EXAMINATION OF THE SUMMER FISHERIES OF PAMLICO AND CORE SOUNDS, N. C., WITH SPECIAL REFERENCE TO THE DESTRUCTION OF UNDERSIZED FISH AND THE PROTECTION OF THE GRAY TROUT

Cynoscion regalis (Bloch and Schneider)

By ELMER HIGGINS and JOHN C. PEARSON

DEPARTMENT OF COMMERCE
Bureau of Fisheries Document No. 1019

DEPARTMENT OF COMMERCE
BUREAU OF FISHERIES
HENRY O'MALLEY, Commissioner

EXAMINATION OF THE SUMMER FISHERIES OF PAMLICO AND CORE SOUNDS, N. C., WITH SPECIAL REFERENCE TO THE DESTRUCTION OF UNDERSIZED FISH AND THE PROTECTION OF THE GRAY TROUT

Cynoscion regalis (Bloch and Schneider)

By

ELMER HIGGINS, *In charge, Division of Scientific Inquiry*
and
JOHN C. PEARSON, *Temporary assistant*
U. S. Bureau of Fisheries

APPENDIX II TO THE REPORT OF THE U. S. COMMISSIONER OF FISHERIES FOR 1927

Bureau of Fisheries Document No. 1019

PRICE 10 CENTS
Sold only by the Superintendent of Documents, Government Printing Office
Washington, D. C.

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON
1927

EXAMINATION OF THE SUMMER FISHERIES OF PAMLICO AND CORE SOUNDS, N. C., WITH SPECIAL REFERENCE TO THE DESTRUCTION OF UNDERSIZED FISH AND THE PROTECTION OF THE GRAY TROUT CYNOSCION REGALIS (BLOCH AND SCHNEIDER)[1]

By Elmer Higgins, *In charge, Division of Scientific Inquiry*, and John C. Pearson, *temporary assistant, United States Bureau of Fisheries*

CONTENTS

INTRODUCTION[2]

DECLINE OF THE FISHERY

Many persons interested in the fishing industry of North Carolina are convinced that the supply of food fish in the waters of that State is insufficient to meet the demand. Despite the increase in catching power, brought about by the introduction of power vessels, the use of modernized gear, and the improvement of methods of refrigeration and distribution, the total yield of the fisheries of the State has not shown a corresponding increase during the past 45 years. The occasional statistics collected by the United States Bureau of Fisheries indicate that the average annual yield since 1880 of all aquatic food products, including fresh and salt water fish, mollusks, crustaceans, turtles, etc., but omitting nonfood fish, such as menhaden, has been 37,600,000 pounds. The total yield in 1880 amounted

[1] Appendix II to the Report of the United States Commissioner of Fisheries for 1927. B. F. Doc. No. 1019.
[2] The original report on this investigation was read by permission of the United States Commissioner of Fisheries, before the North Carolina Fisheries Commission Board at their regular meeting, Dec. 8, 1925, at Morehead City, N. C. The present paper contains all of the subject matter of the first report, together with some supplementary material resulting from further analysis of the original data.

to 32,249,000 pounds. This production rose to a maximum of 52,924,000 pounds in 1897, but since that time the available statistics show a continual though gradual decline until the period from 1918 to 1923, when the annual yield approximated 31,000,000 pounds, or about the same amount as that produced at the beginning of the period for which we have records. While the decline in total yield has not been disastrous to the industry, several important species have suffered serious decline. The most important of these are the shad and the mullet, although bluefish and striped bass also have shown a marked reduction. The total yield has been maintained only by the increased utilization of the cheaper and less desirable varieties of fish and by an increased intensity of fishing and improved methods of production.

This unsatisfactory trend of the fisheries of the State was forcibly pointed out by Dr. Hugh M. Smith in 1907,[3] when he asserted that the condition of the industry demanded the thoughtful consideration of the fishermen and lawmakers. He declared that:

> The fisheries may be expected to deteriorate—
> (*a*) Through failure of the State to provide prompt and adequate protection to those fishes which begin to show a decrease in abundance. The history of the sturgeon is an unmistakable indication of what will eventually happen to the shad, alewives, striped bass, and other species unless ample provision is made for the survival of a sufficient percentage of the annual run until spawning has ensued.
> (*b*) Because of unnecessarily wasteful methods, such as the capture of larger quantities of food fishes than can be utilized or disposed of to advantage and the useless destruction of larger numbers of fishes of no present market value but of prospective importance.
> (*c*) Owing to careless methods of packing and preserving the catch, and failure to keep abreast of the progress of the times in matters affecting the shipment and sale of fish.

The wisdom of his predictions is attested by the present condition of the fisheries, for the decline in abundance actually has occurred, and many of the conditions that caused this decline still remain to be remedied almost 20 years since the original warning.

The general shortage of fish has increased the rivalry between the operators of two dominant types of gear operated in Pamlico and Core Sounds—pound nets and haul seines—and endless discussion concerning the effects of these nets on the fish supply has resulted. As early as 1883, L. H. Hardy, a North Carolinian, wrote to the United States Fish Commissioner as follows:[4]

> We have in Carteret County, N. C., a great many fish, and our people live by catching and selling them. For the last four years our waters, both in the sounds and ocean, have been obstructed by Dutch nets (pound nets), which have proved very destructive to our fish. Thousand of fish too small to be serviceable are caught by these nets and suffered to remain in them until they are dead and then turned out to drift upon the shore in numbers that would seem incredible to relate. * * * Thus millions of good fish are being destroyed yearly that are not worth a cent while so small. * * *.

In 1912, C. H. Sterling, a fish dealer of Washington, N. C., said:[5]

> As to the pound nets, dragnets, and seines, some man has said that the pound nets are the root of all evils. I think he is mistaken. I have seen seines pull in hundreds of small fish that a pound net would not catch.

---

[3] Fishes of North Carolina, by Hugh M. Smith. North Carolina Geological and Economic Survey, Vol. II, p. 412. Raleigh, 1907.
[4] Bulletin, U. S. Fish Commission, for 1884, p. 317.
[5] Report of the Fisheries Convention held at New Bern, N. C., Dec. 13, 1911. North Carolina Geological and Economic Survey, Economic Paper No. 29, p. 37. Raleigh, 1912.

In 1909, J. H. Potter, of Beaufort, N. C., said:[6]

I have been engaged in the fish business for 30 years. I commenced before the first pound nets were set in North Carolina, and was instrumental in putting in the first pound net. I have seen that net destroy more fish than have been caught in North Carolina since.

THE PROBLEM

As a result of this controversy there has arisen a general feeling that wasteful practices existed in these fisheries, which were in part responsible for the shortage of the fish supply. Many proposals for the regulation of the various types of gear have been offered by one faction or the other, and it was recognized by the State authorities that some regulation was necessary. Because of strong sectional feeling, it was impossible for the fishing interests to agree upon a method of regulation, and it finally became apparent that, in the interests of future constructive regulations, a comprehensive, impartial, investigation should be conducted. Three problems were presented for consideration:

1. To find the actual composition of both the pound-net and long-haul seine catches throughout the entire summer fishing season and the degree of competition between the two types of gear.
2. To ascertain the amount of destruction caused by taking undersized food fish by each type of gear.
3. To find a method of protecting undersized fish until they became valuable to the fishermen, to the fish dealers, and to the people of North Carolina.

With these problems in mind, the Bureau of Fisheries, with the full cooperation of the North Carolina Fisheries Commission, under Commissioner J. A. Nelson, undertook an extensive survey of these fisheries. Too much credit can not be given to Captain Nelson for the excellent assistance rendered. The launch *Neuse*, with crew under the able handling of Capt. J. R. Morris, was detailed to the field work, and the financial burden of its operation, as well as half of the incidental cost of the investigation, was borne by the State.

SUMMARY

The findings of this investigation may be summarized as follows:

1. Many lines of evidence indicate that the fisheries of North Carolina are undergoing depletion.
2. Wasteful methods in the fisheries are believed to be a contributing cause to the exhaustion of the supply. Pound nets and long-haul seines both have been accused as responsible for the decline in abundance.
3. Pound nets are stationary gear operating on deep muddy bottoms. Long-haul seines are dragged over shallow sandy bottoms.
4. The catch of pound nets consists chiefly of gray trout or squeteague (*Cynoscion regalis*) and starfish or harvest fish (*Peprilus alepidotus*). The catch of long-haul seines consists chiefly of croakers (*Micropogon undulatus*), spots (*Leiostomus xanthurus*), and spotted trout (*Cynoscion nebulosus*). Hence there is little competition between the two types of gear.
5. The two types of gear are highly selective in their action, pound nets catching smaller sizes of all species than do long-haul seines.

[6] Report of the Fisheries Convention held at New Bern, N. C., Dec. 13, 1911. North Carolina Geological and Economic Survey, Economic Paper No. 29, p. 184. Raleigh, 1912.

6. The average monthly destruction of undersized fish by long-haul seines is: Spotted trout, 4 per cent of the total number of that species caught; croakers, 8 per cent; and spots, 17 per cent. The average monthly destruction of undersized fish by pound nets is: Gray trout, 31 per cent; starfish, 59 per cent; butterfish, 6 per cent; croakers, 35 per cent; and spots, 51 per cent.

7. Pound nets are highly destructive; long-haul seines are not unduly destructive of undersized fish.

8. The greatest wastage of all pound-net fish occurs in June.

9. The greatest wastage of gray trout occurs in June and July and is most extensive on the northwest side of Pamlico Sound.

10. Two-year-old gray trout are less than legal size during June and July, but by August they have grown so that most of them are legally marketable.

11. Certain facts concerning the life history of the gray trout, ascertained in the course of this investigation, may guide our efforts at conservation. These are—

(*a*) Spawning in 1925 reached its height by June 1 and was completed by August 10.

(*b*) Gray trout approximately 5 inches long in June are believed to be 1 year old; when 8 inches long, 2 years old; when 10 inches long, 3 years old.

(*c*) Gray trout spawn for the first time when 3 years old.

(*d*) Immature fish remain in the sounds during the spring, summer, and fall.

12. The present regulation establishing minimum size limits does not operate to conserve the fishery, for many are destroyed in order to market the few.

13. Regulations increasing the size of mesh in pound nets or establishing areas closed to pound-net fishing are undesirable.

14. A closed season on pound netting in Pamlico Sound, from the end of the shad season until August 1, would prevent the destruction of undersized gray trout and protect the spawning fish. This regulation is recommended.

THE FISHERY

The fishery with which this investigation is concerned is conducted chiefly by pound nets and long-haul seines during the summer season, beginning in the latter part of May and continuing into November. The duration of the fishing season, however, depends upon the weather, for the gear is frequently destroyed by storms during October and is not replaced. Six species constitute the bulk of the catch, which consists, in order of their importance, of squeteague or gray trout, croakers, spots, spotted trout, starfish or harvest fish, and butterfish. All of these species are taken by both types of gear but in different quantities. While the same species are taken by other types of gear, such as stake gill nets, drop gill nets, and short-haul seines, by far the greater part is taken by the two gears under consideration.

The total yield of these species in the six counties surrounding Pamlico and Core Sounds amounted in 1923 to 8,225,000 pounds, valued at $337,475, or 58.5 per cent by weight of the total yield of all aquatic food products in the State.[7] The gray trout was the most

[7] For detailed statistics of yield and valuation see Fishery Industries of the United States, by Oscar E. Sette, p. 369 ff. Appendix II, Report United States Commissioner of Fisheries for 1925 (1926). Washington.

important of this yield and amounted in the same year to 2,954,000 pounds, or 21 per cent of the total yield of aquatic food products; croakers, 2,208,000 pounds, or 15.7 per cent; spots, 1,751,000 pounds, or 12.5 per cent; spotted trout, 845,000 pounds, or 6 per cent; starfish or harvest fish, 519,000 pounds, or 3.7 per cent; and butterfish, 298,000 pounds, or 2.1 per cent.

METHODS OF FISHING

Pound netting.—The pound net is a type of stationary fishing gear that operates by directing the fish into inclosures or traps by means of leads. While the principle of pound netting is always the same, the actual setting and arrangement of the gear varies in different localities. A typical pound-net rig used in the summer fisheries of Pamlico

FIG. 1.—Pound-net fishing. Setting a net. The crib or pound is at the left; the men in the boat are setting the heart, and the lead extends off to the right

Sound and many of its tributaries consists of lead, heart, and pound. The lead is 175 to 300 yards long, having a depth of 17 to 20 feet, made of cotton webbing of 12-inch stretched mesh. It is supported in the water by stakes (pine poles) about 18 feet apart. This lead ends at a 9-foot opening into the heart—a semipound, which is usually 30 yards on each side, of the same depth as the lead, and made of webbing of a stretched mesh of 5 inches. At the end of the heart opposite the lead opening is a tunnel 20 feet square at the heart, tapering into a 34-inch square exit into the pound proper. This tunnel is about 12 feet long of 4-inch stretched mesh and the ends are held open by ½-inch iron-bar frames. The pound proper, into which the tunnel leads and which the fish finally enter, is about 27 feet square, having a depth of about 16 feet (depending upon the depth of water in which the gear is set), a stretched mesh of 2¼ inches, and is supported at each corner and at varying intervals by stakes. All parts of the rig, with the exception of the pound itself, must touch bottom and, of course, must rise above the level of the water for at

least a few inches. The sides of the pound are usually at least 1 foot above the water level so as to prevent the trapped fish from jumping over. (See figs. 1 to 3.)

FIG. 2.—Pound-net fishing. When the fish are gathered into one corner of the net the catch is bailed into the boat with dip nets

As many as 8 or 9 pounds are sometimes set in a continuous row or stand, so that the entire distance covered by the leads, hearts, and

FIG. 3.—Pound-net fishing. Culling the catch. It is not feasible to sort the catch on the fishing grounds. All culling is done at the shore station when the fish are sorted for sale. Hence undersized fish are dead when discarded

pounds may be nearly 2 miles in length. Usually a stand consists of not more than four pounds, for this is the maximum that can be handled easily by the average pound-net crew.

A pound-net crew usually is made up of two men, but sometimes three, manning an open power boat, 25 feet long, 6 to 7 feet wide, and having a speed of about 7 miles an hour. The fishermen usually camp on some island or point within an hour's run from their nets, returning home only for the week-ends.

The pound net is fished by running the boat nearly over one side of the pound into the inclosure, and by means of a hook a side of the pound is raised and brought on board. The sides and bottom of the pound are then gradually taken up to the surface of the water until the fish are gathered or bunted into a small section of the side, from which they can be bailed into the boat. The entire process does not take the experienced fishermen more than 10 minutes in good weather, but hours are sometimes consumed in clearing the nets of small fish that have become gilled in the meshes. After fishing all their pounds

FIG. 4.—Long-haul seining. The seine has been removed and the men are now hauling the bunt net. The bunt net is used to inclose the fish so that they may be landed. Finer mesh and heavier twine in this net prevent the fish from rushing the net and escaping or becoming gilled in the meshes

the fishermen return to their camp and weigh and sell the catch to waiting buy boats sent by various wholesale fish dealers.

Pound nets are set in the deepest waters of Pamlico Sound, which are from 16 to 20 feet in depth. The gear is always set on a muddy bottom because of the necessity of a good holding ground for the stakes and because the fishermen believe that fish gather on this muddy bottom to feed.

Long-haul seining.—This is a method of fishing in which a seine is dragged between two power boats for a certain distance and then landed by hand in shallow water.

The nets consist of eight sections, each 150 yards long, and 12 feet deep, made of cotton webbing of a 3-inch stretched mesh. At the ends of each section are fastened 8-foot wooden staffs, leaded at the lower ends. A bunt net, 125 yards long and 100 to 125 meshes deep, with a mesh of 2½ inches, is also a part of the equipment. The more efficient boats are 30 to 40 feet long, drawing not more than 3 feet of

water, and are powered with 16 to 20 horsepower engines. Each power boat has a crew of three men and tows a skiff about 20 feet long, which carries half of the nets.

In fishing the seine, the power boats first come together, join the ends of the sections of the seine, and commence to run in opposite directions, letting out the nets, section by section, until all eight seines—four from each tow skiff—have been let over the side. The seine is then slowly hauled in a shallow semicircle for approximately three-fourths of a mile. When the power boats reach the shallow water they come together and the staffs at the ends of the seines are fastened together, thus making a circle about 1,200 yards in circumference. (See figs. 4 and 5.)

FIG. 5.—Long-haul seining. The haul is here completed and the men are bailing the catch from the bunt net into the boats

After the circle is completed, two men in each of the tow skiffs untie the staffs that fasten the end pair of nets, the power boats take the ends of the second pair on each side, one at a time, and continue hauling to "cut out" or to remove the nets from the circle. Similarly, the second pair are replaced by the third pair, and the third pair by the fourth, so that the circle finally is reduced to a single pair of nets, each 150 yards long. The bunt net is then fastened to the farther staff of one of the last pair of nets and is laid out in the position of one of the fourth pair while that net is taken into the skiff. The remaining fourth seine is then hauled by power or by hand, depending on the depth of water, past the inward staff, until the two staffs of the bunt net are brought together. The final hauling of the net is performed by hand while one man holds down the lead line with his foot so as to keep the gap completely closed at the bottom. When the bunt net has been pulled in far enough (depending on the quantity of fish taken) hauling on the cork line is stopped and the lead line is hauled past the staff until all of it is landed in the skiff. This completed, the fish are secured beyond danger of escape, and they are easily bailed into one of the skiffs. Everything is landed except sharks and stingrays or occasional catches of large drum.

A modification of this method of hauling, called "swiping," is practiced by a few crews. This consists in merely laying out the nets, surrounding a given area of water, and then taking them in. There is no hauling done except to close the ends of the nets. This method is employed chiefly to save the expense of fuel used in hauling, which usually takes from three to four hours, but this is not the common practice.

The haul must be on a clean bottom, with the tide, and usually with the wind, otherwise the boats could not pull the seines because of the accumulating amount of floating grass. It must be made in a place where shallow water is at least a mile away and in which the nets can be removed both by power and by hand. Such shallow water in North Carolina generally consists of sandy shoals, and the suitable hauls are so well known and recognized that several crews frequently await their turns to fish a productive ground. Owing to the gradual process by which the nets are removed, the small fish apparently have time to escape. Often fish can be seen forcing the nets before the bunt net has been put out, and the presence of large-sized gilled fish in the pairs of seines removed by power indicates that the fish are attempting to escape during the cutting-out process. The bunt net serves a necessary purpose in preventing the frightened fish from rushing the net and gilling or escaping, and also serves to protect the fishermen from the attacks of stingrays, which are of frequent occurrence in the catches.

Owing to the relatively high cost of equipment for this type of fishing, which is valued at about $4,000, and to the relatively small number of haul areas available, there were not more than 25 crews operating in Pamlico and Core Sounds in the summer of 1925. Each crew usually sells to the buy boat of a fish dealer, who is under agreement to take the season's catch. The nets usually are laid out at about 6 o'clock in the morning, and the catch is aboard the buy boat by 2 or 3 o'clock in the afternoon. Some of the crews do not land their catch until later in the afternoon, while others, more energetic, may sometimes make two hauls in a single day, ending their last haul in the dark.

METHODS OF INVESTIGATION

To determine the actual composition of the catches of the two types of gear, it is obviously necessary to visit personally the various fishing areas and to inspect the unsorted catches of fish when taken. Representative areas should be chosen for examination, and the study should be continued during the whole fishing season.

In the sampling of the pound-net catch a route was selected covering as nearly as possible representative portions of Pamlico Sound, no pound netting being carried on in Core Sound; but choice of localities was limited by the fact that pound nets are fished only in the early morning, five days a week. (See fig. 6.) On this account, and on account of the distances to be covered, but one pound-net station could be visited daily. The following localities were visited regularly once each week, with the exception of one station that was discontinued because of lack of fish: Lupton, with 15 to 20 stands of nets set off Cedar Island; Brant Island, with 6 to 8 stands of nets off the mouth of the Neuse River along Brant Island Shoal; Gull

Rock, with 10 to 12 stands set along Gull Shoal; Portsmouth, with 1 to 12 stands about Royal Shoal (this place was visited during only one month because of discontinuance of fishing); and Point of Marsh, with 4 stands set along Brant Island Shoal. The only pound-net localities of any importance that remained were Ocracoke, with 6 stands, Hatteras, with 2 stands, Englehard, with 3 stands, and Stumpy

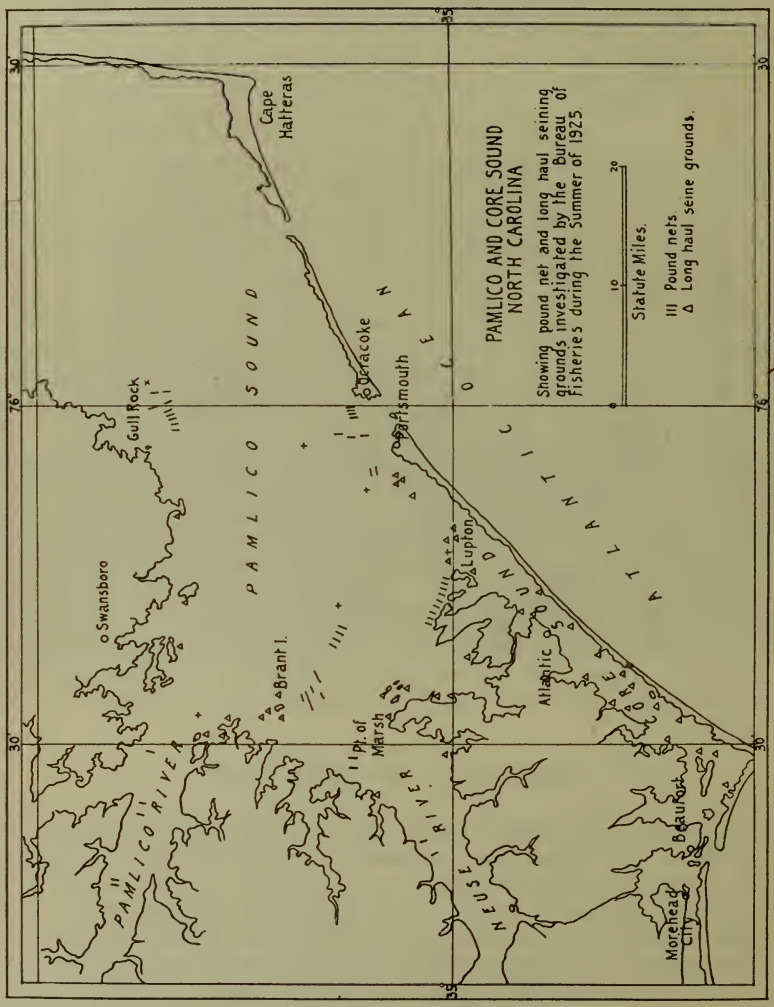

FIG. 6.—Pamlico and Core Sounds, N. C.

Point, with 20 stands. Lupton represented the southern end of the sound, Brant Island and Point of Marsh the western and central parts, Gull Rock the northwestern side, and Portsmouth the eastern part. The distance around the whole route was nearly 200 miles. Approximately 200 pound-net catches were sampled. Only a very few stations were omitted from the weekly visitation, and this was because of adverse weather conditions when very little fishing was carried on even by pound netters.

Long-haul seine fishing is conducted chiefly in the southern and western parts of Pamlico Sound and in the northern half of Core Sound. Moreover, this fishing is regulated greatly by weather conditions, so that the taking of samples was necessarily more irregular than was the case with pound nets. However, experience showed that samples could be procured more or less regularly while en route from one pound-net station to another, and since noon is the customary time for long haulers to end their fishing for the day, samples usually were secured as soon as the fish had been bailed into the skiffs. Samples were taken at varying intervals in virtually all the long-haul localities, 44 samples in all being studied.

Taking a random sample of about 50 pounds of unculled fish from each of three crews of pound-net fishermen, a total amount of approximately 150 pounds of fish was secured from each locality every week. The average daily catches of the crews seemed to be from 300 to 600 pounds of market fish to the crew, with the exception of Monday's catches, which were always larger than those of any other day because the pounds usually are not fished either Saturdays or Sundays. Personal observations were taken each morning on the majority of the catches brought in, and any unusual catch, both as to quantity and quality of fish taken, was noted.

A different problem was presented in obtaining samples of the catch of long-haul seines because of the variation in both quantity and quality, which ranged from 500 to 1,500 pounds of marketable fish. When the catch consisted chiefly of large fish, somewhat larger samples were taken than was the case when the catch was made up of small fish. In general, from 50 to 100 pounds of fish constituted the sample.

In obtaining all samples no hand selection was permitted, all fish being bailed, unculled, into a large bucket container by the fisherman, under the personal inspection of the investigator. The samples, once obtained, were sorted according to species, the species of scrap fish, such as pinfish and menhaden, alone being unseparated. The weights of certain food species and also the weights of scrap fish in the samples were secured. Each specimen of food-fish species was carefully measured on a rule constructed for the purpose,[8] each fish sexed, and the spawning or resting condition of the fish was noted. Scales were taken from many fish for the ultimate purpose of determining the age composition of the catch. Over 26,000 pound-net fish and 2,500 long-haul fish were thus measured during the 20 weeks, from the middle of June until the first of November, spent in actual field operations.

In analyzing the data collected by these means, length-frequency tables were constructed from the measurements of the samples obtained. While each sample was originally tabulated separately, frequency tabulations for the day were made for the three samples together. The day samples were then combined by months, by simple addition, and these monthly frequencies were then reduced to a percentage basis. In so far as the unweighted samples are representative, the actual composition of the commercial catch is accurately portrayed; but, because of the varying number of samples taken in the different months, it was deemed advisable to weight the

[8] The measurement of length used in this work is the projection of the distance from the snout, or point of the mandible, to the end of the middle rays of the caudal fin.

monthly frequencies to a constant number. Thus the conditions in each locality are represented by 12 separate samples taken on four occasions in each month.

The conclusions concerning the actual or total destruction of undersized fish, however, are subject to some criticism, from the fact that the total amount of the commercial yield at any time during the season is unknown. It is presumed that the fishery has a normal cycle of abundance, reaching a maximum at some period and dying away to a final end. Since the sampling was uniform throughout the season and the results are not weighted according to the total yield, a distortion of facts would occur from overemphasizing the early and late parts of the season, when the yield is presumably smaller, and underemphasizing the middle part of the season, when the maximum yield is supposed to occur. There are no statistics in North Carolina that can be used to weight our figures according to the total yield, and since it was not feasible, because of conditions in the field, to collect these figures at the time of the investigation, it is impossible to estimate the magnitude of this error. The authors believe that this error is negligible, however, because of evidence based on records of the catch of pound-net fishermen at Gull Rock. The actual yield of three different crews was obtained throughout the entire season. Since the nets are fished irregularly in this locality daily yields could not be obtained, but a table of total yield during each weekly period from each of the three crews was constructed. (See table 1.) During the period from June 28 to October 31, when all three crews were working without interruption, the average weekly yield does not vary more than 1,000 pounds, ranging between 2,000 and 3,000 pounds. If this condition obtains throughout Pamlico Sound, it is likely that maximum production is reached as early in the season as all the gear is installed and continues at a horizontal level until the removal of gear in early November.

TABLE 1.—*Pound-net catch of three fishermen at Gull Rock, N. C., in 1925, weekly totals of marketable fish*

Date	Crew No. 1	Crew No. 2	Crew No. 3	Total	Average
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
June 7–13	1,219	708	----------	1,927	----------
June 14–20	2,483	1,453	----------	3,936	----------
June 21–27	2,398	1,065	244	3,707	----------
June 28–July 4	4,478	2,507	1,650	8,635	2,878
July 5–11	5,126	2,242	1,812	9,180	3,060
July 12–18	3,077	1,155	1,673	5,906	1,969
July 19–25	5,200	1,599	1,818	8,617	2,872
July 26–Aug. 1	1,828	1,092	1,657	5,577	1,859
Aug. 2–8	2,439	1,561	2,400	6,400	2,133
Aug. 9–15	3,049	1,651	2,837	7,537	2,512
Aug. 16–22	4,304	2,072	2,469	8,845	2,948
Aug. 23–29	2,958	222	3,183	6,363	2,121
Aug. 30–Sept. 5	2,669	2,766	3,372	8,807	2,936
Sept. 6–12	3,385	1,299	1,052	5,736	1,912
Sept. 13–19	2,502	1,926	3,110	7,538	2,513
Sept. 20–26	1,834	2,913	3,799	8,546	2,849
Sept. 27–Oct. 3	3,480	889	3,439	7,808	2,603
Oct. 4–10	2,802	1,720	2,921	7,443	2,481
Oct. 11–17	3,213	1,375	3,701	8,289	2,763
Oct. 18–24	3,523	1,163	2,605	7,291	2,430
Oct. 25–31	1,102	288	1,810	3,200	1,067
Nov. 1–7	303	380	435	1,118	----------
Nov. 8–14	224	----------	628	852	----------
Nov. 15–21	----------	----------	549	549	----------
Total	63,596	32,028	48,164	----------	----------

Since no further refinement in the analysis of the data is feasible, and since, on the basis of this evidence, the yield of the fishery appears to be quite uniform, it is believed that the conclusions drawn are not unwarranted because of the possible error of the method. This view is further supported by the internal evidence of uniformity of the data; for it appears, as is shown in the following tables, that the important features of the data are consistent among themselves.

COMPOSITION OF THE CATCH

As indicated in a previous paragraph, the yield of the pound nets and long-haul seines in Pamlico and Core Sounds comprises more than three-fifths of the aquatic food produced in North Carolina, and the species that make up this great catch, in order of importance, are the sea trout, croakers, spots, starfish, and butterfish. This estimate of relative importance is based upon the total weight of each species landed in the markets annually; but, from the point of view of wise regulation of the fishery, the total amount of fish *landed* is of less significance than the amounts actually *caught*, and in this case the disparity between the two figures is surprisingly great, for a tremendous waste of immature fish occurs in these fisheries. From the same point of view, the *weight* of the fish caught is of less significance than are the *numbers* of individuals taken, for an individual specimen, regardless of how young or how small it may be, barring the normal mortality occasioned by its enemies in the sea, has the potentiality of developing to a size that is of real value either to man as food or to the species as the brood stock of the future supply.

In the following discussion, therefore, the relative abundance of the different kinds of fish and of the various sizes representing each species is determined by calculating the percentage by number and not by weight in the entire unsorted catches of food fish in the different nets. Hence the following figures represent more fully the real stock of fish, as caught, than would any analysis of the catch as marketed. Let us examine the records, then, to discover what kinds of fish are caught by each type of gear and the relative importance of each species in the total catch.

SPECIES TAKEN

The following species, arranged in the order of importance, were observed in the catches of long-haul seines during the season. The common names are those in most general use in this locality. Those marked with an asterisk are marketed; all others are discarded as trash fish.

FISH TAKEN IN LONG-HAUL SEINES IN PAMLICO AND CORE SOUNDS, N. C., 1925

*Spotted trout	*Cynoscion nebulosus.*
*Gray trout	*Cynoscion regalis.*
*Croaker	*Micropogon undulatus.*
*Spot	*Leiostomus xanthurus.*
*Bluefish	*Pomatomus saltatrix.*
Pinfish	*Lagodon rhomboides.*
Menhaden	Brevoortia sp.
*Starfish	*Peprilus alepidotus.*
*Spanish mackerel	*Scomberomorus maculatus.*
*Red drum	*Sciænops ocellatus.*

Perch	*Bairdiella chrysura.*
*Hogfish	*Orthopristis chrysopterus.*
Stingaree	*Dasyatis say.*
Sea catfish	*Galeichthys milberti.* / *Felichthys felis.*
Garfish	*Tylosurus marinus.*
*Mullet	*Mugil cephalus.*
*Pompano	*Trachinotus carolinus.*
*Sheepshead	*Archosargus probatocephalus.*
*Sea mullet	Menticirrhus sp.
*Flounder	Paralichthys sp.
Toadfish	*Opsanus tau.*
Bur fish	*Chilomycterus spinosus.*
Puffer	*Spheroides maculatus.*
*Rockfish	*Roccus lineatus.*

The following species, arranged in order of importance, were observed as occurring in the pound nets. The common names are those in most general use in this locality. Those marked with an asterisk were marketed, if large enough; all others were discarded as trash fish.

FISH TAKEN IN POUND NETS IN PAMLICO SOUND, N. C., 1925

*Gray trout	*Cynoscion regalis.*
*Starfish	*Peprilus alepidotus.*
*Croaker	*Micropogon undulatus.*
*Spot	*Leiostomus xanthurus.*
*Butterfish	*Poronotus triacanthus.*
Menhaden	Brevoortia sp.
Pinfish	*Lagodon rhomboides.*
*Flounder	Paralichthys sp.
*Bluefish	*Pomatomus saltatrix.*
*Porgy	*Chaetodipterus faber.*
*Spanish mackerel	*Scomberomorus maculatus.*
Cutlass fish	*Trichiurus lepturus.*
Lookdown	*Selene vomer.*
Sea catfish	*Galeichthys milberti.*
Stingaree	*Dasyatis say.*
Eel	*Anguilla rostrata.*
Nanny shad	*Dorosoma cepedianum.*
Garfish	*Tylosurus marinus.*
*Mullet	*Mugil cephalus.*
Olbacore	*Caranx hippos.*
Threadfish	*Alectis ciliaris.*
*Pompano	*Trachinotus carolinus.*
Sergeantfish	*Rachycentron canadus.*
*Spotted trout	*Cynoscion nebulosus.*
White perch	*Bairdiella chrysura.*
*Tripletail	*Lobotes surinamensis.*
*Hogfish	*Orthopristis chrysopterus.*
*Sheepshead	*Archosargus probatocephalus.*
*Red drum	*Sciænops ocellatus.*
*Sea mullet	Menticirrhus sp.
*Black drum	*Pogonias cromis.*
Foolfish	*Monacanthus hispidus.*
Puffer	*Spheroides maculatus.* / *Lagocephalus lævigatus.*
Bur fish	*Chilomycterus spinosus.*
Sea robin	Prionotus sp.
Remora	*Echeneis naucrates.*
Toadfish	*Opsanus tau.*
Hogchoker	*Achirus fasciatus.*
Hairy back	*Opisthonema oglinum.*

Table 2 shows the composition, by species, of the catch of the pound nets and long-haul seines throughout the season. The average composition in each locality for each month is taken and from these figures the average composition for the season is calculated. Starfish constitute 45 per cent of the catch of pound nets, gray trout 40 per cent, spots and butterfish each 5 per cent, and croakers 4 per cent, while spotted trout are not taken in any appreciable quantity. Other species are taken, but in such insignificant quantities that they are omitted from consideration.

Long-haul seines, however, fail to catch many starfish or butterfish. Their catch consists of 38 per cent croakers, 18 per cent each spots and spotted trout, 7 per cent gray trout, and 19 per cent mixed fish, comprising many species in small but varying quantities, most important of which are bluefish, Spanish mackerel, and red drum.

TABLE 2.—*Composition of catch of different gear, by species, in Pamlico and Core Sounds, N. C., 1925.* (*In per cent, by number*)

	Gray trout	Spotted trout	Starfish	Butterfish	Croaker	Spot	Mixed	Total
POUND NETS								
June	39.1	.....	35.7	9.4	8.0	7.9	.....	.....
July	40.8	.....	38.6	7.4	8.1	5.0	.....	.....
August	32.3	.....	58.4	4.0	2.0	3.2	.....	.....
September	34.3	.....	59.1	2.1	1.8	2.8	.....	.....
October	53.3	.....	35.2	.8	2.3	8.3	.....	.....
Average for season	40.0	.....	45.4	4.7	4.4	5.4	.....	99.9
LONG-HAUL SEINES								
July	2.4	15.6	.....	.....	55.9	20.3	6.0	.....
August	7.5	10.6	.....	.....	44.1	20.4	13.8	.....
September	10.4	21.4	.....	.....	28.4	12.3	27.3	.....
October	7.6	24.0	.....	.....	22.9	19.0	29.0	.....
Average for season	7.0	17.9	.....	.....	37.8	18.0	19.0	99.7

It is therefore apparent that the two types of gear supplement each other—pound nets yielding the valuable gray trout in large quantities, and long-haul seines providing spotted trout, which is highly prized. Starfish and butterfish would be absent from the markets if pound nets were not fished, and while both types of gear take croakers and spots, these fish form a larger percentage of long-haul seine catches than do any other species. Neither is there competition between the two types of nets in the locality fished, for the pound nets are confined to the deeper waters of Pamlico Sound and its tributaries, where the muddy bottoms are so soft that it is difficult to drag seines, while the long-haul seines operate on the shallow, sandy bottoms of Pamlico and Core Sounds, where conditions are unfavorable for pound netting. It would seem that both types of gear are desirable and necessary for yielding a balanced supply of fish to the markets.

SIZES OF FISH

The sizes of fish taken in the pound nets in Pamlico Sound are presented in Tables 3 to 7 and Figures 8 to 13 showing the length frequencies of the various species, month by month, during the season. Gray trout taken in pound nets range in size from 5.5 to

23.6 inches. One abundant size group is evident in this range, consisting of fish that are in all probability more than 2 years of age—that is, in their third year. The older groups are represented but scatteringly, and by the end of the fishing season a smaller size group also appears in moderate numbers. Starfish taken range in length from 2 to 8.3 inches and consist of two distinct sizes, which in all probability are separate year classes. The group of larger fish is taken during June and July, and the smaller size becomes abundant in August, September, and October, during which time the larger fish are absent. Butterfish range in length from 2.4 to 8.3 inches and constitute but one clearly marked size group. Spots range in length from 3.9 to 9.5 inches and are readily divided into two distinct size groups. The larger fish are more abundant in June and July and the smaller ones in August and September. Croakers range in length from 5.1 to 15.8 inches, but, as has been noted in other investigations, are separated with difficulty into distinct size groups. It is probable that two major size groups can be distinguished, but from our records it is difficult to assign ages to these groups. All sizes of fish are taken throughout the season, but the larger fish are notably reduced in relative abundance during October.

TABLE 3.—*Length frequencies of 9,497 gray trout taken in pound nets in Pamlico Sound, N. C., 1925, all localities.* (*In per cent of total number*)

Length, centimeters	June	July	Aug.	Sept.	Oct.	Length, centimeters	June	July	Aug.	Sept.	Oct.
14	------	------	------	0.09	0.08	39	0.18	0.97	0.31	0.88	1.15
15	0.27	------	------	.29	.23	40	.06	.33	.49	.40	1.06
16	.64	------	------	.20	.75	41	------	.18	.08	.20	1.36
17	.85	0.11	------	.62	2.47	42	------	.15	.12	.48	1.05
18	3.65	.33	------	1.05	4.39	43	------	.11	.13	.27	.94
19	8.68	1.25	0.17	1.24	4.40	44	------	.16	.21	.05	.72
20	13.62	3.94	.66	.71	3.25	45	------	.02	.37	.10	.78
21	15.78	10.27	1.87	.77	1.21	46	------	------	.08	.05	.26
22	10.20	13.92	7.79	1.46	.65	47	------	.03	------	.10	.38
23	4.20	11.54	13.51	5.01	.72	48	------	.04	.35	.06	.16
24	3.79	8.58	18.20	10.15	4.09	49	.05	------	------	.06	.18
25	7.19	6.24	12.38	14.68	7.08	50	------	.03	------	.11	.22
26	7.94	7.14	8.98	12.73	10.41	51	------	------	------	------	.30
27	7.33	8.28	6.75	8.53	9.52	52	------	.03	------	------	.18
28	4.32	6.05	6.19	7.65	6.54	53	------	.03	------	------	.22
29	3.20	4.79	5.51	6.11	5.63	54	------	------	------	.06	------
30	1.61	3.23	4.20	6.26	5.02	55	------	------	------	.06	.06
31	2.18	2.88	3.45	3.89	5.19	58 [1]	------	------	------	------	.08
32	.67	2.03	1.87	4.14	3.81	59	------	------	------	------	.04
33	.17	1.81	1.85	3.12	3.79	60	------	------	------	------	.08
34	.84	1.36	1.23	2.60	3.37						
35	.91	1.11	1.42	2.77	2.63	Total	99.92	100.00	100.02	99.96	100.01
36	.18	1.25	.77	1.73	2.19						
37	.31	.54	.79	1.11	1.58	Number of fish	1,202	2,377	1,678	2,218	2,022
38	1.10	1.27	.29	.69	1.79						

[1] Indicates break in continuity of table.

TABLE 4.—*Length frequencies of 13,508 starfish taken in pound nets in Pamlico Sound, N. C., 1925, all localities.* (*In per cent of total number*)

Length, centimeters	June	July	Aug.	Sept.	Oct.	Length, centimeters	June	July	Aug.	Sept.	Oct.
5	------	0.11	0.54	0.03	------	16	6.23	13.86	6.61	.59	.16
6	------	.20	1.67	.18	0.03	17	2.03	7.54	2.49	.50	.14
7	------	.76	6.08	1.37	.63	18	.91	2.81	1.01	.23	.11
8	------	1.89	10.24	10.05	4.02	19	.14	.64	.58	.10	------
9	0.16	1.96	12.07	23.20	18.05	20	.06	.38	.22	.02	.04
10	1.33	.15	20.79	24.40	37.69	21	------	------	.02	.04	.12
11	7.21	2.12	11.23	25.75	25.66						
12	15.90	6.34	2.39	10.37	11.12	Total	99.90	99.93	100.02	100.03	99.99
13	25.24	11.38	3.84	1.16	2.01						
14	27.04	22.40	8.12	1.08	.18	Number of fish	1,115	2,576	3,650	4,291	1,876
15	13.65	27.39	12.12	.96	.03						

TABLE 5.—*Length frequencies of 1,184 butterfish taken in pound nets in Pamlico Sound, N. C., 1925, all localities.* (*In per cent of total number*)

Length, centimeters	June	July	Aug.	Sept.	Oct.	Length, centimeters	June	July	Aug.	Sept.	Oct.
6	0.43					16	9.01	29.90	41.30	41.10	19.45
7	1.72					17	14.60	9.90	19.85	26.40	41.68
8	1.72					18	7.72	4.65	3.50	9.20	30.58
9	3.43					19	3.00	1.41	1.56	1.84	5.53
10	2.58	0.40				20		.20	.78	.61	
11	7.72	1.21	0.39			21		.20			
12	5.58	2.83									
13	13.30	4.85	2.34	3.07		Total	100.00	100.01	100.02	100.04	100.02
14	17.17	13.54	5.84	6.14	2.78						
15	12.02	30.92	24.46	11.68		Number of fish	233	495	257	163	36

TABLE 6.—*Length frequencies of 1,101 spots taken in pound nets in Pamlico Sound, N. C., 1925, all localities.* (*In per cent of total number*)

Length, centimeters	June	July	Aug.	Sept.	Oct.	Length, centimeters	June	July	Aug.	Sept.	Oct.
10		0.38				20	10.34	12.12	9.52	5.66	6.25
11		.38				21	3.45	10.61	8.33	6.92	10.42
12	1.15	.38	1.19	0.63	0.60	22		3.41	7.14	5.66	6.55
13		1.53	2.98	6.92	2.08	23		.38	1.19	2.52	3.87
14	4.60	3.03	11.90	7.54	11.01	24		.38	1.19	.63	1.19
15	16.75	2.27	14.28	14.45	9.82						
16	17.80	6.44	10.72	18.23	13.40	Total	100.04	100.02	99.98	99.97	100.00
17	14.94	15.90	3.57	16.98	21.12						
18	17.23	25.38	9.52	9.43	6.84	Number of fish	174	264	168	159	336
19	13.78	17.43	18.45	4.40	6.84						

TABLE 7.—*Length frequencies of 942 croakers taken in pound nets in Pamlico Sound, N. C., 1925, all localities.* (*In per cent of total number*)

Length, centimeters	June	July	Aug.	Sept.	Oct.	Length, centimeters	June	July	Aug.	Sept.	Oct.
13	0.82					29	2.88	4.63	5.66	4.90	0.81
14	1.23				0.81	30	1.65	1.09	1.89	3.92	1.62
15	4.53	0.27	1.89		.81	31	1.23	2.18	.94	4.90	
16	8.65	.54	.94	0.98	4.03	32	1.23	.82	3.78	1.96	.81
17	11.50	1.36		3.92	5.65	33	.41	1.64	1.89		
18	15.63	6.26	11.31	7.85	6.45	34	.41	.54	.94	1.96	.81
19	9.05	6.80	.94	3.92	12.09	35		.54	.94		.81
20	4.94	12.00	9.43	6.86	12.90	36	.41	.27	.94		
21	2.06	7.08	12.25	12.72	11.29	37	.41	.54	.94		.81
22	2.88	5.45	12.25	10.79	11.29	38		.54			
23	4.94	6.54	4.72	6.86	8.86	39					
24	7.40	11.70	1.89	.98	5.65	40		.27			
25	4.94	9.54	9.43	4.90	3.23						
26	6.17	7.08	6.60	3.92	4.84	Total	99.96	99.93	99.96	99.96	100.02
27	4.12	4.90	1.89	13.72	2.42						
28	2.47	7.35	8.50	4.90	4.03	Number of fish	243	367	106	102	124

In the long-haul seine catches (Tables 8 to 11) but scattering specimens of gray trout are found. Those caught range in length from 9.8 to 25.6 inches, and the more abundant sizes consist of fish that are in all probability more than 3 years old. The spotted trout taken range in length from 9.1 to 27.2 inches, but the size groups are not readily distinguished. The spots caught are from 4.3 to 10.6 inches in length. These also represent older fish than those taken in the pound nets, except in October, when the older fish are notably lacking; the same sizes are caught by both gears. Croakers range in length from 5.9 to 16.2 inches, and, as in the pound-net catches, the larger fish are abundant in the earlier part of the season but virtually absent in October.

TABLE 8.—*Length frequencies of 210 gray trout taken in long-haul seines, 1925, all localities. (In per cent of total number)*

Length, centimeters	Aug.	Sept.	Oct.	Length, centimeters	Aug.	Sept.	Oct.
25	2.02			41		2.60	5.88
26	2.02	3.90	2.94	42	4.04	1.30	5.88
27	3.03	9.09	8.82	43	2.02	5.20	2.94
28	3.03	6.50	8.82	44	1.01		
29	9.09	2.60		45			
30	8.08	2.60	8.82	46	4.04	2.60	
31	7.07	6.50	2.94	47	1.01		
32	8.08	2.60	2.94	48	1.01		2.94
33	5.05	5.20	2.94	49	1.01	2.60	
34	9.09	9.09	11.77	50		2.60	
35	5.05	7.79	14.70	55 [1]		1.30	
36	7.07	10.39	2.94	65 [1]	1.01		
37	2.02	5.20	2.94				
38	5.05	1.30	2.94	Total	99.99	100.06	99.97
39	7.07	3.90	8.82				
40	2.02	5.20		Number of fish	99	77	34

[1] Indicates break in continuity of table.

NOTE.—Only 15 specimens secured during the month of July.

TABLE 9.—*Length frequencies of 460 spotted trout taken in long-haul seines, 1925, all localities. (In per cent of total number)*

Length, centimeters	July	Aug.	Sept.	Oct.	Length, centimeters	July	Aug.	Sept.	Oct.
23				2.67	46	.90	1.67	.72	2.67
24				2.67	47	5.41		2.88	2.00
25				2.67	48	.90	5.00	.72	.67
26	0.90			3.34	49	1.80		1.44	
27	.90			2.67	50			.72	.67
28	3.61			2.67	51	.90		2.16	1.34
29	3.61	1.67		3.34	52		1.67		
30	7.21	3.44		2.00	53			.72	
31	6.30		1.44		54		1.67		
32	9.00	3.44	2.88		55				
33	6.30	8.34	1.44	.67	56	.90			
34	3.61	6.66	5.04		57				
35	9.80	8.34	7.91	1.34	58		1.67		.67
36	5.41	11.68	11.51	.67	59	.90	1.67		
37	3.61	8.34	8.63	8.00	60	.90		.72	
38	1.80	6.66	8.63	8.00	61	.90			
39	6.30	8.34	9.35	7.33	68 [1]			.72	
40	4.51	3.44	7.91	9.34	69	.90		.72	
41	3.61	5.00	9.35	6.00					
42	1.80	5.00	4.32	8.00	Total	99.91	100.37	100.01	100.06
43	2.71		2.16	6.66					
44	2.71	1.67	4.32	9.34	Number of fish	111	60	139	150
45	1.80	5.00	3.60	4.66					

[1] Indicates break in continuity of table.

TABLE 10.—*Length frequencies of 586 spots taken in long-haul seines, 1925, all localities. (In per cent of total number)*

Length, centimeters	July	Aug.	Sept.	Oct.	Length, centimeters	July	Aug.	Sept.	Oct.
11			0.81		22	11.10	31.61	25.00	8.96
12					23	6.17	11.61	12.10	4.14
13	0.61			2.07	24	.61	2.58	2.42	.69
14	1.23			.69	25		.65	.81	.69
15			2.42	4.83	26		.65		.69
16			4.84	12.40	27				.69
17	2.46	4.53	8.06	21.40					
18	10.50	5.16	6.45	14.50	Total	100.00	100.04	100.04	100.00
19	11.72	4.53	3.23	17.90					
20	20.40	14.20	10.50	4.83	Number of fish	162	155	124	145
21	35.20	24.52	23.40	5.52					

TABLE 11.—*Length frequencies of 1,303 croakers taken in catches of long-haul seines, 1925, all localities. (In per cent of total number)*

Length, centimeters	July	Aug.	Sept.	Oct.[1]	Length, centimeters	July	Aug.	Sept.	Oct.[1]
15				0.91	31	4.94	4.22	8.50	
16				.46	32	3.30	1.58	4.40	.91
17				.91	33	1.92	1.06	2.35	
18				3.20	34	.82		2.64	.91
19	0.27		0.29	7.30	35		.26		.46
20	1.37	0.26	2.35	16.45	36	.55		.88	
21	3.02	1.32	3.23	18.70	37	.27			
22	3.84	2.37	10.85	16.90	38			.59	
23	5.50	9.50	8.50	14.60	39			.29	
24	7.42	11.61	8.80	8.67	40		.26	.29	
25	9.34	12.66	5.87	2.74	41			.29	
26	12.60	17.94	7.92	4.10					
27	18.94	11.87	8.80	.91	Total	99.91	99.98	100.00	99.96
28	11.09	8.18	5.57	.46					
29	9.05	9.50	12.60	.46	Number of fish	364	379	341	219
30	5.76	7.39	4.99	.91					

[1] Includes collections on Nov. 2.

These data are all presented graphically in Figures 8 to 13, and for the benefit of the average practical reader, unfamiliar with graphical methods of analysis, Figure 7 is given to illustrate the method of construction of these curves and to make more complete the mental picture they are intended to convey.

SELECTIVE ACTION OF FISHING GEAR

It will be noted above that the size of fish taken in pound nets differs materially from those taken in the long-haul seines. Not only do pound nets catch the smaller fish, such as butterfish and starfish, which seldom appear in the catches of the long-haul seines, but the long-haul seines catch spotted trout, drum, rockfish, and other large species not frequently taken in pound nets. The sizes of fish of the same species are uniformly larger in long hauls than in pound nets. Thus, the maximum size of gray trout taken in long-haul seines is 2 inches greater than those taken in pound nets. The maximum size of spots is 1.1 inches greater, and the maximum size of croakers is 0.4 inch greater. The same disparity in sizes is shown in the minimum sizes taken, pound nets taking smaller fish of all species than are ever caught in quantities by long-haul seines. There is, therefore, a very evident selection of different sizes of fish by the two types of gear, which is more clearly illustrated by Figures 8, 11, and 12, showing the length frequencies of fish of the three species caught most abundantly by the two methods. Figure 8 shows the size composition of gray trout, and while the curve for the long-haul seine catch is quite irregular, due to the relatively small numbers it represents, it is quite apparent that fish under 25 centimeters in length seldom are caught by this gear. If we assume that the abundant size group found at 24 centimeters in August represents the 2-year-old fish, it is apparent that only fish 3 years and more of age are caught by long hauls. As the 2-year-old fish grow through the summer, the number of this group taken by the long hauls increases; but in all months of the season the older fish are taken in

far greater relative abundance by long hauls than by pound nets. The same kind of size selection is shown by the catch of spots in Figure 11. If ages are assigned provisionally to the prominent size groups as shown in the graph, it is apparent that the III-group is taken far more abundantly in the early part of the season by long-haul seines than by pound nets. As the I and II groups grow, however, increasing amounts are taken by the long hauls until in October,

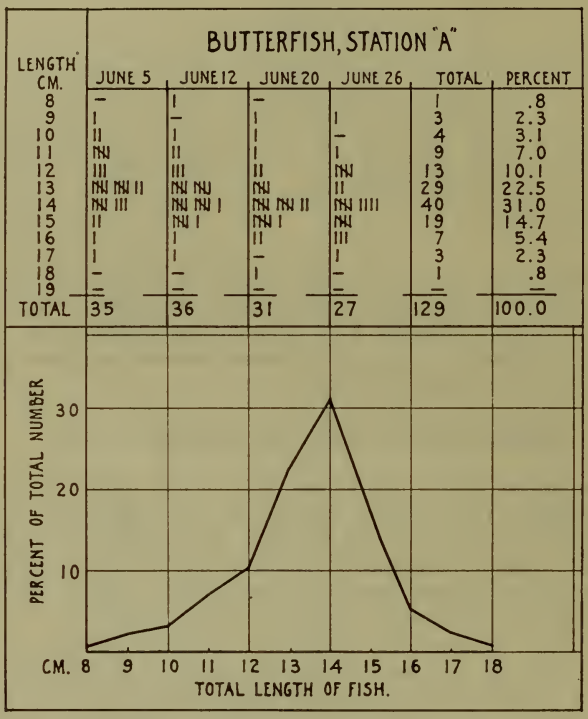

FIG. 7.—Illustrating method of tabulating length frequencies and constructing curves. At station A 35 butterfish contained in the gross sample obtained from the pound-net catch of one crew were measured and their lengths tallied on the record sheet opposite the correponding length in centimeters, as in the first column. On succeeding visits to this station (on June 12, 20, and 26) the butterfish taken were measured and tabulated. The total number of fish occurring at each centimeter length was then determined by adding together the samples, as shown in the total column. The number of fish at each length was reduced to a percentage of the total number, as shown in the per cent column, and comprise a length-frequency table corresponding to Tables 3 to 11. These figures were then used to plot the curve here shown by placing points at the corresponding heights on the vertical scale over the proper lengths on the horizontal scale. Fictitious and not actual figures have been used in this illustration

when the majority of the fish are above 15 centimeters in length, virtually equal numbers of the I and II groups are taken by both gears.

Figure 12 illustrates the catch of croakers. As was said before, the separate-age groups can not be distinguished readily, but it is again apparent that the larger fish are taken more abundantly by long-haul seines throughout July, August, and September, and that the smaller group appears in numbers only when the fish have grown beyond 19 centimeters in size.

No direct observations on the causes of this selection in sizes were made in the course of the investigation. It may be remembered, however, that pound nets operate in different localities than do long-haul seines and upon bottom of different character. It must also be remembered that the size of mesh used in the seines is much

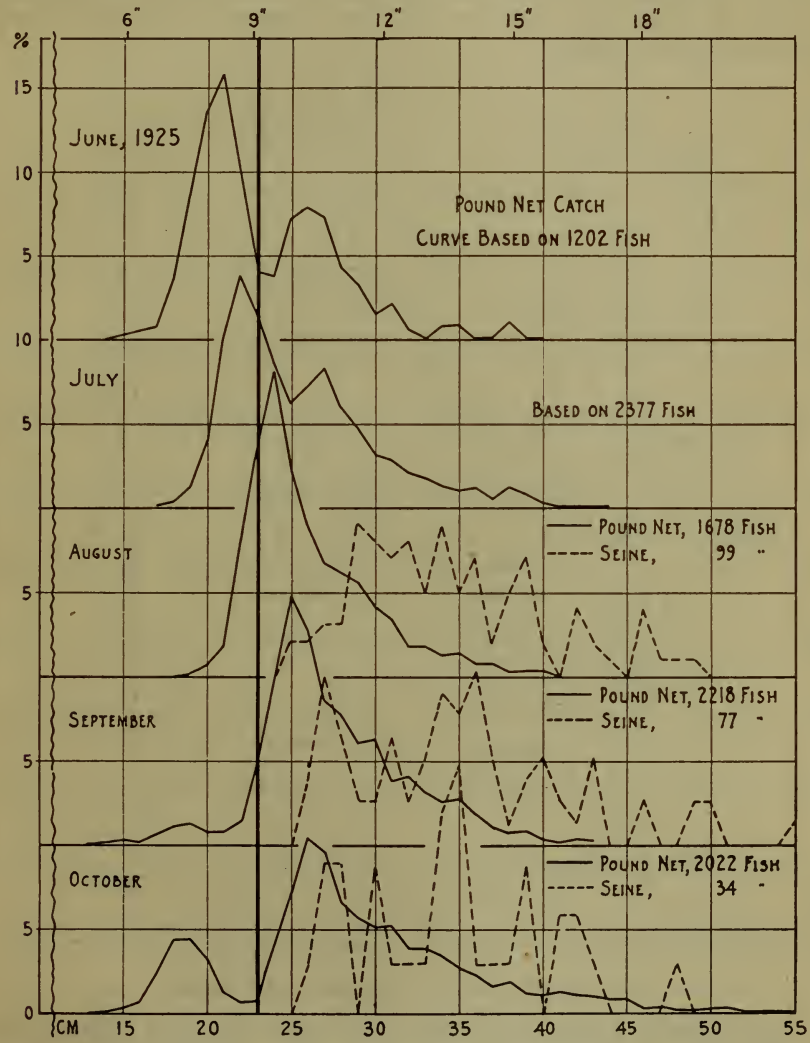

FIG. 8.—Length frequencies of gray trout from pound nets and long-haul seine catches in Pamlico and Core Sounds, N. C., 1925. The heavy vertical line is placed at the legal minimum size limit.

greater than that used in the crib of the pound net, and both of these factors, in all probability, are responsible. But whether this selection by pound nets and long-haul seines is due to the segregation of the size of fish according to the depth of water and character of bottom, or whether it is due to differences in size of mesh and in the method of operating the nets, is of little practical importance. That

long-haul seines tend to catch more of the larger sizes of fish and that pound nets take greater quantities of the younger and smaller fish are facts of great importance. From this evidence alone, and unless counteracted by other undesirable features not discovered by this investigation, this selection of the larger species and of the larger fish in each species would warrant the encouragement of long-haul seining as being more efficient and less harmful to the fish supply than pound-net fishing.

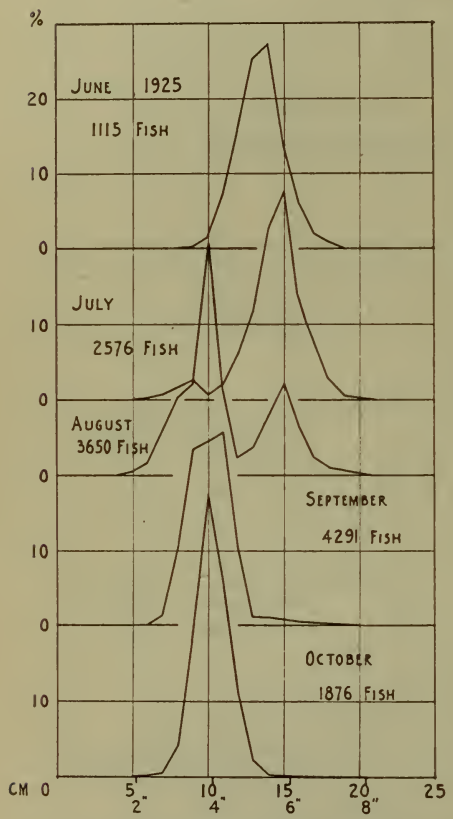

FIG. 9.—Length frequencies of starfish (harvest fish) in pound-net catches in Pamlico Sound, 1925

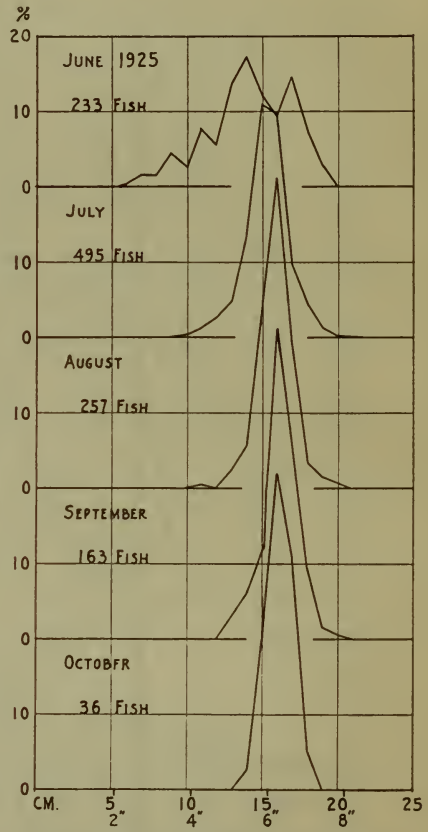

FIG. 10.—Length frequencies of butterfish in pound-net catches in Pamlico Sound, 1925

DESTRUCTION OF UNDERSIZED FISH

The Fisheries Commission Board of North Carolina has enacted regulations that prohibit the marketing, possession, or the unnecessary destruction of various commercial fish below a certain size. Rule 12, passed December 11, 1923, and published in "Orders, Rules, and Regulations" of the Fisheries Commission Board in 1925, provides the following minimum size limits: Gray trout, 9 inches; spotted trout, 11 inches; croakers, 8 inches; spots, 7 inches. Size limits are assigned also to other species not taken by pound nets or long-haul seines. Starfish and butterfish have no legal minimum

size limit, but a very effective market limit of about 5 inches is placed upon these species by the dealers, for fish below this size are virtually worthless and are refused by the fish buyers.

The provisions of this rule regarding marketing or possession are undoubtedly well enforced in this State and are accepted without

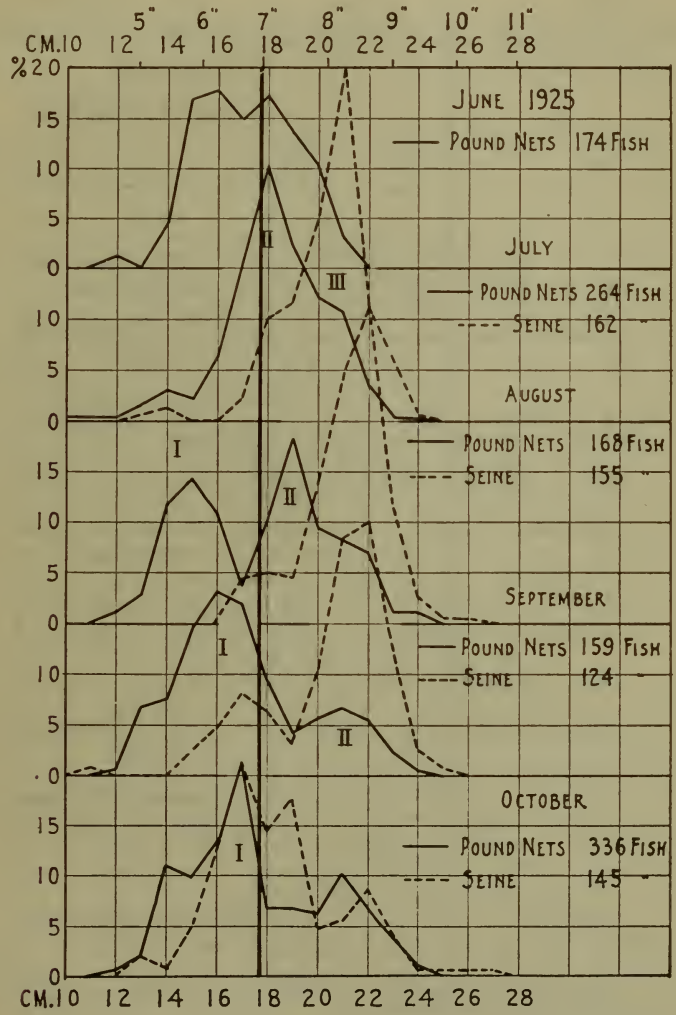

FIG. 11.—Length frequencies of spot in pound-net and long-haul seine catches in Pamlico and Core Sounds, N. C., 1925. The heavy vertical line is placed at the legal minimum size limit

protest by the fishing interests. Whether or not the third provision of the rule, concerning unnecessary destruction, is effective may be seen by an examination again of Tables 3 to 11, which show relative numbers of the various sizes of each species caught by the different kinds of gear. Table 12 summarizes the percentage, by number, of

unmarketable fish—that is, fish below the legal or marketable size limit taken in the pound nets and long-haul seines during 1925. From the averages of destruction in different months it may be seen that long-haul seines waste no gray trout that are unmarketable,

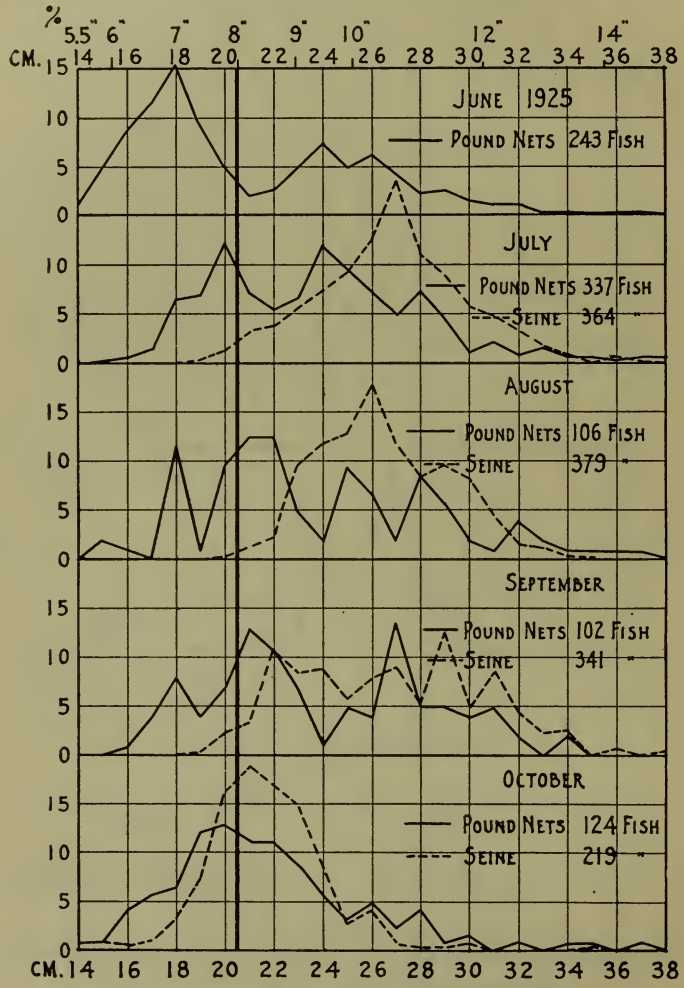

FIG. 12.—Length frequencies of croaker in pound-net and long-haul seine catches in Pamlico and Core Sounds, N. C., 1925. The heavy vertical line is placed at the legal minimum size limit

while pound nets waste, on the average, 30.6 per cent of the catch. Long-haul seines waste 4 per cent of the catch of spotted trout; pound nets destroy 59 per cent of the catch of starfish and 5½ per cent of the catch of butterfish.

TABLE 12.—*Percentage (by number) of unmarketable fish, Pamlico and Core Sounds, N. C., 1925, all localities*

Species	June	July	Aug.	Sept.	Oct.	Average
LONG-HAUL SEINES						
Gray trout	----------	0	0	0	0	0
Spotted trout	----------	1.8	----------	----------	14.0	4.0
Croaker	----------	1.6	.3	2.6	29.2	8.4
Spot	----------	4.3	4.5	16.1	41.4	16.6
POUND NETS						
Gray trout	57.9	41.4	24.0	11.4	18.2	30.6
Starfish	24.6	13.5	65.0	95.4	97.2	59.1
Butterfish	23.2	4.4	.4	0	0	5.6
Croaker	56.4	27.2	24.5	23.5	42.7	34.9
Spot	55.2	30.3	44.6	64.7	58.0	50.6

Long-haul seines waste 8½ per cent of the catch of croakers, while pound nets waste 35 per cent. Long-haul seines destroy 16½ per cent of the catch of spots, while pound nets destroy 50½ per cent. Long-haul seines also take appreciable numbers of mixed fish, but the numbers of each species is so small and variable that the percentage of destruction of small fish, such as rock or striped bass, drum, bluefish, and sheepshead, has not been reduced to exact figures; but of the total number approximately 12 per cent are below marketable or legal limit and are thus destroyed. It can be seen that long-haul seines destroy but small quantities of fish that are too small to market, while pound nets, on the other hand, are extremely destructive. A simple average of the percentage of waste by pound nets of each species shows a destruction of more than 36 per cent; but this is far under the real destruction of all fish taken, when it is considered that the destruction of the most numerous species—starfish—amounts to almost 60 per cent for the season.

The figures of size composition given in Tables 3 to 11 represent the size of fish landed in the boats. All of the fish below the legal or marketable size limit, indicated by the heavy vertical line in Figures 8 to 14, are utterly destroyed and wasted, for culling of these small fish from the marketable catch is not attempted in the case of the pound-net fishing until the boats have returned with the catch to the market places or waiting buy boats. They are then scooped up, sorted, and thrown overboard, where they float upon the water in great quantities, affording food only for gulls and crabs. (See fig. 3.)

Table 12 further shows that the destruction of the various species by pound nets varies throughout the season. The greatest destruction of gray trout occurs in June and declines through July and August, reaching the lowest point in September, with a slight increase in October. The destruction of starfish falls from June to July, but increases rapidly until the tremendous waste of 97 per cent occurs in October. Butterfish are wasted in appreciable quantities only in June, but the wastage of spots and croakers appears to be virtually constant throughout the season, with somewhat greater waste occurring in both species in June. The tremendous waste of croakers and spots is deplorable, but these species represent only 4 and 5 per cent, respectively, of the total season catch of the pound nets,

while trout and starfish represent 40 and 45 per cent, respectively. Hence further consideration of undersized fish will be limited to a consideration of the pound-net catch of gray trout and starfish.

The previous figures, based upon observations at Portsmouth, Lupton, Brant Island, Gull Rock, and Point of Marsh, apply to the average conditions over the whole of Pamlico Sound. There is considerable variation, however, in the relative destruction of gray trout and starfish in the various localities. Table 13 gives the percentage destruction of small gray trout taken in pound nets in Pamlico Sound, according to month and locality.

TABLE 13.—*Percentage destruction of undersized gray trout by pound nets in Pamlico Sound, N. C., 1925, according to locality and month*

Locality	June	July	Aug.	Sept.	Oct.
Portsmouth	29.36	25.30			
Lupton	50.46	54.38	25.68	4.92	10.42
Brant Island	77.73	43.99	16.50	6.29	28.40
Point of Marsh		29.94	14.88	6.83	20.43
Gull Rock	74.17	53.16	38.93	27.76	13.28
Average	57.93	41.35	24.00	11.45	18.13

In the month of June the smallest fish are taken at Brant Island and Gull Rock, the number of unmarketable fish reaching 78 and 74 per cent, respectively while at Lupton virtually 50 per cent of the catch is below legal size. At Portsmouth less than 30 per cent are unmarketable, the bulk of the catch coming from the older spawning fish. In July the amount of destruction at Brant Island and Gull Rock has fallen somewhat and is exceeded by the destruction at Lupton, which amounts to 54 per cent. The amount of destruction at Portsmouth still remains low, although the preponderance of spawning fish is somewhat reduced. In August the destruction in all localities has fallen below 40 per cent, with the highest figure at Gull Rock. Fishing at Portsmouth has been discontinued until the very end of the season, but records are so scattering that they do not appear in our study again. The destruction at Gull Rock still remains high, but has fallen in September to about 28 per cent. This amount of destruction is largely due to the incoming of the smaller year class of trout, which scarcely appears in the catches at other localities. The total destruction at the other three pound-net localities is 5 or 6 per cent. In October the larger sizes of fish are relatively more important in all localities. The fish remaining below the legal limit have increased, however, to 20 and 28 per cent at Point of Marsh and Gull Rock, due to the increasing abundance of the youngest year class taken in commercial gear. If it can be assumed that conditions at Gull Rock are typical of the northwest side of Pamlico Sound, we may conclude that this region supports a population of very small fish with but a scattering of the larger sizes. The destruction of fish in this locality is, therefore, more severe than at any other place. Only the larger sizes are taken in the fishery at Portsmouth in June and July, hence the destruction of small fish there amounts to very little.

EFFECT OF GROWTH ON MARKETABILITY

Figure 8 shows the composition of the catch of gray trout in pound nets in all localities for the various months. The heavy vertical line at 23 centimeters marks the legal minimum size limit. It may be seen that in June two well-marked size groups are present in the range of sizes, one with a mode at about 21 centimeters and another with a mode at about 26 centimeters. The group above 23 centimeters is, of course, composed of marketable fish, while the smaller group lies entirely below the legal limit and these fish are wasted. In July the group of the smaller fish has grown to a modal or average length of 22 centimeters, when the larger members of this group are now beyond the minimum limit. In August the modal size of the same group has reached 24 centimeters, and in September more than 25 centimeters, with increasing percentages above the minimum size limit. Thus the decreasing destruction of the gray trout from June to September is explained by the growth of the most numerous year class, which passes from an unmarketable to a marketable size in the period of rapid growth during the summer. In October the percentage destruction rises somewhat because of the fact that the next younger age group has reached a size of 14 to 23 centimeters in length, which is large enough to be taken by the pound nets. They apparently are not very numerous, however, for they amount to but 18 per cent of the total number of fish taken.

The size composition of starfish taken in the pound nets during the season is shown in Figure 9. Here it may be seen that in June the market limit of 5 inches falls almost in the middle of an abundant year class with a mode at about 13.5 centimeters, hence the destruction of unmarketable fish is relatively great. This group has grown, however, by July so that but few remain below the limit. For some reason the smaller fish are not taken during the month of July, but in August a smaller size group becomes relatively abundant and the larger group diminishes in importance. Since this smaller group consists of fish from 5 to 12 centimeters in length, they are worthless in the market and hence are discarded from the catch. In September and October the catch consists almost entirely of this smaller year class, which apparently does not grow sufficiently to pass the minimum market limit. Hence, the destruction of this species reaches 95 and 97 per cent, respectively, in the latter months of the season.

THE PROBLEM OF CONSERVATION

It is now plainly evident that grossly wasteful and uneconomic practices exist in the pound-net fishery in North Carolina. From our records and from the statistics published by the State authorities it is not possible to estimate with any accuracy the total number of pounds of fish wasted, nor can any valuation be placed upon them, since they are all unmarketable. Despite this fact, the destruction of immature and unmarketable fish is a real economic loss to the fishery, and means should be devised to safeguard the supply against unnecessary strain, particularly when it is remembered that the supply is insufficient to meet the demand. Of the 8,225,000 pounds landed in Pamlico and Core Sounds in 1923, the landings of the two species of sea trout amounted to 27 per cent, butterfish 2.1 per cent,

starfish 3.7 per cent, croakers 15.7 per cent, and spots 12.5 per cent. With the exception of spotted trout, these species bring the fishermen from 2 to 4 cents per pound. Spotted trout, however, are more in demand, bringing the fishermen 8 to 12 cents per pound. The trout, therefore, are a staple market fish in North Carolina; and although starfish are subject to a greater destruction of undersized fish, gray trout must be considered of greatest value as a natural resource.

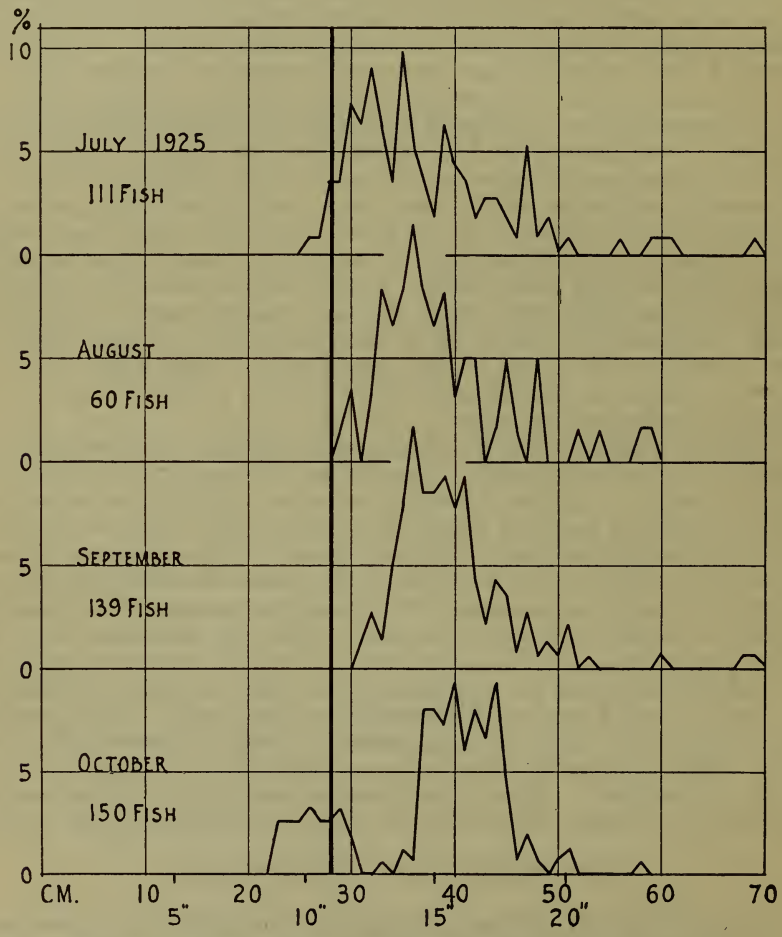

FIG. 13.—Length frequencies of spotted trout in long-haul seine catches in Pamlico and Core Sounds, N. C., 1925

We are faced, therefore, with the problem of affording the gray trout maximum protection from wasteful and excessive exploitation, at the same time disrupting as little as possible the operations of the fishing industry. The protection of the species, however, depends upon many facts in the life history and habits of the fish, which must be considered in drafting effective regulations.

LIFE HISTORY OF THE GRAY TROUT

In outlining the life history of the gray trout it must be admitted at the start that our knowledge is extremely fragmentary and quite inadequate in many directions. No complete or convincing study has been made of the details of the life history and habits of this species. The most useful contributions to our knowledge have been made by Taylor,[9] Welsh and Breder,[10] and Hildebrand and Schroeder.[11]

In the present investigation no attempt has been made to study the life history of the trout by means of scales, for it was felt that the major objects of the investigation would be served by employing less involved methods. All our discussions, therefore, concerning age and rate of growth, age at first maturity, etc., are subject to revision when more exact determinations of age are possible. Extensive collections of scales from the fish studied in this investigation have been retained for that purpose for subsequent treatment.

Spawning.—As has been noted by other authors, the spawning period of the gray trout occurs during the summer months, from May to September. Welsh and Breder state that the great majority of the fish spawn between the middle of May and the middle of June and that the season appears to be little affected by latitude. Spawning occurs from the Carolinas to Cape Cod.

Table 14 presents our data concerning the relative number of spawning fish among all mature females [12] taken in pound nets in Pamlico Sound. When our investigation began in the second week of June virtually all mature females were found to be in a spawning condition; that is, the eggs were large and distinct and the ovaries greatly swollen. In only a few, however, were free-running, ripe eggs discovered. Although there is variation among the different localities, it can be seen from the column of averages that the percentage of spawning fish fell rapidly during the season, from 100 per cent in early June to 0 by the end of the first week in August. This indicates that spawning in Pamlico Sound reached its height during June and was completed for that season by August 10. These facts are represented graphically in Figure 14.

TABLE 14.—*Percentage of spawning females among all mature females in pound-net catches, Pamlico Sound, N. C., 1925. (Average by weeks)*

Date	Portsmouth	Lupton	Brant Island	Point of Marsh	Gull Rock	Average
June 8–13	100					100
June 15–20	100	95	100			98
June 22–27	99	92	58		87	84
June 29–July 4	98	75	60		95	82
July 6–11	100	68	43		89	75
July 13–18		60	29		73	54
July 20–25		51	12	22	48	33
July 27–Aug. 1		18	4	28	52	26
Aug. 3–8		0	3	3	0	2
Aug. 10–15		0	0	0	0	0

[9] The Structure and Growth of the Scales of the Squeteague and the Pigfish as Indicative of Life History. By Harden F. Taylor. Bulletin, U. S. Bureau of Fisheries, Vol. XXXIV, 1914 (1916), pp. 285–330, Pls. L–LIX, 8 text figs. Washington, 1916.

[10] Contributions to Life Histories of Sciænidæ of the Eastern United States Coast. By William W. Welsh and C. M. Breder, jr. Bulletin, U. S. Bureau of Fisheries, Vol. XXXIX, 1923–24 (1924), pp. 141–201, 60 figs. Washington, 1923.

[11] Fishes of Chesapeake Bay. By Samuel F. Hildebrand and William C. Schroeder. Bulletin, U. S. Bureau of Fisheries, Vol. XLIII, 1927, Part I. (In press.)

[12] Mature fish, as shown in Table 15, are never less than 20 centimeters (7.9 inches) in length.

We have no observations upon the exact localities of spawning, but the fish are supposed to spawn in open water. They are known to spawn in Delaware and Chesapeake Bays, where the fish assemble in fairly deep water and spawn on the bottom. The fertilized eggs immediately float to the surface and are freely distributed by tidal currents. (Welsh and Breder.) It is not known whether conditions inside Pamlico Sound are favorable for spawning. Some slight evidence indicates, however, that the spawning individuals leave the inland waters and spawn in the Atlantic Ocean. Thus a scarcity of mature specimens was noted in June in experimental pound-net catches made in Beaufort Harbor in 1913 to 1916, and the early-spring run of large specimens is well recognized by the fishermen in the vicinity of Ocracoke Inlet. Figure 14 indicates that only ripe individuals were taken in the Portsmouth pound-net fishery

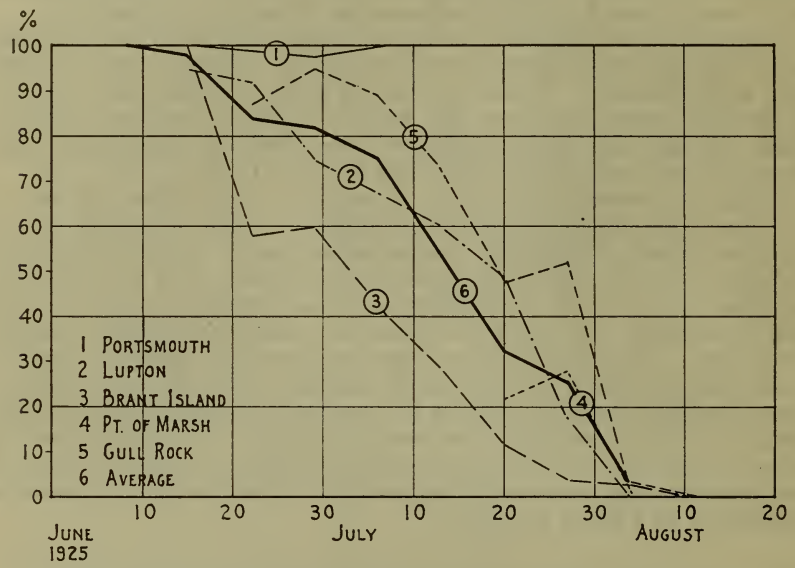

FIG. 14.—Percentage of spawning gray trout among all mature females occurring in pound-net catches in Pamlico Sound, N. C., 1925, computed by weeks during June, July, and August

until early July, when fishing operations were abandoned at that place. The proportion of spawning females is greater here than at any other locality in the sound, and it may be supposed that the outward migrating schools are intercepted by the nets at this locality.

Growth.—We have no knowledge of the early life of the trout in Pamlico Sound until they have reached the size large enough to be taken in the pound nets—that is, 14 centimeters in length. Some collections (Hildebrand) in the vicinity of Beaufort, N. C., however, include specimens ranging from 50 to 120 millimeters in length on August 1 and from 70 to 135 millimeters by October 15. Welsh and Breder also estimate that the length of trout at Cape May, N. J., is from 10 to 13 centimeters during their first winter. The smallest sizes taken in the pound nets in Pamlico Sound have a modal size of about 18 centimeters in October. We believe, therefore, that

these fish are in their second year (I-group) and thus roughly agree with the estimate by Welsh and Breder of 21 centimeters in the second winter. By reference to Figure 5 the first size group in our length-frequency studies has a modal length of 21 centimeters in June. These fish, therefore, are the next older year group—the II-group—and are in their third year. Growth of this age group very clearly progresses to 22 centimeters in July, 24 centimeters in August, 25 centimeters in September, and to somewhat more than 26 centimeters in October. Welsh and Breder estimate that this group reaches a length of 28 centimeters in the third winter, and this is in fairly close agreement with our observations.

The next older year class in our series appears in June to have a modal length of approximately 26 centimeters. This figure, however, may be somewhat lower than the true average of the age group because of the evident selection of the smaller sizes in pound-net catches. The growth of this group can not be satisfactorily followed through the season because of the selective action of the fishing gear. An abundant size group occurs in the long-haul seine catch, which approximates 30 centimenters in length in August, and an estimate of growth during this period may therefore be made. Welsh and Breder estimate that a length of 33 centimeters is attained by the fourth winter, and this again agrees fairly well with our provisional estimate of age. This group, therefore, is the III-group and in the fourth year.

Based on these estimates by various authors, together with the imperfect evidence afforded by the separation of the length-frequency curves into distinct groups, the following estimate of size and age of the gray trout in Pamlico Sound appears to be warranted:

Age	Midwinter size
½ year	11 centimeters (4.3 inches).
1½ years	21 centimeters (8.3 inches).
2½ years	28 centimeters (11 inches).
3½ years	33 centimeters (13 inches).

Age at maturity.—Observations as to the state of maturity of the sexual products were made in all of the fish measured in this investigation. Trout containing swollen ovaries, in which the eggs were distinctly granular and which would obviously spawn during the present season, were considered mature, as well as those in which spawning was under way or in which the ovaries were partially spent. All others were considered immature. The males were not considered in this study, since it is difficult to judge the condition of the male organs. Some error occurred by classing fully spent fish with the immature, but since spent fish were early recognized and relatively scarce during the month of July the records for that month are reasonably accurate and a determination of maturity at each size is possible. Table 15 presents the relative maturity of female gray trout taken in pound nets in Pamlico Sound during July, in which the number of mature females at any size is shown as a percentage of all fish at corresponding sizes. These data are presented graphically in Figure 15, in which the average obtaining in the whole sound is shown superimposed upon a curve of length frequency of all fish taken. It is plainly evident that of the II-

group but a relatively small percentage are mature females, but that the III-group is composed chiefly of mature females in July. From the appearance of the frequency curve it seems that there are but few of the older year classes present in the sounds; hence the future supply must depend chiefly upon the spawning of the 3-year-old fish. This condition differs from that reported by Welsh and Breder at Cape May, N. J., where the majority of the spawning fish were from 4 to 6 years old and the 5-year-old fish were the most numerous.

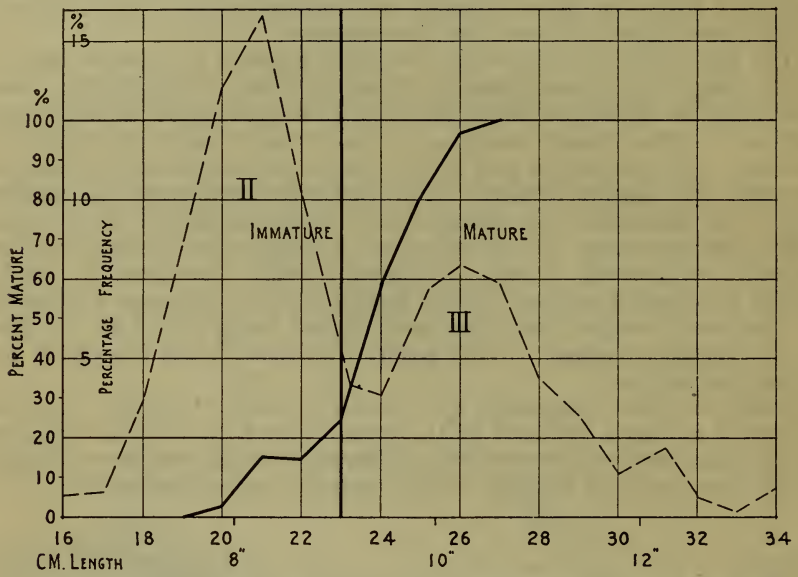

FIG. 15.—Relative maturity of female gray trout in Pamlico Sound, N. C., in July, 1925. The heavy curve rising from 0 to 100 represents the number of mature females occurring at any size, expressed in per cents of the total number of fish at that size. The length frequency curve of both males and females combined is superimposed. These data indicate that the II-group (fish in their third year) are largely immature, while of the III-group nearly all are mature, and that the fish larger than 27 centimeters in length are all mature females.

TABLE 15.—*Percentage of mature female gray trout occurring at any size in pound-net catches, Pamlico Sound, N. C., July, 1925* [1]

Length, centimeters	Lupton	Ports-mouth	Brant Island	Gull Rock	Point of Marsh	Average
17	----------	----------	0	0	----------	0
18	0	----------	0	0	----------	0
19	0	----------	0	0	----------	0
20	0	0	0	11.1	----------	2.8
21	8.9	40.0	3.5	23.6	0	15.1
22	11.0	30.8	5.7	26.7	0	14.8
23	11.0	58.4	13.1	33.7	5.6	24.4
24	29.6	80.0	46.7	51.0	35.3	58.5
25	64.4	100.0	91.7	86.3	66.7	81.8
26	90.8	100.0	100.0	94.9	100.0	97.1
27	100.0	100.0	100.0	100.0	100.0	100.0
28	100.0	100.0	100.0	100.0	100.0	100.0

[1] Because of the difficulty (under the conditions obtaining in the field) experienced in determining the sex of the younger immature individuals, the percentage of mature females is calculated on the basis of the frequency of both males and females together.

Migrations.—Very little is known regarding the migrations of the gray trout. Welsh and Breder report that in the Chesapeake and Delaware regions the fish appear in April, move up the bays until brackish water is encountered, and then turn back and move seaward, spawning just within or near the mouths of the larger estuaries. After spawning, the fish return to the ocean, remaining near the coast until July or August, when they again seek the bays and sounds. No such distinct routes of migration have been recognized in Palmico Sound; however, there is some evidence to indicate a westward movement of the larger fish from Ocracoke Inlet, but our stations are not close enough together to determine the route of travel. It is well known that fish become very scarce early in November, and it is supposed that they return to the Atlantic Ocean.

Regarding the movements of the gray trout (weakfish) in northern waters, Bigelow and Welsh remark [13] that "it is now generally assumed that their autumnal migration takes place to avoid falling temperature and that they either move offshore to pass the cold season on the continental edge, or southward." While a considerable southward migration of fish in the region about Cape Cod and Long Island Sound is quite conceivable, it seems less probable that such movement occurs on the Carolina coast where Gulf Stream tempertures and shallow bottoms are within easy reach of the coast.

The records of fish taken at Gull Rock indicate that here is a concentration of the smaller sizes of trout. Not only are the larger age groups very scarce, but the average size of the younger fish is also less than in other localities. Some have argued that this is a distinct race of the species, which is localized in Hyde and Dare Counties on the northwestern side of Pamlico Sound, but we have no evidence to support this contention. Our measurements indicate the presence of the II-group and in all probability of the I-group throughout the season. The III-group is present early in the season but dwindles in importance as the season progresses. Whether or not this reduction in number is due to their migration to the sea or to their destruction by fishing gear is a question difficult to answer. It may be confidently stated, however, that the immature fish that are present in the sounds in the spring remain in inside waters throughout the entire fishing season.

EFFECT OF PRESENT FISHERY REGULATIONS

Regulations establishing minimum size limits are ordinarily enacted by the various States theoretically as conservation measures to protect the immature fish. Since the supply of fish in North Carolina waters is inadequate to meet the demand, it is but common sense to seek to prevent the useless waste of the present supply. But minimum size limits are actually designed to protect the dealer from the necessity of accepting from the fishermen fish too small to market profitably. Little attention is given to the protection of the species, for the limits are not placed high enough to protect the fish until they reach a spawning size. Whatever may be the merit of this principle, the present 9-inch minimum limit in North Carolina does not operate as a

[13] Fishes of the Gulf of Maine. By Henry B. Bigelow and William W. Welsh. Bulletin, U. S. Bureau of Fisheries, Vol. XL, 1924 (1925), Part I, p. 275. Washington.

conservation measure in this way, because, as shown in Figure 15, trout do not spawn until the third year, when they average more than 10 inches long in June. It is plainly evident, therefore, that where pound nets operate any minimum size limit is entirely ineffective, offering no protection whatever, for fish of all sizes above 5½ inches are taken freely, marketable sizes are selected and sold, and the remainder, which constitute, as we have seen, more than half by number of the total catch of trout, are destroyed.[14]

These small 2-year-old fish should be saved, for, although too small to be of value in the markets in June and July, their growth is so rapid that they are marketable by August, and they are really of desirable size by October. Table 16 shows the increase in length and weight of these 2-year-old trout during the fishing season. The lengths, in centimeters and inches, are the observed modal lengths of this year class caught in pound nets, as shown by Figure 5. The weights are calculated according to the formula by Crozier and Hecht.[15] While the length increases only 26 per cent from June to October, the weight increase during that period amounts to 101 per cent. In other words, while length increases only one-fourth, the weight of 2-year-old fish more than doubles during the growing season. It is highly desirable, therefore, that the small fish destroyed during June and July receive full protection until August and September, when they have reached a marketable and commercially valuable size. Since the imposition of a minimum size limit is both ineffective and wasteful, let us consider what other means are available for protecting the species.

TABLE 16.—*Growth in length and weight of 2-year-old gray trout*

Month	Length			Weight		
	Centimeters	Inches	Per cent increase	Grams	Ounces	Per cent increase
June	21.0	8.3		81.2	2.8	
July	22.0	8.7	5	93.4	3.3	15
August	24.0	9.5	14	121.3	4.3	49
September	25.5	10.1	21	145.4	5.1	79
October	26.5	10.5	26	163.2	5.8	101

REMEDIAL MEASURES

The only regulations that afford any promise of protection to the gray trout are (1) limits upon size of mesh in the nets fished, (2) the establishment of closed areas prohibiting fishing where immature fish congregate in greatest numbers or where spawning occurs most abundantly, and (3) designation of closed seasons prohibiting fishing

[14] It is claimed that culling of the catch in such manner that undersized fish are promptly returned to the water uninjured is generally practiced by trap and pound net fishermen on the Great Lakes, and similar care is exercised by certain conscientious fishermen in the Chesapeake Bay (Hildebrand and Schroeder). No attempt is made in North Carolina to save the undersized fish, for culling takes place at the base of operations, where the marketable fish are sold miles from the fishing grounds. Because of such local conditions as the prevailing weather and the unseaworthy construction of boats, it is unlikely that culling at the time of capture could be successfully practiced. But even if such culling were practicable, it would be impossible strictly to enforce the present minimum size limit so as to insure the return of undersized fish alive to the water.

[15] Correlations of Weight, Length, and Other Body Measurements in the Weakfish, *Cynoscion regalis*. By William J. Crozier and Selig Hecht. Bulletin, U. S. Bureau of Fisheries, Vol. XXXIII, 1913 (1915), pp. 139–148, 4 figs. Washington, 1914.

by pound nets during the part of the year when immature fish are most abundantly taken and during the height of the spawning season.

It has been suggested that increasing the mesh in the cribs of the pound nets from 1⅛ to 1½ inches or more would permit the escape of the smaller fish of all species and thus permit fishing at all times of the year with a minimum of wastage. This suggestion, however, is vigorously opposed by the fishermen on the grounds that any increase in size of mesh would permit the gilling of such quantities of the smaller fish in the meshes of the net that it would be impossible to operate. They contend that removing the gilled fish from the cribs of the nets would consume so much time that pound-net fishing would no longer be practical and that the nets would be destroyed by sharks feeding upon the gilled fish. Furthermore, it is unlikely that a slight increase in the mesh of the cribs would effect the release of the smaller sizes in appreciable quantities, for a gray trout from 5 to 6 inches in length can readily be passed by hand through meshes of a 1⅛-inch pound net, but these small fish follow the lead of the net, which is 12 inches or more stretched mesh, and are readily caught. If this method were at all feasible, the mesh should be increased so as to permit the escape of trout up to 12 inches in length in order to protect the fish until one year's spawning has occurred. Such a regulation would practically destroy the pound-net fishery, however, for our measurements show that relatively few fish exceeding that length are taken in the Pamlico Sound pound nets. It is not likely, therefore, that limits upon the size of mesh employed in pound nets would ever be an effective means of protecting the gray-trout fishery from depletion.

It is fairly well established that certain areas in Pamlico Sound are nurseries for the younger fish. Our records indicate that fishes taken on the northwest side of the sound are not only smaller representatives of the year groups but are composed of the younger classes, the older fish being notably lacking. Thus, Hyde and Dare Counties, including the pound-net areas of Stumpy Point, Englehard, Gull Rock, and Pamlico River, may be designated as nursery grounds and closed to commercial fishing. The presence of uniformly larger fish, most of which are in spawning condition, from May until July may be noted in the vicinity of Ocracoke Inlet, and the same conditions probably obtain at Hatteras as well. Protection may be afforded to the spawning stock by prohibiting pound-net fishing in these areas, but such regulations could hardly be considered desirable when the interests of the fishing populations are considered. Since pound netting is the chief industry of the people in these districts, the prohibiting of this form of fishing would work extreme hardship. Unless more satisfactory methods of protection can not be devised, such oppressive measures should be avoided.

The most promising method of protecting the species is that of imposing closed seasons. The most destructive period of fishing throughout the sound area is in the early months of the summer, when, as has been shown, a maximum wastage of gray trout of 78 per cent and 55 per cent, respectively, in June and July occurs in certain districts. This tremendous waste of potentially valuable fish could be overcome by imposing a closed season on all pound-net fishing in Pamlico Sound from the end of the shad season, in May,

to the 1st of August. In this way the abundant supply of 2-year-old trout would be permitted to grow to marketable size. Our records also show that spawning is at its height during this same period, and the 3-year-old fish, as well as those still older, would be protected until after the year's crop of eggs had been laid. Such a regulation should apply to the whole sound area, for while relatively few of the smaller fish are destroyed near the inlets, the protection to the spawning fish is equally desirable, and while few spawning fish are taken on the northwest side of the sound, the reckless destruction of the immature should be prevented.[16]

Not only would this closed season tend to build up the fishery by increasing the stock of spawning fish and by insuring the depositing of spawn unmolested, but the increase in weight of the marketable fish thus protected would largely offset the economic loss resulting from inactivity of the fishermen during the closed season. We have no means of calculating accurately the gross amount of undersized trout caught and wasted in Pamlico Sound during the months of June and July. We do know, however, that it is a very great amount. Based on figures of the yield of fishermen at Gull Rock, given in Table 1, the weight of fish destroyed may be estimated at approximately 200,000 pounds. There is no evidence that these young fish leave the sounds during the season, so that if they were permitted to escape capture and to grow until August, September, and October, and if we assume that one-third of these young fish were caught in each of these months, they would weigh, when caught, approximately 331,000 pounds. Based upon this crude estimate, these fish, if permitted to remain in the water until the latter part of the season, would add to the income of the fishermen in this district more than $10,000.

This restriction would afford the same protection to the small fish of other species that are wasted during this period, such as butterfish, croaker, and spot, and would permit the spawning of starfish and butterfish, which spawn at the same time of year as the gray trout. The regulation would be easy to enforce, is favored by the fishermen themselves in preference to the alternate remedy of an increased mesh, and is opposed only by those who are opposed to any regulations whatever.

The arguments opposed to this plan of regulation are based upon selfish motives of personal gain. It may be argued that the imposition of the closed season during June and July would result in the loss of markets by the wholesale dealers of this region. The pound-net fisheries of Virginia produce virtually the same class of fish as those taken in Pamlico Sound. It is said that if pound-net fish are not available during June and July Virginia dealers will supply the trade and thus capture the regular customers. While such contentions must be given careful consideration, the argument loses force when we remember that great quantities of trout, spot, butterfish, and starfish are produced in the lower Chesapeake Bay during

[16] Following the presentation of this report on Dec. 8, 1925, the North Carolina Fishery Commission Board adopted a rule establishing the closed season from May to Aug. 1, in accordance with the plan herein recommended. Because of the dissatisfaction of certain interests, the board rescinded the rule at the April meeting, and provision was made for a public hearing on the question of pound-net regulation at the next regular meeting. On Aug. 16, 1926, before about 100 fishermen and dealers, the outstanding results of the investigation were again presented and the board passed a rule establishing a closed season ending June 1. Since the pound-net fishing for summer fish seldom starts before May 20, the gray trout thus receive only 10 days' protection!

April and May, when Pamlico Sound fish are not produced, and it is not apparent why this trade is not already captured by the Virginia dealers during these months. Moreover, it is said that conditions in the pound-net fishery of Chesapeake Bay closely parallel those in Pamlico Sound, and if this be true it can only be a matter of time until the facts will be ascertained and similar remedies applied.

RECOMMENDATIONS

We have seen that the supply of fish in North Carolina does not equal the demand, that wasteful practices exist in the pound-net fishery, and that the establishment of a closed season for all pound-net fishing in the sound during the months of June and July would correct these wasteful practices and tend to increase the fish supply.

With the facts discovered and impartially published, it now remains for the people of North Carolina to decide, through the agency of the Fisheries Commission Board, how long they shall permit such wasteful and destructive exploitation of the public resources to continue. The importance of sales in June and July for the benefit of the few must be balanced against the importance of maintaining the fisheries for all time for the benefit of all.

We therefore recommend that such closed season be established to meet the demand of the fishermen to "put more fish in the sounds."

○