tongs:</b>						
Oysters, market—						
Public.....	39,375	\$1,500			1,906,366	\$1,945
Private.....					33,656	1,914
Total.....	39,375	1,500			1,940,022	83,859
Grand total.....	59,375	3,827	92,000	8,158	7,930,519	398,834

## WHOLESALE FISHERY TRADE.

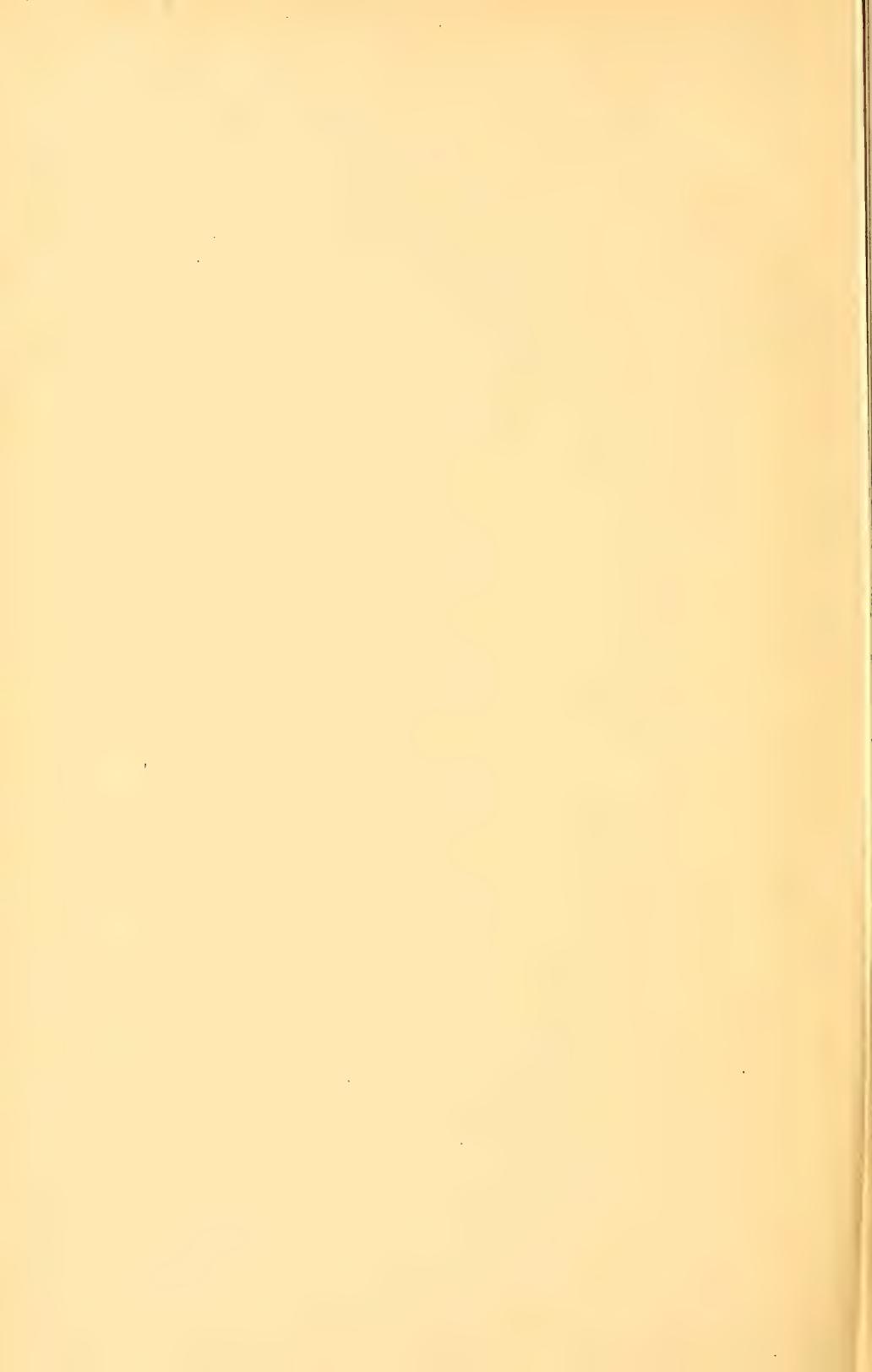
The wholesale trade in fishery products in Texas in 1918 was conducted by 35 establishments, one of which carried a small quantity of oysters in addition to handling fresh fish and raw oysters; two produced crushed oyster shells, lime, and dust; and two were engaged in the manufacture of dried scrap and oil from menhaden, the remainder dealing principally in fresh fish and oysters. The wholesale establishments were valued at \$396,288, used cash capital to the amount of \$36,400, and employed 450 persons, to whom \$150,330 were paid in wages during the year. In addition to the pack of oysters and the crushing of oyster shells for poultry food, which are included under Louisiana, other products having a value of \$215,169 were prepared.



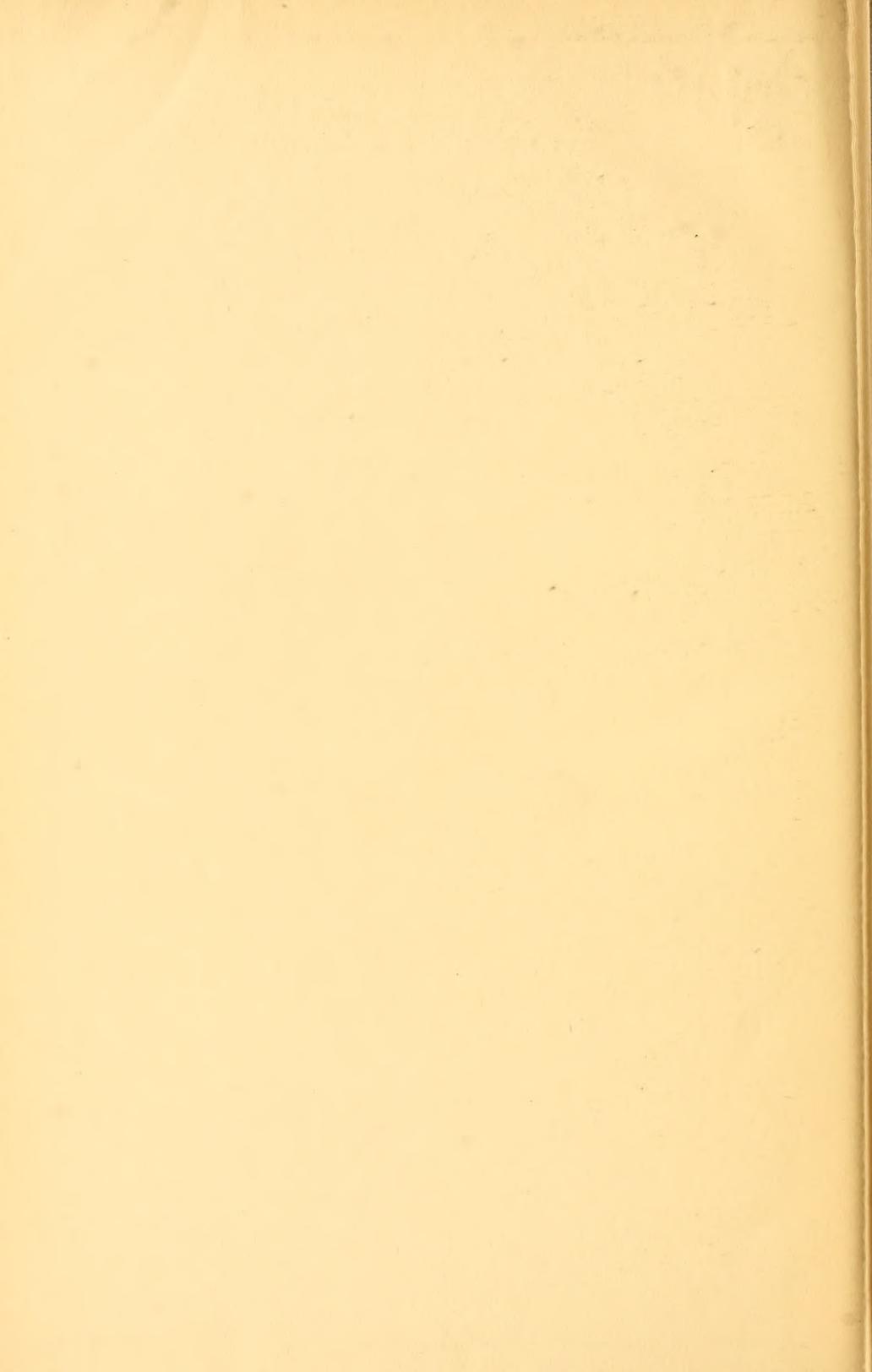


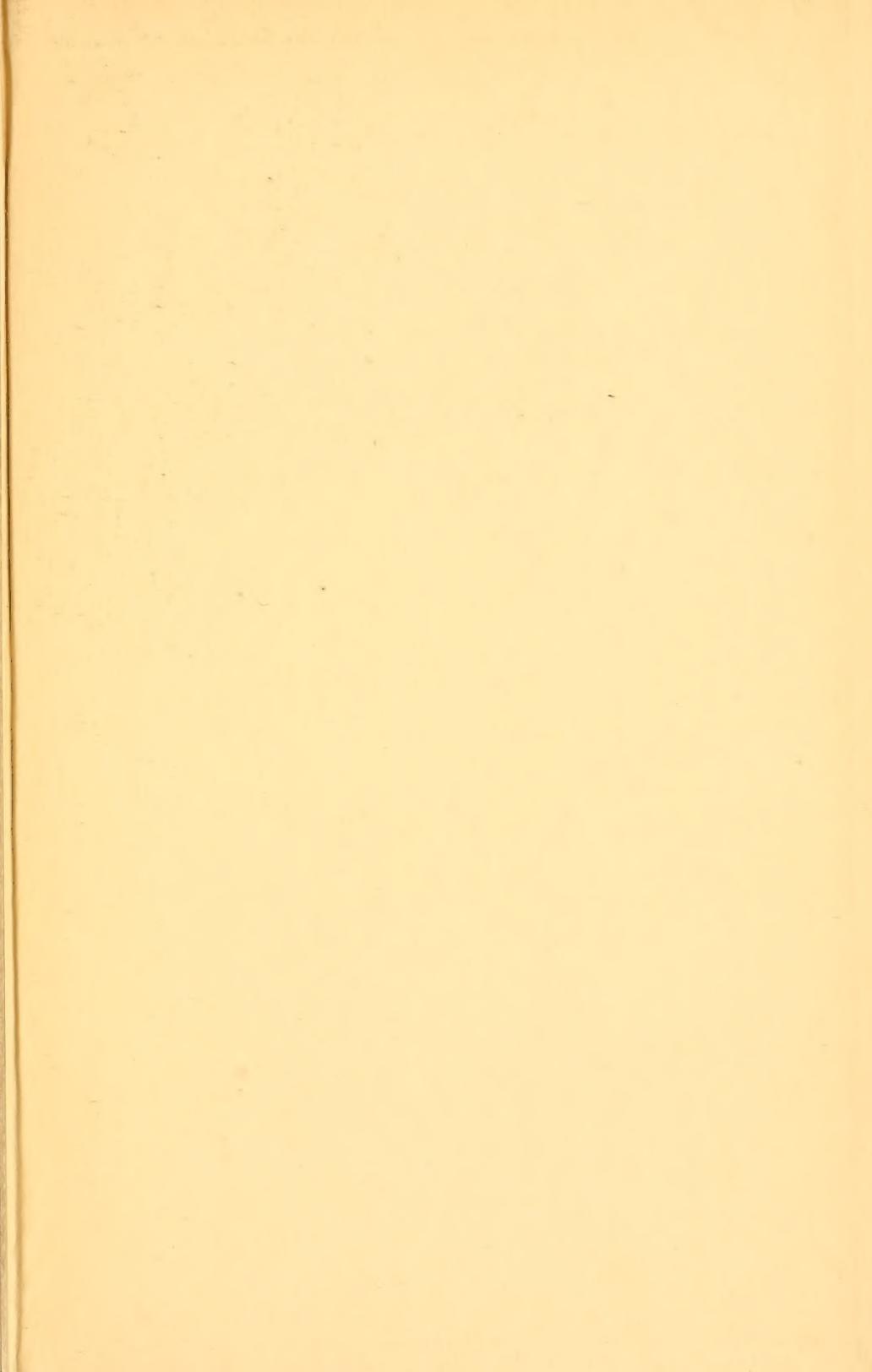












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