

3.—NOTES ON AN INVESTIGATION OF THE MENHADEN FISHERY IN 1894, WITH SPECIAL REFERENCE TO THE FOOD-FISHES TAKEN.

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GENERAL IMPORTANCE OF THE MENHADEN INDUSTRY.

The taking of menhaden (*Brevoortia tyrannus*), for the purpose of converting them into oil and guano, is one of the most prominent fisheries prosecuted with vessels on the eastern coast of the United States. The fishery is carried on in every coast State from Maine to North Carolina, inclusive, with the exceptions of Massachusetts and New Hampshire, and is very extensive in Rhode Island, Connecticut, New York, New Jersey, and Virginia. Purse seines, operated from steam and sail vessels, are used in taking the fish. In the more northern States steamers predominate, while south of New Jersey sail vessels are more numerous. The shore industry dependent on the fishery is very important, affording employment to many persons and representing large investments.

At present between 50 and 55 menhaden factories are in operation annually; the value of the plants is about \$925,000, and the additional cash capital is \$700,000. The number of persons employed as factory hands and in other capacities about the factories is about 1,600. The vessels engaged in taking the menhaden and in transporting the catch number about 135, worth, with their apparatus and outfit, over \$950,000. The fishermen number about 1,800. The total investment in this industry amounts to fully \$2,580,000.

The number of fish taken and the quantity of oil and fertilizer prepared annually vary considerably from year to year. Some years over 700,000,000 fish have been handled by the factories. The fish are much fatter some seasons than others, and similar quantities will yield very different quantities of oil. During the past three or four years, between 400,000,000 and 600,000,000 menhaden have been utilized each season, the value of the fish in a crude state being from \$1 to \$4 per 1,000, depending on their fatness. The average value of the manufactured products has been over \$1,000,000.

At the meeting of the United States Menhaden Association in New York in January, 1895, the report of the secretary showed that 44 factories were in operation during the season of 1894, employing 1,055 men on shore and 1,301 on vessels; the fishing fleet consisted of 28 sailing vessels and 56 steamers; the total number of fish utilized was 533,361,900, which yielded 1,999,505 gallons of oil and 47,639 tons of scrap. These figures apply only to menhaden firms who are members of the association.

OBJECT AND METHODS OF THE INQUIRY.

The menhaden fishery has received much attention from Congress, the legislatures of most of the States whose citizens are engaged therein, and several Federal and State courts. The fishery has encountered great opposition on account of its supposed injurious influence on the abundance of other fishes, especially those species which prey upon the menhaden and are taken by anglers and in the professional line fisheries. In recent years, probably no fishery on the Atlantic coast has attracted more attention, occasioned more discussion, and been the object of such marked opposition.

The contention is made by sportsmen and others, and very generally accepted by the newspapers and the public, that in menhaden fishing large quantities of game and other food-fish are taken; that these are usually landed at the factories, where they serve the same purpose as menhaden; that on account of the extensive menhaden fishing along the coast the supply of food-fish has been greatly reduced; that important fishing-grounds for game fishes have been ruined; that where food-fish are not actually caught in the purse seines they are driven off; that fish which frequent the bays and there undergo the spawning process are prevented from reaching the desired grounds by the presence of menhaden vessels at or near the mouths of the bays. Of the foregoing objections to the fishery, greater importance is laid on the first two points.

All of these statements are denied by the menhaden fishermen. They assert that the quantities of food-fish taken in the menhaden fishery are insignificant and do not even regularly supply the vessels' crews with food; that desirable fishes are not utilized for oil and guano; that the food-fish destroyed in a season by any one of the thousands of sharks killed each year in the menhaden fishery would vastly outnumber those caught by the entire fleet of vessels. The menhaden fishermen contend that there is no proof that their operations have even remotely affected the abundance of other fish and that this fishery is as legitimate and no more destructive than many other fisheries which are sanctioned by popular opinion.

Neither party to the controversy has brought forward any facts or made any arguments which the other felt bound to indorse, owing to the *ex parte* nature of the testimony; and during the entire controversy there has been an absence of detailed authentic data bearing on that phase of the subject now under consideration.

In the Report of the Commissioner of Fish and Fisheries for 1892 the following statement is made :

Since it appears probable that the menhaden fishery will for some years at least be the object of legislative consideration and personal controversy, it seems important to secure and have available for use all information that can possibly be obtained that is calculated to aid in the solution of the very difficult problems involved. It is therefore conceived that valuable material relating to the special point under discussion may be obtained by placing the field force of the division [of fisheries] on vessels fishing off various parts of the coast, and having the agents make actual records of the results of every seine-haul during a period of two or three months. While this plan would involve a study of a small part of the menhaden fleet, it would nevertheless afford a valuable basis for generalization.

In 1894 the Commission made arrangements for carrying on the inquiries in question. Owing to the necessity for undertaking important field work of another character, it was impossible to utilize the full force of the division to which the investigation was assigned, and it became necessary to restrict the inquiry to two vessels, whose operations during the entire season it was the intention to cover.

Before the beginning of the fishing season, correspondence was opened with several prominent owners of vessels and operators of factories, explaining the object of the investigation and asking permission to place an agent on one of their vessels. It was finally decided to take advantage of the offers of Messrs. Luce Brothers, of Niantic, Connecticut, and Mr. A. J. Morse, manager of the American Fish Guano Company, of Harborton, Virginia, the Commission meeting all expenses connected with the work.

The steamer *Quickstep*, hailing from New London, Connecticut, was the vessel offered for this purpose by Messrs. Luce Brothers. To this vessel, on May 16, 1894, the Commission assigned as its agent Mr. Clarence E. Latimer, a former employee of the office, recently connected with the fisheries division of the Eleventh Census. At the end of two weeks, illness necessitated Mr. Latimer's withdrawal from the work, and his place was supplied by Mr. W. P. Hay, teacher in zoölogy in the Washington City High School. On June 22, owing to insufficient accommodations on the *Quickstep*, Mr. Hay was transferred to the steamer *Arizona*, of New London, which vessel was the basis for observations during the remainder of the season. On August 1, Mr. Hay was relieved by Mr. Andrew E. Marschalk, who continued on the vessel until the suspension of fishing, on November 7.

The *Arizona* is a screw steamer of 103 net tons, valued, with its outfit, at \$25,000. The vessel's crew consists of 2 captains, 2 mates, 1 pilot, 1 engineer, 2 firemen, 2 cooks, and 30 fishermen. Two purse seines are used, the vessel being what is known as a "double-gang" steamer; only one other such steamer was employed in 1894. The seines are about 11,000 meshes (1,400 feet) long and 715 meshes (100 feet) deep, the sizes of mesh being $2\frac{1}{8}$ and $2\frac{1}{4}$ inches, stretch measure; the cost of each seine rigged is about \$900. Four seine boats and two "drive" or "striker" boats are carried.

On May 7, Mr. E. F. Locke, field agent of the Commission, began his observations on the steamer *J. W. Hawkins*, of Onancock, Virginia, and continued with the vessel until December 3, being relieved during the month of October by Mr. Edward E. Race, field agent.

The *J. W. Hawkins* is a screw steamer of 125 net tons, with a value of over \$20,000, including outfit. It carries 1 captain, 1 mate, 2 engineers, 2 firemen, 2 cooks, and 18 fishermen. Two seines are carried, but only one is in use at a time; it was 9,520 meshes (900 feet) long and 750 meshes (85 feet) deep; its value was about \$700. During a part of the season the vessel had a larger seine, 1,500 feet long and 150 feet deep.

The instructions issued to the agents called for the exercise of great care in obtaining and recording correct data. For each haul of the seine it was required that a record be made showing the following information: Date, hour, location of fishing-ground, quantity of menhaden taken, the number of each kind of other fish taken, the disposition made of fish other than menhaden, and physical observations on the condition of water, direction of wind, etc. On charts the position of each seine haul was indicated in such a way that reference might be made to the record for a history of the haul. General notes on the condition of the fishery, the abundance, size, movements, and spawning condition of the fish were desired. The agents were cautioned to avoid the expression of any opinion as to results of the investigation and to refrain from a discussion of the general menhaden question.

OUTLINE OF THE VESSELS' MOVEMENTS.

By the selection of vessels making their headquarters on Long Island Sound and Chesapeake Bay, respectively, and fishing chiefly in or near these bodies of water, it was possible to cover the most important fishing regions on the coast and to secure data that were typical of a large part of the menhaden fleet. It happened, however, that the vessels in question did not confine their operations to the vicinity of the factories which they supplied, but extended their cruises over a wide area, and, in fact, took fish from Maine to North Carolina, inclusive.

Prior to June 22, during the period when the observations were conducted on the steamer *Quickstep*, that vessel mostly frequented the outer coast of Long Island, a few lots of fish being obtained from the northern part of the New Jersey coast and a few off Rhode Island. During the last few days of June and until July 3 the *Arizona* fished in Long Island Sound and off the adjacent coasts of Rhode Island and Massachusetts. From July 5 to 15 most of the time was spent in New York Bay, one visit being made to the New Jersey coast. During the last two weeks in July most of the fishing was done off the southern part of New Jersey and in New York Bay. During August and September practically all the time was passed in or near the mouth of Delaware Bay, where an unprecedentedly large body of fish was found. By October 1 the vessel moved east, and during the remainder of the season restricted its operations to Gardiner Bay, Neapeague Bay, and the Long Island coast.

The observations on the *J. W. Hawkins* began May 7 and ended December 3, fishing having commenced a few days before the agent reached the vessel. Up to June 18 all the fishing was done in Chesapeake Bay. The vessel then went east, and on June 29 began a six weeks' fishing cruise on the coast of Maine, chiefly near the mouth of the Kennebec River and in Casco Bay. On August 6 the vessel left Maine waters and started for the Chesapeake. Ten days were passed in Boston Harbor, where fish were found to be abundant. Fishing was renewed in the Chesapeake on August 30 and continued until October 13. The steamer then again cruised east and had a few days' fishing off the coast of New Jersey and New York. The remainder of the season was passed near the mouth of the Chesapeake and along the coast of Virginia and North Carolina, the final set being made November 27, 8 miles north of Cape Lookout, North Carolina.

GENERAL RESULTS OF THE FISHERY.

The season of 1894 was, on the whole, considered a very fair one for the menhaden fishery. While none of the menhaden firms made a great deal of money, nearly all had a balance to their credit at the close of operations. There was a large body of menhaden along the entire coast from Maine to North Carolina. One of the vessels on which observations were conducted had a much larger catch than usual, but the other's output was less than the average in recent years.

During the time when observations were conducted on the *Quickstep*, that is, from May 16 to June 21, the catch of that vessel was 2,532,000 menhaden. The number of menhaden taken by the *Arizona* in the remainder of the season was 16,174,800. The combined catch of these two vessels, while their operations were being studied by agents of the Commission, was therefore 18,706,800 menhaden. The *Arizona* took about 5,870,000 fish before June 22, and during the entire season obtained 22,000,000 menhaden. The catch in 1894 was the largest in the history of the vessel, with the exception of one season, when nearly 23,000,000 were secured.

The catch of the steamer *J. W. Hawkins* during the year 1894 was 9,301,955 menhaden. This was much less than in the previous season and far below the average of the past two or three years, and was smaller than that of other steamers fishing for the same firm. Prior to the arrival of the Commission's agent the vessel took 43,000 menhaden.

The inquiries of the Commission thus related to and completely covered the fishing operations during which 27,965,755 menhaden were caught, this quantity representing about one-twentieth of the total yield of menhaden in 1894, and affording, with the other data obtained, a reasonable basis for generalizations on certain important points.

The five weeks' fishing of the *Quickstep* on the Long Island coast was quite successful. Fish were abundant and on some days large catches were taken. The average number of fish to a set was 43,000. Each of 9 hauls out of a total of 60 resulted in the capture of between 100,000 and 200,000 fish. On June 18 230,000 menhaden were secured in 3 hauls off Shinnecock, Long Island, and on June 14 220,000 fish were taken in 4 hauls off Bridgehampton and Amagansett, these being the largest daily catches. At a single haul off Shinnecock (on June 19) 200,000 fish were obtained.

The principal feature of the operations of the *Arizona* was the extent of the fishing in Delaware Bay and off the adjacent coasts of Delaware and New Jersey. Of 558 times the seines of the *Arizona* were set between June 22 and November 2, 212 sets were made in or off the mouth of Delaware Bay and 164 additional sets in the ocean immediately adjacent to Capes May and Henlopen. Menhaden were more abundant in the Delaware Bay region during August and September than in any previous season, so far as available records show, and the *Arizona* took more menhaden in a single month than during a similar period in any other year in her history. The August catch of the vessel was 6,434,500 fish, of which 2,744,000 were secured in Delaware Bay, and 3,156,500 off the adjacent ocean shores. In September 3,210,000 fish were taken in this bay and 1,440,000 off the adjoining coasts.

The average number of menhaden taken at each seine haul of the *Arizona* was 30,850. While this was less than the average for the *Quickstep*, there were many days when the *Arizona's* total catch was double the largest daily yield of the other vessel. The single haul in which the largest number of menhaden were secured was on September 1, off Hereford Inlet, New Jersey, when 150,000 were taken. The following days were noteworthy in the *Arizona's* fishing operations for the quantities of menhaden caught: July 9, 362,000 fish in 14 sets in New York Bay; July 16, 554,500 fish in 9 sets off Squan Beach, New Jersey; July 19, 535,000 fish in 6 sets off the southern shore of New Jersey; July 23, 388,000 fish in 8 sets in New York Bay; August 6, 525,000 fish in 15 sets off the southern coast of New Jersey; August 7, the same number in 11 sets on the same ground; August 29, 398,000 fish in 12 sets in and near Delaware Bay; August 30, 395,000 fish in 7 sets off Cape May; September 1, 475,000 fish in 5 sets off the southern part of New Jersey; September 12, 425,000 fish in 12 sets in Delaware Bay and vicinity; September 17, 379,000 fish in 16 sets in Delaware Bay; September 20, 451,000 fish in 8 sets in the same place; October 27, 321,500 fish in 9 sets off Montauk Point, New York.

Of the 1,078 seine hauls of these vessels, 132 resulted in the capture of no menhaden, owing to various causes. Shyness of the fish, failure to drop the seine around the moving school in a way to intercept it, fouling of the seine by the tide,

breaking of essential parts of the net, and several other causes contribute to the making of a relatively large number of "stabs," as such failures are called. The *J. W. Hawkins* had 96 and the *Arizona* and *Quickstep* 36 "stabs."

KINDS AND NUMBERS OF OTHER FISH TAKEN.

The extensive areas covered by these vessels, the size of the seines used, and the frequency with which the hauls were made, would naturally be expected to yield a large variety of fishes that were among or adjacent to the schools of menhaden. An analysis of the records shows that there were taken with the menhaden some sixty species of fishes, which, considering the richness of the fish fauna of the east coast, is perhaps a smaller number than might have been anticipated.

The fish which appear most prominently in the returns are those which, like the menhaden, swim at or near the surface, such as bluefish, alewives, shad, butter-fish, and mackerel. With the exception of flounders and skates, which are taken in comparatively shallow water, the typical bottom fish, such as cod, pollock, hake, haddock, etc., are very sparingly represented in the catch.

The number of other fish taken with the menhaden was 94,795. Of these, 93,893 were what are ordinarily termed food-fish, and 902 were of no recognized value as food. The former consisted chiefly of a fish useful in the manufacture of oil and fertilizer in addition to having considerable value as food and bait. Omitting these, the number of food-fish taken was 6,990.

Outside of the menhaden more alewives were taken than all other fishes combined. Over 86,000 appear in the returns, nearly all being caught on the New England coast by one vessel; about half were obtained at one haul in Boston Harbor. These fish were usually among schools of menhaden, although in some instances the alewives greatly outnumbered the menhaden or appeared to be unmixed with other fish. Alewives swim at the surface like menhaden, and, when accompanied by menhaden, the entire school may be mistaken for the latter fish. The alewives contain some oil, and are suitable for use at the menhaden factories. On the Maine coast, where they are known as "kyacks" or "blueback herrings," they have for many years been utilized in larger or smaller quantities for fertilizer. In addition to the alewives retained, a number of large schools were released after their identity was discovered; these do not appear in the returns.

The fish of which the next largest number was taken was the bluefish. Only a few single seine hauls yielded a noteworthy number of bluefish, the bulk of the catch being made up of fish taken in small quantities in numerous hauls. The aggregate number was 2,274. The largest number secured in one haul was 140; this was in Chesapeake Bay.

The shad caught with the menhaden numbered 1,816. These were taken under the same conditions as the alewives, and nearly all were obtained at the mouth of the Kennebec River, Maine; in three seine-hauls, on July 5, 11, and 16, 1,700 were caught with 111,200 menhaden, 6,400 alewives, and small numbers of skates, flounders, mackerel, haddock, goosefish, and other species.

About 800 butter-fish, mostly of a size too small to serve as food, were caught. Two hundred of these were taken in two hauls.

The mackerel family is represented in the catch by the common mackerel, the Spanish mackerel, the cero, and the bonito; the numbers of each of these fish appearing in the returns are 631, 150, 3, and 35, respectively.

Nearly 500 squeteague or "sea trout" were taken. Of other members of the drum family, the croaker and spot were obtained in considerable numbers, while the red drum and the black drum were rarely caught.

Flounders belonging to four species were often seined, although the aggregate catch was comparatively small. The summer flounder was taken in largest numbers.

Nearly 400 sharks were secured. Among the species represented were the common dogfish, the dusky shark, the hammerhead shark, the thresher, the sand shark or shovelnose shark, and the angel-fish; the dogfish and dusky shark predominating in numbers.

Almost as numerous as the sharks were the skates and stingrays. Of the 370 taken, a very large percentage were brier rays and common skates.

The cod family was represented in the catch by 1 cod, 1 pollock, 23 haddock, 40 hake, and 30 whiting or silver hake.

Following is a detailed statement of the number and kinds of fish taken, exclusive of menhaden:

Kind of fish.	Number.	Kind of fish.	Number.
Alewives or herring (<i>Clupea pseudoharengus</i> , <i>C.estivalis</i>).....	86,898	Pompano (<i>Trachinotus carolinus</i>).....	8
Amber-fish (<i>Seriola dumerilii landi</i>).....	1	Rudder-fish (<i>Seriola zonata</i>).....	1
Anchovy (<i>Stolephorus mitchilli</i>).....	2	Sculpins (<i>Cottus</i> , species).....	19
Bluefish (<i>Pomatomus saltatrix</i>).....	2,274	Soup (<i>Stenotomus chrysops</i>).....	73
Bonito (<i>Sarda sarda</i>).....	35	Sea bass (<i>Centropristis striatus</i>).....	39
Butter-fish (<i>Stromateus triacanthus</i>).....	811	Sea herring (<i>Clupea harengus</i>).....	5
Catfish (<i>Ameiurus albidus</i>).....	2	Sea-horse (<i>Hippocampus hudsonius</i>).....	4
Cero (<i>Scomberomorus regalis</i>).....	3	Sea-raven (<i>Henitripterus americanus</i>).....	1
Cod (<i>Gadus morrhua</i>).....	1	Sea-robins (<i>Prionotus carolinus</i> , chiefly).....	43
Croaker (<i>Micropogon undulatus</i>).....	134	Shad (<i>Clupea sapidissima</i>).....	1,816
Cunner (<i>Ctenolabrus adpersus</i>).....	4	Sharks (<i>Carcharinus obscurus</i> , <i>Squalus acanthias</i> , <i>Sphyrna zygaena</i> , <i>Carcharias americanus</i> , <i>Mustelus canis</i> , <i>Alopias vulpes</i> , <i>Squatina squatina</i>).....	388
Cutlas-fish or hairtail (<i>Trichiurus lepturus</i>).....	2	Skates and rays (<i>Raja erinacea</i> , <i>R. eglanteria</i> , <i>R. levis</i> , <i>Dasyatis centrurus</i> , <i>Rhinoptera quadriloba</i>).....	372
Drums (<i>Pogonias cromis</i> , <i>Sciaen ocellata</i>).....	11	Spanish mackerel (<i>Scomberomorus maculatus</i>).....	150
Filefish or foolfish (<i>Alutera schlegelii</i>).....	9	Spot (<i>Leiostomus xanthurus</i>).....	20
Flounders (<i>Paralichthys dentatus</i> , <i>Pleuronectes maculatus</i> , <i>Achirus fasciatus</i> , <i>Limanda ferruginea</i>).....	369	Squeteague or weakfish (<i>Cynoscion regalis</i> , <i>C. maculatus</i>).....	8
Gar (<i>Tylosurus</i> , species).....	6	Striped bass (<i>Morone saxatilis</i>).....	1
Goosefish (<i>Lophius piscatorius</i>).....	11	Swellfish, swell-toads (<i>Chilomycterus geometricus</i> , <i>Tetrodon turgidus</i>).....	6
Haddock (<i>Melanogrammus aeglefinus</i>).....	23	Tautog (<i>Tautoga onitis</i>).....	17
Hake (<i>Phycis chuss</i>).....	40	Whiting or silver hake (<i>Merluccius bilinearis</i>).....	30
Hickory shad (<i>Clupea mediodoris</i>).....	9		
Kingfish (<i>Menticirrhus saxatilis</i>).....	1	Total.....	94,795
Lamprey (<i>Petromyzon marinus</i>).....	11		
Lumpfish (<i>Cyclopterus lumpus</i>).....	8		
Mackerel (<i>Scomber scombrus</i>).....	631		
Pipefish (<i>Siphostoma fuscum</i>).....	7		
Pollock (<i>Pollachius virens</i>).....	1		

The animals besides fish taken with the menhaden were not especially numerous or important, but represented a comparatively large number of species of mollusks, crustaceans, reptiles, echinoderms, and porifers, most of which were bottom forms. The mollusks consisted of 2 oysters (*Ostrea virginica*), 75 mussels (*Mytilus edulis*), and 34 squid (*Loligo pealei*). Besides 12 lobsters (*Astacus americanus*), and 322 blue crabs (*Callinectes hastatus*), numerous other crustaceans were obtained, such as rock-crabs, spider-crabs, hermit-crabs, shrimp, and horseshoe or king crabs, of which no accurate count was made. The order of reptiles was represented by 2 loggerhead turtles (*Thalassochelys caretta*) and 1 green turtle (*Chelonia mydas*). Several species of starfishes and sponges were taken on numerous occasions.

THE FISHING-GROUNDS AND THE FISH TAKEN ON EACH.

If the operations of the vessels be classified by fishing-grounds, a very interesting and suggestive presentation may be made. The *Arizona* did not fish south of Delaware and took the largest numbers of manhaden on the outer coasts of New York and New Jersey, and in New York and Delaware bays. The *J. W. Hawkins*, on the other hand, fished from North Carolina to Maine, but secured by far the most fish in Chesapeake Bay and on the western Maine coast.

Of the 619 sets of the seine made by the *Arizona* (and *Quickstep*), 212 were in Delaware Bay and 158 were off the eastern coast of New Jersey, these two regions yielding two-thirds of the vessels' catch of menhaden and an equally prominent part of other fish taken. In Delaware Bay comparatively few bluefish were obtained, the average catch being less than one fish to two seine-hauls. More butter-fish were here caught than elsewhere, although the average was only one fish to a set. The yield of other food-fish was insignificant. A conspicuous feature of the fishing in this bay was the relatively large number of sharks caught; more of these predaceous fishes were there destroyed than on any other grounds. Following is a summary of the operations of the *Arizona* on the different grounds (a):

Summary by fishing-grounds of the number of menhaden and other fish taken by the steamer *Arizona* in 1894.

Fish taken.	Long Island Sound.	New York Bay.	Neapeague Bay.	Gardiner Bay.	Delaware Bay.	Off Massachusetts coast.	Off Rhode Island coast.	Off New York coast.	Off New Jersey coast.	Off Delaware coast.	Total.
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Menhaden	466,800	1,009,000	423,000	520,000	5,935,500	15,000	86,500	3,093,500	6,159,500	998,000	18,708,800
Alewives <i>b</i>	5	8			16			1	5		35
Amber-fish								1	1		1
Anchovy		2									2
Bluefish		22	7		94			9	496	19	647
Butter-fish	3	99	30	1	226	3	8	62	157	8	597
Bonito	2				8				17	6	33
Croaker									30	10	40
Cunner	2										2
Drum					1				2		3
Flounders	108	36	9	4		1	22	32	51	6	260
Hake	1	3								1	5
Kingfish									1		1
Mackerel		6					175	93			274
Pipefish	1	4					2				7
Pompano					1						1
Rudder-fish										1	1
Scup		44	1					28			73
Sea bass								39	2		41
Sea-horse		3									3
Sea-raven				1							1
Sea-robins		11			1			13	17	1	43
Sculpins								3	2		8
Shad								6			8
Sharks	1	15			166		2		90	49	323
Skates and rays	33	19	26	25	18		3	33	139	7	303
Spanish mack'l.					8			86	12	2	108
Squeteague or weakfish		2			25		8	11	190	13	249
Striped bass				1							1
Swellfish								1			1
Tautog	1	5					11				17
Whiting or silver hake							8				8
Total	466,957	1,009,279	423,073	520,032	5,936,064	15,004	86,739	3,093,917	6,160,712	998,123	18,709,900
Seine-hauls	36	44	15	25	212	1	8	67	158	53	619

a In all tabular statements of the catch of the steamer *Arizona*, the operations of the steamer *Quickstep* up to June 21 are included (see page 238).

b Includes alewives, hickory shad, and sea herring.

The *J. W. Hawkins* made 315 seine sets in Chesapeake Bay and its tributaries out of a total of 459; 77 hauls were made on the Maine coast. Over two-thirds of the menhaden were taken in the former region. Among the most numerous food-fish caught were bluefish, butter-fish, alewives, mackerel, shad, and squeteague; of these only the bluefish, alewives, and shad were noticeably numerous. Nearly all the bluefish were obtained in Chesapeake Bay, where the average catch to a set was 5 fish; the butter-fish were taken on the Maine and Maryland coasts, and in the bay; the alewives were chiefly secured in Casco Bay, Maine, and Boston Harbor, Massachusetts; the mackerel were found on the coast of Maine and in Long Island Sound; practically all the shad were from Casco Bay and the mouth of the Kennebec River; the squeteague were principally from Chesapeake Bay and the North Carolina coast. The number of each kind of fish taken on each ground is shown in the following table:

Summary by fishing-grounds of the number of menhaden and other fish taken by the steamer *J. W. Hawkins* in 1894.

Fish taken.	Maine coast.	Massachusetts coast.	Long Island Sound.	New Jersey coast.	Maryland (ocean side).	Virginia (ocean side).	Chesapeake Bay and tributaries.	North Carolina coast.	Total.
	No.	No.	No.	No.	No.	No.	No.	No.	No.
Menhaden	905, 850	540, 600	95, 503	30, 097	577, 500	408, 800	6, 263, 005	377, 60 0	9, 258, 955
Alewives	43, 876	41, 500					1, 501		86, 877
Bluefish		1			59	27	1, 530	10	1, 627
Bonito							2		2
Butter-fish	59				102	3	50		214
Catfish							2		2
Cero							3		3
Cod	1								1
Croaker						1	85	8	94
Cunner	1			1					2
Cutlas-fish							2		2
Drum							8		8
Eel	11								11
Filefish							9		9
Flounders	68	2			2	1	21	6	100
Garfish							6		6
Goosefish	11								11
Haddock	23								23
Hake	33			2					35
Lumpfish	8								8
Mackerel	235	6	118						357
Pollock	1								1
Pompano							7		7
Sculpins	3	12					1		16
Sea-horse							1		1
Shad	1, 799			1			8		1, 808
Sharks					1	2	60	15	78
Skates	28	10		2	2	3	13	6	69
Spot								20	20
Spanish mackerel							42		42
Squeteague				17	2	6	81	143	249
Swellfish							3	2	5
Whiting	22								22
Total	1, 012, 029	582, 131	95, 619	30, 120	577, 068	408, 843	6, 266, 445	377, 810	9, 350, 665
Seine-hauls	77	22	7	2	11	15	315	10	459

DISTANCES FROM SHORE AT WHICH FISHING WAS DONE.

The prominent feature of several proposed or enacted measures for the regulation of the menhaden fishery by Congress and the State legislatures has been the prohibition of the fishing operations within certain distances of the shore. By the advocates of this method of restricting the fishery, the 3-mile limit has been regarded as a proper or desirable one within which no menhaden fishing should be permitted. The question of constitutionality has debarred the States from assuming jurisdiction over this zone, and Congress has shown no inclination to attempt the regulation of the fishery,

so that at present the capture of menhaden is attended with but few restrictions as to fishing-grounds, and these apply chiefly to bays and other waters under the control of the States.

As is well known, the menhaden is a fish which, as a rule, is found in comparatively close proximity to the land, both during the time of its sojourn on the coasts of the different States and during its spring and fall migrations. A large part of the catch has consequently always been taken within a few miles of the shore.

The operations of the two vessels under consideration, which may be regarded as entirely typical of the fleet, are shown in the following table, which brings out in detail the special point under discussion. The distances from the shore within which the menhaden and other fish were taken are specified as (1) under one mile, (2) between one and two miles, (3) between two and three miles, (4) between three and five miles, (5) five miles and beyond. More fish were taken between 1 and 2 miles from shore than within any other distances; more than half were caught within 2 miles of shore, and more than two-thirds under 3 miles from shore. Less than two-ninths of the total yield was obtained 5 miles or more from land, and a large part of the fish thus shown was secured in Chesapeake and Delaware bays.

The farthest distance from shore at which the *Arizona* fished was $9\frac{1}{2}$ miles. This was in Delaware Bay. The *J. W. Hawkins* took fish $9\frac{1}{2}$ miles off Windmill Point, Virginia, in Chesapeake Bay. None of the fishing of these vessels in the open ocean was so far from land, and most of it was under 2 miles from shore.

STEAMER ARIZONA.

Species.	Under 1 mile.	Between 1 and (under) 2 miles.	Between 2 and (under) 3 miles.	Between 3 and (under) 5 miles.	Five miles and over.	Total.
Menhaden	3,525,500	7,057,500	1,891,200	1,486,600	4,746,000	18,708,800
Alewives or river herrings ^a	8	10	1	1	16	35
Amber-fish			1			1
Anchovy			2			2
Bluefish	189	312	28	22	96	647
Bonito	17	6	2	3	5	33
Butter-fish	124	155	288	18	12	597
Croaker	12	26	2			40
Cunner	1	1				2
Drum	2	2		1		3
Flounders	44	87	74	61	3	269
Hake	2	1	1	1		5
Kingfish	1					1
Mackerel	2	231	41			274
Pipefish	2	1	1	3		7
Pompano	1					1
Rudder-fish		1				1
Sculpins		3				3
Scup		27	46			73
Sea bass	41					41
Sea-horse	1	1		1		3
Sea-raven			1			1
Sea-tobins	9	22	6	5	1	43
Shad		8				8
Sharks	52	76	32	76	87	323
Skates and rays	52	165	35	30	21	303
Spanish mackerel	10	93		1	4	108
Squeteague or weakfish	74	133	15	1	26	249
Striped bass		1				1
Swellfish		1				1
Tautog	12	3	1	1		17
Whiting			8			8
Total	3,526,154	7,058,800	1,891,785	1,486,824	4,746,271	18,708,800
Number of times seine set	98	234	77	67	143	619

^a Includes a few hickory shad and sea herring.

STEAMER J. W. HAWKINS.

Species.	Under 1 mile.	Between 1 and (under) 2 miles.	Between 2 and (under) 3 miles.	Between 3 and (under) 5 miles.	Five miles and over.	Total.
Menhaden	2,324,631	2,107,389	1,481,150	2,002,681	1,343,104	9,258,955
Alewives or river herrings	50,966	35,900			11	86,877
Bluefish	147	203	451	481	345	1,627
Bonito			1	1		2
Butter-fish	114	70	12	6	12	214
Catfish		2				2
Cero		1		1	1	3
Cod	1					1
Croaker	34	17	6	22	15	94
Cunner	1	1				2
Cutlas-fish	2					2
Drum			1	3	4	8
Eel	6	3	2			11
Filefish	2	3	2	2		9
Flounders	64	22	4	8	2	100
Gar	1	1	1		3	6
Goosefish	6	3	2			11
Haddock	14	8	1			23
Hake	24	11				35
Lumpfish	6	2				8
Mackerel	198	59	96		4	357
Pollock		1				1
Pompano	2	3			2	7
Sculpins	14	2				16
Sea-horse				1		1
Shad	1,156	644	1	2	5	1,808
Sharks	21	18	23	9	2	78
Skates and rays	40	17	6	6		69
Spanish mackerel	10	10	2	10	10	42
Spot	20					20
Squeteague or weakfish	210	29	6	2	2	249
Swellfish	2	1		1		5
Whiting	13	9				22
Total	2,377,705	2,144,429	1,481,772	2,003,236	1,343,523	9,350,665
Number of times seine set	109	102	70	103	75	459

From the foregoing table it appears that the largest average hauls were made under 1 mile from shore and the next largest between 1 and 2 miles. Between 3 and 5 miles from shore the average number taken was less than elsewhere.

THE CATCH IN DIFFERENT MONTHS.

The season for menhaden fishing is from the latter part of April to the first part of December, though but few fish are caught as early as April or as late as December, except in North Carolina. The best months are generally considered to be from August to November, inclusive. During the latter part of the season the fish are fatter and consequently yield more oil; they move in larger schools than at other times, and they are less shy and more easily caught.

The following table shows the monthly catch of menhaden and other fish by the steamers *Arizona* and *J. W. Hawkins*. Considerably more than half the menhaden taken by the former vessel were obtained in August and September; the largest catch of the other vessel was in September, followed by May and November. The months in which the largest numbers of other fish were taken were as follows: Flounders, mackerel, shad, and skates in July; alewives, sharks, squeteague, and butter-fish in August, and bluefish in September:

STEAMER ARIZONA.

Species.	May.	June.	July.	August.	September.	October.	November.	Total.
Menhaden	751,000	2,291,100	2,851,700	6,434,500	4,731,000	1,529,500	118,000	18,706,800
Alewives or river herrings <i>a</i>			14	16	5			35
Amber-fish				1				1
Anchovy			2					2
Bluefish	3	12	152	382	91	7		647
Bonito				31		2		33
Butter-fish		6	167	307	35	81	1	597
Croaker			12	28				40
Cunner			2					2
Drum				3				3
Flounders	16	67	142	27		17		269
Hake		1	4					5
Kingfish				1				1
Mackerel	88	180	6					274
Pipefish			7					7
Pompano				1				1
Rudder-fish				1				1
Sculpins	3							3
Scup	28		44			1		73
Sea bass	39	1	1					41
Sea-horse			3					3
Sea-raven						1		1
Sea-robins	4	1	36	2				43
Shad	2					4	2	8
Sharks		1	42	185	94		1	323
Skates and rays	15	27	107	81	11	61	1	303
Spanish mackerel				17	5	81	5	108
Squeteague or weakfish	3		24	190	4	8	20	249
Striped bass					1			1
Swellfish	1							1
Tautog			17					17
Whiting		8						8
Total	751,202	2,291,404	2,852,482	6,435,773	4,731,246	1,529,763	118,030	18,709,900
Number times seine set	24	44	102	258	120	65	6	619

a Includes a few hickory shad and sea herring.

STEAMER J. W. HAWKINS.

Species.	May.	June.	July.	August.	September.	October.	November.	Total.
Menhaden	2,542,000	595,050	776,800	854,600	2,576,000	491,105	1,423,400	9,258,955
Alewives or river herrings	1,500	13	14,864	70,500				86,877
Bluefish	224	50		64	1,158	30	101	1,627
Bonito				2				2
Butter-fish		50		55	4		105	214
Catfish	2							2
Cero					3			3
Cod			1					1
Croaker	53				1	31	9	94
Cunner			1			1		2
Cutlas-fish					2			2
Drum	4			2	2			8
Eel			11					11
Filefish	2	4			3			9
Flounders	8	37	36	6	3		10	100
Gar		5				1		6
Goosefish			11					11
Haddock			23					23
Hake		5	28			2		35
Lumpfish		6		6				12
Mackerel			228	13		116		357
Pollock			1					1
Pompano	1				6			7
Sculpins	1	1	2	12				16
Sea-horse		1						1
Shad	8	1	1,760	38		1		1,808
Sharks				4	52	2	18	78
Skates and rays	2	8	27	12	6	2	12	69
Spanish mackerel		1		3	36	2		42
Spot							20	20
Squeteague or weakfish	5				51	34	159	249
Swellfish	2	1					2	5
Whiting			22					22
Total	2,543,812	595,235	793,815	925,313	2,577,327	491,327	1,423,836	9,350,665
Number times seine set	115	60	58	43	99	36	48	459

Of 1,078 seine-hauls, 301 were made in August and 219 in September. Some idea of the variations in the relative sizes of the schools, shyness of the fish, etc., may be obtained from the following table, showing the average number of menhaden taken at each seine-haul during each month:

Months.	Number of successful sets.	Number of unsuccessful sets.	Average catch at each successful set.
May	117	22	28, 145
June	83	21	34, 773
July	130	30	27, 912
August	277	24	26, 315
September	211	8	34, 630
October	79	22	25, 577
November	49	5	31, 457
Total	946	182	29, 562

DISPOSITION MADE OF THE CATCH.

The following table is a detailed exhibition of the use which was made of the menhaden and other fishes taken, the figures for the two vessels being shown separately in order to illustrate more fully the variations that occurred. It will be observed that 199,900 menhaden were sold for bait and 25,000 were salted for food by the vessels' crews. The remainder of the menhaden catch was rendered into oil and scrap, with the exception of 2,500 fish that were thrown away, owing to the vessel's distance from the factory.

Of the most important food-fish taken, bluefish, 1,292 were consumed fresh by the crew and factory hands, and 572 were salted on occasions when more were taken than were necessary for the food of the crew. The agent on the steamer *J. W. Hawkins* reports that the bluefish landed at the factory with the menhaden numbered 410; none of the fish caught by the other vessel was so disposed of. It is probable that a large part of these were later taken by the shore employees and eaten; there are about the factories persons always on the lookout for good fish brought in by the vessels.

The foregoing statement applies also in part to the croakers, flounders, shad, squeteague, and other typical food-fish shown in the table as being utilized for oil and guano. The discharge of the vessels' cargoes is usually accomplished at night and some fish are thus overlooked in the darkness. In warm weather, and when fishing is done at places remote from the factories, menhaden are sometimes landed in a partly decomposed state, and whatever food-fish happen to be mixed with them are thus lost.

All of the sharks caught were thrown in the vessels' holds and taken to the factories to be treated with the menhaden, with the exception of 13 which were thrown back into the water after being killed. The skates and rays were rendered into oil and guano like the sharks, only 4 being returned to the water.

The observations of the Commission's agents proved that, as a general thing, not enough desirable food-fish are taken by the menhaden steamers to keep the vessels' crews regularly supplied with fresh fish. As a rule, all the food-fish caught are eaten either by the crews or by the factory hands, but it occasionally happens that schools of bluefish, butter-fish, shad, river herrings, etc., are taken, and more fish are thus provided than can be consumed.

STEAMER ARIZONA.

Species.	Utilized for oil and guano.	Eaten fresh by crew and factory men.	Salted by crew.	Sold for bait.	Thrown overboard, etc.	Total.
Menhaden	18,546,800		10,000	150,000		18,706,800
Alewives or river herrings ^a	34	1				35
Amber-fish		1				1
Anchovy		2				2
Bluefish		526	121			647
Bonito		16	17			33
Butter-fish	315	232	50			597
Croaker		40				40
Cunner		2				2
Drum		3				3
Flounders	174	75	20			269
Hake		5				5
Kingfish		1				1
Mackerel		274				274
Pipefish	7					7
Pompano		1				1
Rudder-fish	1					1
Sculpins	3					3
Scup	36	37				73
Sea bass		41				41
Sea-horse					3	3
Sea-raven					1	1
Sea-robins	43					43
Shad		2	6			8
Sharks	323					323
Skates and rays	303					303
Spanish mackerel		108				108
Squeteague or weakfish		159	90			249
Striped bass		1				1
Swellfish	1					1
Tautog		17				17
Whiting		8				8
Total	18,548,040	1,552	10,304	150,000	4	18,709,900

^a Includes a few hickory shad and sea herring.

STEAMER J. W. HAWKINS.

Species.	Utilized for oil and guano.	Eaten fresh by crew and factory men.	Salted by crew.	Sold for bait.	Thrown overboard, etc.	Total.
Menhaden	9,191,555		15,000	49,900	2,500	9,258,955
Alewives or river herrings	71,854	23		10,000	5,000	86,877
Bluefish	410	766	451			1,627
Bonito	2					2
Butter-fish	41	161			12	214
Catfish	2					2
Cero		3				3
Cod	1					1
Croaker	44	46			4	94
Cunner	2					2
Cutlas-fish	2					2
Drum	8					8
Eel	5				6	11
Filefish	9					9
Flounders	72	18			10	100
Gar	5	1				6
Goosefish	8				3	11
Haddock	15	8				23
Hake	28	7				35
Lumpfish	8					8
Mackerel		357				357
Pollock		1				1
Pompano	6	1				7
Sculpins	16					16
Sea-horse					1	1
Shad	266	161	706		^a 675	1,808
Sharks	65				13	78
Skates and rays	65				4	69
Spanish mackerel		42				42
Spot	20					20
Squeteague or weakfish	31	72	146			249
Swellfish	5					5
Whiting	22					22
Total	9,264,567	1,667	16,303	59,900	8,228	9,350,665

^a Released alive.

OBSERVATIONS ON THE HABITS, MOVEMENTS, SPAWNING, ETC., OF MENHADEN.

The full notes obtained by the agents while on the menhaden vessels contain a great deal of interesting general information on menhaden and the fishes associated with them. While much of it does not add to existing knowledge of these fish, some of it may be properly incorporated in this paper because of its bearing on the special points under consideration.

Enemies of the menhaden.—The observations of the agents on the *Arizona* indicated that of all the enemies of the menhaden the bluefish appear to be the most destructive. This predaceous fish destroys immense numbers of menhaden in pure wantonness, killing many times more than are actually eaten. Each of 50 stomachs of bluefish examined by Mr. Marschalk contained fragments of menhaden, but none had a whole fish.

Sharks also destroy enormous quantities of menhaden, but do less damage to the fishery than do bluefish, as they consume the menhaden quietly and do not as a rule scatter the schools. Two bluefish will cause more disturbance in a body of menhaden than a dozen sharks.

Examination of the stomachs of a number of sharks caught by the *Arizona* showed that these fish were subsisting chiefly on menhaden, although croakers and occasionally squeteague were found in a few.

Of fish taken with the menhaden on the *Arizona*, the weakfish, next to the bluefish and sharks, appeared to be the most destructive. The agent on the vessel examined the stomachs of 22 of these fish, finding in them 13 whole menhaden and parts of 32 others.

Flounders do not seem to prey on menhaden. Most of the flounders taken in the seines were too small, however, to afford ground for satisfactory conclusions. Of 15 opened, none contained any menhaden, except the largest, a fish 18 inches long, which had one menhaden in its stomach.

Six mackerel caught by the *Arizona* in September were examined with reference to their food. No signs of menhaden were discovered in their stomachs.

Notes on the movements of the schools.—The well-defined migrations of the menhaden to and from the coasts of the Atlantic States, and their movements in the bays and rivers, depending largely on temperature, are often, in the case of even large bodies of fish, much modified by the presence of such predaceous species as bluefish, squeteague, and sharks. Several well-marked illustrations of this were observed in 1894.

The autumnal migratory movement of the menhaden begins with the fish on the shores of Maine and Massachusetts and gradually embraces the entire coast. The menhaden frequenting the bays and inlets of New England are driven out by the falling temperature and begin to move toward the south, following the shores as far as the eastern end of Long Island. In that region, according to the observations of the fishermen, by far the greater part of the fish leave the coast, move directly out to sea, and are seen no more. In the fall of 1894, owing to the remarkable abundance of bluefish and squeteague in the vicinity of Montauk Point, vast schools of menhaden were detained in Gardiner and Neapeague bays for several weeks beyond their accustomed time and were unable to reach the ocean until their enemies had left. About October 21, the bluefish disappeared from that region and the departure of the menhaden rapidly ensued.

By the middle of November the menhaden had very generally withdrawn from Chesapeake Bay, and all the schools observed during the latter part of that month on the ocean shores of Maryland and Virginia, north of Cape Henry, were moving south at the rate of 1 or 2 miles an hour. On November 16, the *J. W. Hawkins* made three hauls off Currituck Light, North Carolina. All the fish caught or seen were swimming north several miles an hour. After the last set, 3 miles southeast of Currituck Light, the vessel steamed 20 miles farther south and fell in with a large body of bluefish, which had apparently driven the menhaden back. A week later, in the same region, all the menhaden met with were moving north along the coast at the rate of 1 to 3 miles per hour, while between Currituck and Bodie Island lights large schools of bluefish were found which had evidently intercepted the migrating menhaden and caused them to reverse their course. Bluefish were practically absent from the schools of menhaden; in the 6 seine-hauls made in this section on November 16 and 23, only 2 bluefish were taken with 140,500 menhaden; 84 squeteague, however, mostly of small size, were caught.

Size and fatness of menhaden.—On the size and fatness of the fish depends, to a considerable degree, the financial success of the industry. Some years, during the greater part of the season, especially in the more southern waters, the fish are very lean and yield practically no oil. In the Chesapeake a million fish have frequently been known to produce less than a barrel of oil; in July, 1893, the steamer *I. N. Veasey* caught 2,000 barrels of menhaden (equivalent to about 700,000 fish) which yielded only 6 gallons of oil. The fish taken on the New England coast always average larger and fatter than those obtained elsewhere. The menhaden caught by the steamer *J. W. Hawkins* on the Maine and Massachusetts coasts in June, July, and August were from 10 to 12 inches long, averaging 11 inches. The quantity of oil produced was from 8 to 12 gallons per 1,000 fish, though menhaden taken in Boston Harbor in August yielded 14½ gallons per 1,000, and those caught about September 1 produced 16 to 18 gallons.

The menhaden caught on the coasts of New York, New Jersey, and Delaware were from 6 to 12 inches long, the average prior to October being rather under 9 inches, while in October and November the average was 10½ or 11 inches. At times in July the schools were made up of menhaden showing an unusually large variation in size, some hauls consisting of fish as small as 6 inches and as large as 12 inches, with every gradation between those limits. The remarkable body of menhaden in Delaware Bay in August and September consisted of small fish. No fish over 10 inches long were taken, and the average size was probably not over 8 inches. These fish were almost invariably smaller than those caught at the same time outside the bay and seemed to the fishermen to be an entirely different lot from those taken in the adjacent ocean.

The menhaden on the coasts of Maryland, Virginia, and North Carolina in October and November were mostly from 9 to 12 inches long and were quite fat, making about 10 gallons of oil per 1,000, but those obtained in the Chesapeake at the same time continued to run small (6½ to 8 inches, on an average); some schools had fully half the fish 12 inches long, and toward the end of the season the fish averaged 11 inches.

The fish obtained in the Chesapeake during the spring and summer are usually of small size, and it is reported that since 1890 the average size of the fish in the bay has been smaller than prior to that time. In 1894 the menhaden obtained during the spring and summer by the *J. W. Hawkins* ranged from 4½ to 11 inches in length, the average being 6 to 8 inches; these produced under 2 gallons of oil per 1,000,

The largest menhaden observed during 1894 was taken by the *J. W. Hawkins*, July 27, at the mouth of the Kennebec River, Maine. The fish was 14 inches long and weighed 1 pound 14 ounces.

Spawning of menhaden.—Notwithstanding the attention which the subject has received, much yet remains to be learned regarding the spawning season and spawning-grounds of the menhaden. Knowledge of the spawning habits of the fish has a very important practical bearing on the question of legislation, for it is clear that any truly protective measures adopted by the States must take cognizance of the time and place chosen by the menhaden for depositing their eggs.

Throughout the season, the agents of the Commission examined the menhaden with reference to the condition of their reproductive organs. The observations of Mr. Locke on the steamer *J. W. Hawkins* were especially complete. In Chesapeake Bay early in the season, when only small fish were caught, examinations were made daily, but later, on the New England coast and on the southern grounds, when the fish taken were of larger size, some menhaden in every seine-haul were eviscerated.

The diversity of the testimony of fishermen on the question of the spawning season of menhaden and the observations of the Commission suggest the existence of different spawning times on different parts of the coast, a peculiarity strikingly exemplified in the case of the sea herring, which spawns in May in the Gulf of St. Lawrence and in November on the New England coast.

The testimony of fishermen and others as to the spawning of menhaden on the Maine coast indicates that the spawning period occupies part of the summer and may extend over most of the time when the fish are in those waters. The observations of the Commission's agent, extending from June 29 to August 6, tended to corroborate this view. An examination of 7 large menhaden, caught in Muscongus Sound July 3 in a school of 19,500 fish, showed that 3 males and 1 female were spent fish, while 3 females (12 inches long) had very large but immature ovaries. From a haul of 42,500 fish at the mouth of the Kennebec River July 5, 1 male examined was about half spent and 5 females had finished the spawning process. Examination of 6 fish from a haul of 66,700 in the same place on July 11 gave the following result: One male spent; 1 male with very large, hard spermaries; 1 female spent; 3 females with very large ovaries full of unripe eggs. On July 20 at the mouth of the New Meadow River, 6 fish from a lot of 14,900 consisted of 1 male with very large but immature spermaries, 3 spent females, 1 female from which eggs (apparently not ripe) would run on very gentle pressure, and 1 female with ovaries much enlarged and containing eggs very nearly ripe. Fish in a similar condition were taken in Casco Bay, July 24. On July 26 and 27, 12 menhaden from schools taken in Casco Bay and off Seguin Island were found to be spent fish, 8 being males. This examination was typical of a number of others made during the latter part of July. In August the fish were found with their reproductive organs in various stages of development. In some male fish the organs were three-fourths mature; some ovaries were one-third to one-half full size with well-defined but unripe eggs, but in most of the fish, especially those taken after August 10, the organs were quite small and the eggs not differentiated.

All the menhaden caught in the Chesapeake in May and June had such very small organs as to suggest the recent completion of the spawning process or the immaturity of the fish. The spermaries of some 7-inch fish taken June 4 were only three-eighths of an inch long, and the ovaries only three-fourths of an inch; on June 6 some 8-inch fish had spermaries 1 inch long and ovaries $1\frac{1}{4}$ inches long, and no further development

was observed during the month. On the resumption of fishing in the bay on August 30 the condition of the fish as to spawning appeared to have undergone little change since June, and during the remainder of the season no fish taken in the Chesapeake contained organs of noteworthy size, with the exception of one 13½ inches long, taken October 13 off New Point, Virginia, which contained large ovaries; the others examined from the same school were small and the reproductive organs rudimentary.

In the latter part of October menhaden taken on the New York, New Jersey, and Virginia coasts contained well-developed organs, three-fourths to seven-eighths of the females opened having large ovaries with distinct eggs.

By the first week in November, the development of the reproductive organs had progressed so far that the approach of the spawning period appeared to be imminent in the fish caught close to land on the ocean shores of Maryland, Virginia, and North Carolina. On November 6, large hauls of menhaden, off the Maryland coast, contained fish 9 to 12 inches long that were very nearly ripe, and on November 7, 9, and 13, small quantities of eggs or milt could be forced by gentle pressure from most of the fish examined taken on the same grounds. On November 13, a female menhaden 11 inches long, caught in a school off the Virginia coast, appeared to be spent; November 16 a similar specimen, with shriveled and empty ovaries, was found among some almost ripe fish on the North Carolina coast. In the latter part of November, eggs or milt could be forced by gentle pressure from nearly all menhaden caught south of Cape Henry.

Complying with instructions from headquarters, Mr. E. E. Race, field agent, forwarded to Washington three lots of fresh menhaden taken off the mouth of Chesapeake Bay on October 30, November 1, and November 2. The first lot, consisting of 8 fish (1 male, 7 females) 11½ to 13 inches long, and weighing three-fourths of a pound, were from a school of 3,000 fish caught by the steamer *Virginia* in water 6 fathoms deep off the coast of Virginia, between Smith Island Light and Old Plantation Light; the water temperature was 62° or 63°. In the male a little milt appeared at the vent on pressure, the condition of the spermaries suggesting the partial completion of the spawning process. In 5 of the females a few eggs could be extruded by making gentle pressure on the abdomen; in the others, although the ovaries were large (4 inches long), no eggs could be expressed.

The second lot contained 19 specimens, taken by the steamer *I. N. Veasey* in a haul of 3,000 fish 4 miles east of Cape Charles Light, in 3 fathoms of water, the temperature of the water being 61°. Fourteen of these fish were over 12 inches long (12½ to 13½); 3 were males with spermaries from three-fourths of an inch to 1 inch wide, but unripe; all the females contained large ovaries (4 to 5 inches long) from which small quantities of eggs could be freely extruded on gently pressing the abdomen; the 5 remaining fish were smaller, averaging about 11 inches long, and had organs much less developed. The third lot of 10 fish came from a haul of 15,000 by the steamer *I. N. Veasey*, three-fourths of a mile northeast of Cape Henry Light, in water 4½ fathoms deep; water temperature, 61°. These fish were about 11 inches long. Their organs were more immature than those in the other lots. The ovaries were only 2½ inches long or less, and no free eggs or milt could be expressed.

These fish were examined by Mr. Richard Rathbun, in charge of the scientific inquiries of the Commission, who has given much attention to the spawning of the menhaden. He regarded none of the specimens as quite ripe, as the eggs were not entirely transparent or wholly spherical; but he thought there was no question that all the larger fish would soon have spawned.