THE SHAD FISHERIES

OF THE

ATLANTIC COAST OF THE UNITED STATES

BY

CHARLES H. STEVENSON.

SYNOPSIS.

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INTRODUCTION.

According to the returns of the United States Fish Commission there were 24,768 men employed in the shad fisheries of the Atlantic coast of the United States in 1896; the boats, apparatus, etc., employed were worth $2,040,342, and the yield of shad numbered 13,053,429, valued at $1,651,443. These figures include only the common shad (*Alosa sapidissima*), and not the several related species known as hickory shad winter shad, mud shad, jack, etc.

The capture of shad is occasionally reported from certain of the tributaries of the Gulf of Mexico, but it does not exist in those waters in sufficient abundance to maintain important fisheries. The several plantings made from time to time have resulted in colonizing shad in nearly all the rivers of the Pacific slope from San Pedro to Puget Sound, and the annual yield on that coast approximates 200,000. In addition to the United States coast, the species is also caught on the eastern coast of the British North American provinces as far north as the Gulf of St. Lawrence, the yield approximating 600,000 annually.

There is no species of fish more important to the residents of the entire Atlantic seaboard than the shad, and none whose preservation so immediately concerns a larger number of persons. The yield of codfish is larger and of greater value, but the fishery for that species is confined to one section of the coast, gives employment to less than half as many men, and its prosecution requires costly vessels and appliances, necessitating lengthy trips from port and much exposure and loss; whereas shad occur more or less abundantly along the entire coast, ascending the rivers as far as they permit, almost to the very doors of fishermen and consumers several hundred miles from the sea, and are caught by all forms of apparatus, from the costly seines and pound nets near the coast to the roughly constructed bow nets and fall traps in the headwaters of the rivers.

However, there are few fishes whose geographical range and local abundance are more easily affected by agencies of man, and during the last fifty years the shad fisheries have undergone great changes. In the early part of the present century these fish ascended the numerous streams until they reached the headwaters or met with impassable falls, and they were caught all along the river course, every point yield-

ing its quota for local use. Not only did this method of reaching the consumers have many advantages over the present, but it also gave opportunity for a large percentage of the shad to spawn in suitable places and thus keep up the supply. There was no concentration at any particular point, and the limited local demand did not warrant the prosecution of the fisheries so vigorously as to cut off the run at points above.

Dams were gradually constructed along the streams, completely blocking the passage to the spawning-grounds in the upper reaches. Then the concentration of the fisheries near the mouths of the rivers resulted, in certain narrow streams, in excluding shad almost entirely from the middle and upper parts, restricting or entirely preventing the reproduction of the species in those rivers. The excessive fisheries and the destruction of spawn by sewage and by washings from cultivated fields, and of young shad by improper modes of capture, make heavy drains upon the natural abundance of these fish. In a number of streams on the Atlantic seaboard the fisheries have been entirely destroyed by these combined agencies, and in most of the others the number of shad that reach the spawning areas has been so far reduced that natural reproduction is yearly becoming less effective in keeping up the supply, and the necessity for artificial hatching becomes proportionately greater.

The history of the shad fisheries shows that there was a decrease in the yield in nearly every river on the coast until 1880, when the results of artificial propagation became apparent, not only maintaining an equilibrium, but increasing the abundance. Since 1880 the aggregate yield has greatly increased, the product in 1896 being 28 per cent greater than in 1888 and nearly three times as great as in 1880. And yet 1896 was what is commonly termed an "off" year for shad, the catch being smaller than in 1895 or in 1897. It should be noted, however, that this largely increased yield has been accompanied and even surpassed by an increase in quantity and effectiveness of the apparatus of capture, but it was made possible by the results of artificial propagation. Comparing 1880 with 1896, it is observed that the increase in the yield numbered 7,905,154. At 25 cents each, the average price paid by consumers, this represents an increase of $1,976,288 in the value, over 60 times the expenditure for shad propagation, a result probably unsurpassed in any other line of fish-culture.

The supporting of profitable shad fisheries is not the only object to be gained in maintaining the supply of shad on the coast. The relation between the different species of fish in the economy of nature is not very well understood, but sufficient is known to indicate that the valuable shore fisheries on the New England coast are intimately associated with the run of shad and similar species up the rivers of that section. Seventy years ago the run of fish up the rivers of the New England States was very much greater than at present, and after the parent fish had disappeared the waters swarmed with the young, which

later in the year descended to the sea in enormous schools, attracting the cod, haddock, and other offshore species, which were caught in great abundance within a short distance of the coast, rendering unnecessary the expensive and hazardous trips to distant banks. But with the depletion of shad, alewives, salmon, and kindred species came a corresponding diminution in the number of cod, haddock, etc., near the coast. And it appears that any measures tending to restore the anadromous fishes to their former abundance will also improve the coast fisheries.

Another subject requiring attention is the conflicting laws regulating the shad fisheries in contiguous waters, and frequently in the same waters when under the jurisdiction of more than one State. Many of the most important shad streams either form the boundary line between two States or they traverse more than one State, thereby subjecting them to more than one system of regulations. Thus in the Delaware River there are three systems of regulations operative, viz, those of New Jersey, Pennsylvania, and Delaware. In the Potomac there are likewise three jurisdictions, viz, Maryland, Virginia, and the District of Columbia. The regulations of the shad fisheries on the New Jersey side of the Hudson River conflict with those on the New York side of that stream. Also in such rivers as the Pee Dee, Susquehanna, and Connecticut, which traverse more than one State, there is usually considerable friction between citizens of the two States because of alleged injurious methods of fishery being permitted in each end of the river.

The main object of this report is to attract more attention to the shad fisheries, to the necessity for improvements in the passage of shad to the headwaters of the rivers, for continued and increased efforts in the line of artificial propagation, and to the desirability of having uniform regulations in the various waters possessing similar physical conditions. It relates exclusively to the fisheries on the Atlantic coast of the United States and contains no reference to the important results accomplished in introducing shad into the waters of the Pacific coast, nor the even more interesting subject of the possibilities of stocking the Mississippi River and tributaries. The general condition of the fisheries and kindred subjects are first discussed, and these are followed by a description of the fisheries of each water area.

In the preparation of this report use has been made of all available material, acknowledgment being given in cases where other reports or publications have been extensively quoted. From the reports of the United States Fish Commission and the State commissions, as well as those of the Chief of Engineers, United States Army, so many data have been obtained that it would be useless to attempt to refer in detail to the authority for each statement therefrom when not of particular importance. The writer has personally visited and investigated the shad fisheries of most of the water areas of the Atlantic coast at some time during the past nine years, and the result of those observations is embodied in this report.

The statistics herein given, showing the extent of the shad fisheries in 1896, which is the year referred to in this report when not otherwise mentioned, were obtained by agents of the United States Fish Commission. Valuable assistance has been received from Messrs. Ansley Hall, John N. Cobb, and H. O. Weaver, of the Commission.

MIGRATIONS OF SHAD.

The shad belongs to the migratory class of fishes, being found in the coastal waters during only a portion of each year. In their annual migration mature shad appear in the southern rivers of the United States in December and January, and as the season advances they appear successively in the various streams, reaching the New England waters about May 1. After remaining in the rivers several months they disappear, renewing the performance the following season.

The young fry, hatched out in the rivers in spring and early summer, remain there until the following fall, when they leave for the ocean, and nothing more is seen of them until they return to the estuaries as mature or nearly mature fish, supposed to be two or three years old. Their habitat from their disappearance on the coast in the summer and fall to their reappearance in the following winter or spring is unknown. It is likewise unknown whether, as they disappear from the estuaries, they remain nearby or go far off from the shore, or whether they retreat in a direction parallel with the coast to the warmer waters of the South. Neither has it been established whether individual shad visit the rivers every year or every two years, but the depletion by casualty and capture is so great that probably only a small proportion ever ascend the rivers a second time.

In accordance with the old-time theory that all seasonal migrations were directed toward and from the equator, it was formerly considered that the entire body of shad wintered in the South and started northward in a vast school at the beginning of the year, advancing along the coast in almost military array, sending a detachment up each successive stream, this division, by a singular method of selection, being the individuals that were bred in those respective streams, the last portion of the great school entering the Gulf of St. Lawrence.

But zoologists now recognize a second kind of seasonal movement, termed "bathic migration," by which uniformity of temperature is secured far more readily than by moving toward or from the equator; and the present theory is that the young shad hatched out in any particular river remain within a moderate distance off the mouth of that stream until the period occurs for their inland migration, and that the schools of fish are generally distributed off the coast at all times, entering the rivers as soon as the temperature of the water is suitable. Their appearance first in the extreme southern river of the coast, the St. Johns, and at later dates successively in the more northern rivers, seems to confirm this view. There are exceptions to this order of

appearance. For instance, the Ashepoo and Edisto rivers are many miles north of the Altamaha or the Savannah, and yet the run of shad in the former is usually coincident with the run in the two latter. Explanation of this is found in the fact that the Ashepoo and the Edisto rise in the sand hills and swamps, while the two latter streams have their sources in the mountains of northern Georgia and South Carolina; consequently at a given date the waters of the two former are warmer than those of the Altamaha or Savannah. Hence it appears that the season of migration is determined by the temperature of the water rather than by geographical location.

The following summary shows for the principal water areas of the Atlantic coast the approximate dates at which shad fishing began in 1896:

Waters.	Date.	Waters.	Date.
St. Johns River	Dec. 1	Chesapeake Bay—continued.	
Altamaha River	Jan. 10	Rappahannock River	Mar. 18
Ogeechee River	4	Potomac River	7
Savannah River	6	Nanticoke River	13
Edisto River	7	Choptank River	14
Santee River	15	Susquehanna River	Apr. 14
Winyah Bay	11	Delaware Bay	Mar. 13
Cape Fear River	21	Delaware River	Apr. 1
Pamlico Sound	Feb. 3	New York Bay	Mar. 30
Neuse River	5	Hudson River	Apr. 1
Pamlico River	6	Long Island Sound	10
Albemarle Sound	4	Connecticut River	13
Roanoke River	Mar. 14	Narragansett Bay	2
Chowan River	8	Casco Bay	25
Chesapeake Bay, lower end	Feb. 26	Kennebec River	May 1
James River	Mar. 6		
Chickahominy River	10		

While the principal motive for, or rather the chief result accomplished by, the migration of shad into the rivers is the reproduction of the species, yet it appears that their movements are more immediately governed by the comparative temperature of the waters than by the approaching ripeness of the spawn. For instance, although they enter the St. Johns about December 1, spawning does not take place there until some time in March or April. In the sounds of North Carolina, and in Chesapeake and Delaware bays, shad enter a month or two before they begin to spawn. But in more northerly streams, as the Connecticut and Kennebec, where the entrance of the fish is delayed by low temperature caused by melting ice flowing down the river, spawning occurs shortly after the shad enter.

An interesting fact in connection with the migratory movements of shad is the arrival of the males several days before the females. This appears common to all the waters of the coast, the bucks constituting nearly two-thirds of the catch during the first third of the season and the roes being equally predominant during the last third.

The great bulk of shad appearing in the rivers are mature fish, weighing 2 pounds and upwards, and averaging about 3 pounds for the males and 4¾ pounds for the females. But in the lower portion of the estuaries and along the coast there are numerous schools of smaller

fish, commonly known on the New England coast as "sea shad," which usually appear somewhat later than the grown fish. Excepting in the St. Johns River, Delaware River, and on the New England coast, comparatively few of the small fish are caught unless unusually low temperature prevails in the rivers during the fishing season.

A subject about which there is much disagreement is whether shad spawned in a certain river return or endeavor to return to the same stream on their reappearance from the sea as mature fish. This idea has been quite generally accepted, and has to some extent furnished arguments for the prosecution of the work of artificial propagation. Not only has it been contended that shad return to the river basin in which they were spawned, but that they endeavor to return to the same locality in that river basin. In a letter written by Professor Baird in 1873 to the Hon. Hamilton Fish, then Secretary of State, the following statement is made:

> Anadromous fish, or such as run up the rivers from the sea to spawn, will return, if possible, to the river in which they first saw the light. So true is this that where there may be two or three rivers entering the sea in close proximity, which have become destitute of shad or herring in consequence of long-continued obstructions, and the central one only has been stocked by artificial means, the fish, year by year, will enter that stream, while those adjacent on either side will continue as barren of fish as before.

While this may be true to a certain extent, yet, as Professor Baird says in the same letter:

> It is difficult to imagine how a shad spawned in any northern stream could avoid entering a more southern river if in its vicinity.

It seems that fish spawned in Kennebec River are more likely to return to that stream than they are to Delaware River, and that shad fry planted in the latter stream will tend to improve the fisheries of that section rather than those of the waters of Georgia. But how is it in case of two rivers in close proximity, like the Ogeechee and Savannah, whose entrances into the sea are only 17 miles apart? The young shad leaving those rivers and remaining in the deep water off the mouths thereof for a period of two or three years must surely commingle as a result of currents, variations of temperature, search for food, etc. Again, in the instance of two or more streams which communicate with the sea through the same outlet, as the Neuse, Chowan, and Roanoke rivers, all of which are tributaries of Pamlico Sound, or the various tributaries of Chesapeake Bay, does the peculiar instinct common to shad cause them to pass by the mouth of one stream and enter another merely because, three years before, they were spawned in that other river? It appears more reasonable to suppose that shad remain in the hydrographic area in which they are spawned, this area including the rivers entering the sea and the submerged areas between the coast line and the Gulf Stream, and that they seek any suitable spawning-grounds within that area and do not necessarily return to the identical river in which they were bred. When shad were introduced

in the Sacramento River it was supposed that they would return only to that stream, but they have since appeared in many of the Pacific coast waters in which they had not been indigenous and had never been planted.

Those who believe that shad return to the identical river in which they were spawned refer to the numerous instances in which the fisheries of a certain river have decreased after the shad have been excluded, by means of dams, from the spawning areas in that stream. But those decreases appear to be due rather to the general depletion of shad in that coastal area. For instance, the Merrimac River was obstructed in 1848 by a dam at Lawrence, 25 miles from the sea, yet shad were caught in considerable abundance below that dam for a period of thirty years thereafter, and the decrease in the Merrimac appears to be merely an incident of the decrease on the New England coast. This decrease is apparent in Casco Bay, where neither obstructions nor spawning-grounds have ever existed. Comparatively few shad ascend the Savannah or the Pee Dee as far as the spawning-grounds, yet the fisheries of those streams appear to be holding their own among the rivers of the South Atlantic States.

It is well known that in their passage through the coastal waters shad pursue certain well-defined paths, which, however, may be varied by unusual conditions of temperature or currents. Thus, in passing up the lower end of Chesapeake Bay shad usually crowd the western shore, and are caught in immense numbers in the pound nets set there, while the nets on the opposite shore take very few, this being due to their following the thread of fresh water entering from the western side of the bay. Yet during certain seasons, when quantities of cold water are flowing down the Virginia rivers, or during the prevalence of northwest winds, shad are caught in considerable abundance on the eastern shore of Virginia and those nets on the western shore take comparatively few. In entering Connecticut River, shad appear to follow the shore west of the mouth of that stream, where they are caught in considerable numbers for a distance of 10 or 15 miles, yet they are rarely caught on the shore immediately east of the river. In this instance they are attracted by fresh water flowing from the Connecticut, which appears to pursue a southwesterly course immediately on leaving that river.

After entering the estuaries the rate and course of the shad movement up the rivers are influenced by various causes, which are thus described by the late Commissioner McDonald:

> If, in consequence of warm rains at the river source, the temperature of the water becomes suitable to the shad at an earlier date than usual, then their upward movement takes place very rapidly, and, we may say, tumultuously, the great schools of fish crowding in and moving up all at once, so as to produce what is termed a "glut." If, however, the temperature of the water rises by insensible degrees with the advance of the season, then the upward movement begins when the water temperature of the river has passed above that of the sea, and takes place gradually, the rate of movement in such cases being slow and the period prolonged. Again, when the shad have entered the rivers, the temperature conditions being such as to deter-

mine a rapid upward movement, yet should the fish encounter floods and consequent muddy waters, their upward movement is arrested, the schools back down before the flood, and, if this condition is prolonged, may be driven entirely out of the river. In short, fluctuations in the river temperature have corresponding influences upon the shad movements; any sudden change, whether to a higher or lower temperature, apparently arrests their upward course for a time, and sometimes even determines a retrograde movement. Many of the anomalies which perplex fishermen in the course of their work may be explained by the varying movements of the fish as controlled by the water temperature in the rivers. We find, for example, that while at a particular seine shore during one season a very large catch is made, yet in the following season the fishery in the same locality may prove a failure, although the general run of fish in the river has not diminished. If we suppose a seine to sweep the flats at the mouth of such a stream as the Occoquan Creek (a tributary of the Potomac River), and if we further suppose that the river waters in the channel are colder than, or as cold as, the waters of the Chesapeake Bay, the shad in their movement up the river would avoid the main current and would slowly work their way up the shores and over the flats, where the temperature of the waters will be found to be, under such circumstances, several degrees warmer than in the channel. Such a season would be profitable to a seine sweeping the flats. Again, if the waters in the main channel of the river were of suitable temperature, then the upward movement of the shad would take place in the channel and not along the flats. Under such circumstances a channel seine would make a very large catch, while a seine hauled over the flats would probably find very indifferent fishing.

In their migrations up the rivers shad ascend the stream until the volume of the water forming the channel of the river becomes quite inconsiderable, or, as is more frequently the case, until their movements are arrested by impassable falls, dams, or other obstructions. However, a discussion of the limit of their range in the rivers is reserved for a special chapter.

RANGE OF SHAD IN THE RIVERS.

In considering the limit of shad range in the rivers the principal points to be kept in view are the size of the stream, uniformity of slope, and its freedom from dams and other obstructions. No river on the Atlantic seaboard appears too long for shad to ascend to its headwaters, provided they meet with nothing to bar their progress. At present they ascend the St. Johns, in Florida, a distance approximating 375 miles; the Altamaha 300 miles; the Santee 272 miles; the Neuse 270 miles, and the Delaware River a distance of 240 miles from the sea. However, these distances do not equal the extreme ranges in the early part of the present century. Then shad ascended the Savannah to Tallulah Falls, a distance of 384 miles, instead of 209 miles as at present. They ran up the Pee Dee to Wilkesboro, a range of 451 miles, whereas the present limit on that river is Grassy Island, 242 miles from the sea, and only one shad was reported from that point in 1896. On James River the former run was 350 miles in length, while the present limit is at Bosher's Dam, 120 miles. But the greatest decrease exists in Susquehanna River, in which shad formerly ascended to Binghamton, 318 miles from the mouth and 513 miles by watercourse from the sea, whereas at present they do not appear to pass beyond Clark's Ferry, 84 miles from the mouth of the river.

The following summary shows, in comparative form, the original and the present limit of the shad range in 23 of the principal rivers of the Atlantic seaboard:

Rivers.	Distance of sources above coast line.	Original limit of shad run.		Present limit of shad run.	
		Locality.	Distance from coast line.	Locality.	Distance from coast line.
	Miles.		*Miles.*		*Miles.*
St. Johns	375	Sources	375	Sources	375
Altamaha	450	Macon	370	Hawkinsville	300
Ogeechee	350	Ogeechee Shoals	200	Millen	100
Savannah	425	Tallulah Falls	384	Augusta Dam	209
Edisto	300	Sources	300	Jones Bridge	281
Santee (Wateree)	350	Great Falls	272	Great Falls	272
Santee (Congaree)	410	Green River	374	Columbia	233
Pee Dee	497	Wilkesboro	451	Grassy Island	242
Cape Fear	290	Haywood	210	Smiley Falls	181
Neuse	340	Sources	340	Fish Dam	100
Pamlico-Tar	252	Rocky Mount	157	Rocky Mount	157
Roanoke	457	Weldon	249	Weldon	249
James	420		370	Bosher's Dam	140
Rappahannock	248	Falmouth Falls	155	Falmouth Falls	155
Potomac	400	Great Falls	190	Great Falls	190
Susquehanna	617	Binghamton	513	Clark's Ferry	279
Delaware	457	Deposit	256	Burrows Dam	196
Hudson	314	Glens Falls	209	Troy	164
Housatonic	202	Falls Village	150	Birmingham	92
Connecticut	409	Bellows Falls	204	Windsor Locks	89
Merrimac	140	Winnepesaukee	125	Lawrence	20
Kennebec	155	Carritunk Falls	108	Augusta	44
Penobscot	255		90	Verona	35

It appears that in 23 of the principal rivers, aggregating 8,113 miles in length from the coast line, shad formerly existed throughout 6,052 miles, or 72 per cent of the length, whereas at present they are to be found in only 4,203 miles, a decrease of 1,849 miles. This summary comprises only the principal rivers, and if the minor streams and tributaries were included, the total length from which shad have been excluded would doubtless appear more than twice as great. In much of that length shad were quite numerous, the catch in many instances exceeding the yield in the part to which the fisheries are now confined. The upper section of the Pee Dee is supposed to have yielded over 100,000 annually. In James River, according to the late Commissioner McDonald, the annual catch of shad in the 230 miles from which they are now excluded "was at one time far in excess of the now (1880) entire catch for the whole river." The present excluded length of the Susquehanna formerly yielded several hundred thousand annually. In a report of special commissioners of Massachusetts, appointed in 1865 to investigate the fisheries of that State, it was estimated that at the beginning of the present century the annual shad yield in Merrimac River ranged from 500,000 to 1,000,000 in number, whereas none ascend that river at present.

The limitation in the range of shad in the rivers is the result of several agencies in addition to the size of the stream, the most important of which are (1) natural falls, (2) insurmountable dams, (3) pollution of the water, (4) agricultural operations, and (5) extensive fisheries.

Natural falls exist at the escarpment line in all of the rivers having their sources above the coastal plane, but in only a few instances are they of sufficient height to form insurmountable obstacles to the range of shad, among these being Weldon Falls on the Roanoke River, Great Falls on the Potomac, and Bellows Falls on the Connecticut, all of which form absolute barriers to the further progress of shad that may reach those points, excluding them from the whole of the river above. Most of the other Atlantic coast streams having their sources above the coastal plane have been made impassable at or a short distance above the escarpment line by means of artificial dams for developing water-power or for navigation improvements. In this class are the Savannah, the Santee, the James, the Susquehanna, the Housatonic, the Connecticut, the Merrimac, the Kennebec, and the Penobscot, the lengths from which shad are excluded appearing in the aforegoing table.

Numerous attempts have been made by the erection of fishways to enable shad to pass above these obstructions, among the costly contrivances of this nature being those in the Savannah at Augusta, the Santee at Columbia, the Potomac at Great Falls, the Susquehanna at Clark's Ferry, the Housatonic at Birmingham, the Connecticut at Holyoke, the Merrimac at Lawrence, and the Kennebec at Augusta. And although these are modern constructions, designed by engineers of ability, familiar with the principles of hydraulics and the habits of fish, none of them appears to be successful for shad, this fish being so timid that it will not enter fishways readily used by salmon, alewives, and other species. True, a few individuals may pass through some of them, but the number is not sufficiently large to be of any practical value, and in a majority of instances where shad are reported above a dam they have swum over the crest during freshets or they have passed through breaks in the obstruction.

Access to suitable spawning areas being necessary for the maintenance of the fisheries if natural reproduction is depended on, and as many of the spawning-grounds are located in the headwaters of the rivers, it follows that while the exclusion of shad from the upper sections is the immediate it is not the most important effect of those obstructions. It has been the common experience in all the shad rivers that whenever a high dam or other obstruction has been erected across the stream the fisheries above that point have at once ceased, and those immediately below have for a year or two flourished on the large number whose ascent has been stopped by the barrier, and then they too have declined. It also appears that the extent of this decrease below the dam is largely dependent on the nearness of the obstruction to the mouth of the river and the proportion of the spawning-grounds to which they are denied access, and if all the breeding-grounds have been cut off in a definite coastal region the shad have almost entirely disappeared.

This is clearly illustrated by the conditions in Connecticut River. The erection of the Holyoke dam in 1849 prevented the fish from

ascending above that point, and as they strayed about in the river below the obstruction they were taken in greater abundance than formerly. At the Parsonage fishery, near the mouth of the river and 40 miles below the dam, the shad yield during the twenty years preceding the erection of the obstruction averaged 9,854 annually; during the five years following 1849 the annual catch averaged 19,490; during the next ten years it was but 8,364, and for the following six years, 1865–1870, the annual average was but 4,482 shad, less than one-half the former yield. The record of the catch on the Connecticut from 1853 to 1896 shows that the total yield below the dam decreased from nearly 500,000 annually to an average of less than one-tenth of that number. In a few rivers the development of water-power has resulted in completely exterminating the anadromous fishes, this being the case in the Thames, the Blackstone, the Merrimac, the Saco, and other rivers. However, instead of the employment of a few hundred persons in taking fish each spring, the water-power on those streams affords employment to thousands of mill operatives.

The utility of the spawning areas below the dams has also been impaired by chemicals, sawdust, and other refuse from mills and towns on the river banks. In a number of small streams these have almost completely destroyed the spawning and breeding areas, but regulations against this practice now exist in many States.

Another factor having some effect on limiting the range of shad up the rivers is the increased agricultural operations. At the time of the settlement of the river valleys most of those areas were covered with forests, and the ground was carpeted with leaves and moss, which checked the surface flow of water and restricted its evaporation, thus tending to constancy in the flow of rivers, and freshets were rare and of insignificant proportions. With increase of population the forests were cleared away and large areas of land brought under cultivation, causing injurious meteorological changes and more numerous and destructive floods. During heavy rains the plowed soil upon the hillsides is easily washed into gullies through which the cold water is quickly conveyed to the rivers, filling them beyond their capacity and bringing into them masses of earth and other débris, thus covering the spawning-grounds. The freshets are soon over, and the flow of water in the streams becomes so small that shad are not induced to proceed so far up as formerly.

On some of the Southern streams decreased navigation has resulted in reducing the length of shad range. This is especially true of the Combahee, the Ashepoo, the Edisto, the Chickahominy, the Mattaponi, and the Pamunkey, the channels of which are now encumbered with drifting logs, overhanging trees, brushwood, and shoals of loose, shifting sand, through which a passageway for the ascent of fish was formerly maintained by navigation and the rafting of timber.

The most important factor in reducing the inland range is the extensive fisheries near the coast. In the first half of the present century

shad were caught all along the river course, every point yielding its quota for local use and the limited demand not warranting the prosecution of the fisheries so vigorously as to cut off the "run" at points above. But the profit derived from shipping shad to distant markets has caused a concentration of the fisheries at points near the mouths of the rivers where convenient shipping facilities exist, resulting, in certain narrow streams, in practically excluding shad from the middle and upper sections where the spawning-grounds are located. The effect is not so apparent as in the case of impassable dams and natural falls, for the latter form absolute barriers, whereas extensive fisheries merely limit the number of fish ascending to the extreme range of the river and not the length of that range. Yet, in many cases they affect the future abundance of the species even more than the dams and natural falls. This is especially noticeable in those narrow streams whose fluvial characteristics extend nearly or quite to the sea, as in most of the rivers between the St. Johns and the Neuse, and to some extent in the Susquehanna, the Hudson, the Connecticut, etc. In the Ogeechee, Savannah, Edisto, Pee Dee, and Cape Fear, the great bulk of the catch is obtained in the extreme lower end, within 30 or 40 miles of the sea, and comparatively few shad ascend as far as the spawning-grounds. In the Connecticut nearly all the shad are caught within 20 miles of the mouth. In those rivers the dams perform a very unimportant part in limiting the run of fish, for few shad ever reach those obstructions. In the broad estuaries tributary to the sounds of North Carolina and to the Chesapeake and Delaware bays the effect of the large quantities of twine is not so apparent; yet, even in those waters only a small percentage of the shad reach the spawning-grounds.

EXTENT OF THE SHAD FISHERIES IN 1896.

The extent by States.—The following tables show the extent of the shad fisheries of the Atlantic coast of the United States during the season of 1896. First is presented a series of three tables showing, by States, (1) the number of persons employed; (2) the boats, apparatus, etc., used, and (3) the number and value of shad taken, and these are followed by three other tables showing similar data for each watercourse. From these it appears that of the 23,128 shad fishermen in 1896, 8,793 operated drift nets; 2,703, stake nets; 4,840, seines; 3,076, pound nets and weirs; 3,926, bow nets, and 253 operated fyke nets and miscellaneous apparatus. In addition there were 1,445 shoresmen, 195 transporters, and also many persons operating apparatus in which shad were taken incidentally. The boats, apparatus, etc., employed aggregated $2,040,342 in value, and the catch of shad numbered 13,053,429, of which 5,998,143 were taken in drift nets, 1,703,099 in stake nets, 1,999,942 in seines, 3,139,830 in pound nets and weirs, 123,803 in bow nets, 73,440 in fyke nets, and the remaining 15,172 were taken by spears, fall traps, etc.

Statement of the number of persons employed in the shad fisheries of the Atlantic coast of the United States in 1896.

States.	Fishermen.								Shoresmen.	Transporters.	Total.
	Drift-net.	Stake-net.	Seine.	Pound-net and weir.	Fyke-net.	Bow-net.	Miscellaneous.	Total, exclusive of duplication.			
Florida	357	20	110	.....	.....	.....	.....	487	31	5	523
Georgia	504	210	.....	3	.....	226	.....	888	.....	.....	888
South Carolina	551	145	95	.....	.....	863	*a* 14	1,646	.....	.....	1,646
North Carolina	566	999	1,357	690	.....	2,514	*b* 17	5,957	930	60	6,947
Virginia	1,609	443	444	1,497	12	.....	*c* 9	3,946	42	73	4,061
Maryland	1,663	474	1,009	689	93	256	*d* 8	4,116	381	17	4,514
Delaware	415	14	252	6	.....	16	.....	699	.....	.....	699
Pennsylvania	353	.....	681	.....	.....	51	*e* 30	1,115	16	2	1,133
New Jersey	1,784	311	574	.....	30	.....	.....	2,701	35	38	2,774
New York	729	87	250	34	14	.....	*e* 20	1,106	10	.....	1,116
Connecticut	138	.....	53	5	.....	.....	.....	190	.....	.....	190
Rhode Island	.....	.....	.....	6	.....	.....	.....	6	.....	.....	6
Maine	124	.....	15	146	.....	.....	.....	271	.....	.....	271
Total	8,793	2,703	4,840	3,076	155	3,926	98	23,128	1,445	195	24,768

a 8 wheel, 6 cast-net. *b* Wheel. *c* 3 hedge, 6 fall-trap. *d* Fall-trap. *e* Spear.

Statement of the boats, apparatus, etc., employed in the shad fisheries of the Atlantic coast of the United States in 1896.

States.	Boats.		Drift nets.			Stake nets.			Seines.		
	No.	Value.	No.	Length (yards).	Value.	No.	Length (yards).	Value.	No.	Length (yds.).	Value.
Florida	251	$9,384	191	91,550	$17,350	10	850	$200	24	7,150	$2,175
Georgia	495	7,023	280	36,994	11,788	148	3,288	1,292	.....	.....	.....
South Carolina	799	14,603	271	85,947	15,490	128	8,300	3,346	22	1,635	931
North Carolina	2,831	80,388	377	34,682	6,063	57,787	1,103,872	73,874	230	76,058	56,561
Virginia	2,028	77,058	1,370	298,043	25,998	9,378	90,214	10,949	42	24,361	19,005
Maryland	1,976	104,492	2,638	472,138	44,464	3,955	84,588	9,532	90	33,349	25,816
Delaware	350	15,645	309	107,361	12,971	7	2,700	240	68	8,307	3,187
Pennsylvania	468	21,340	173	70,770	11,028	.....	.....	.....	96	19,305	12,285
New Jersey	1,180	101,908	848	546,807	94,518	2,027	56,826	16,131	87	19,190	14,663
New York	547	26,165	456	624,265	30,189	1,403	33,895	3,878	41	28,820	5,840
Connecticut	102	2,306	86	20,193	4,265	.....	.....	.....	17	3,048	1,243
Rhode Island	3	90	.....	.....	.....	.....	.....	.....	.....	.....	.....
Maine	281	11,642	228	56,298	2,870	.....	.....	.....	*a* 2	1,230	370
Total	11,311	472,044	7,227	2,445,048	276,994	75,443	1,384,623	119,442	719	223,053	142,076

States.	Pound nets and weirs.		Fyke nets.		Bow nets.		Miscellaneous.		Shore property.	Total investment.
	No.	Value.	No.	Value.	No.	Value.	No.	Value.		
Florida	.....	.....	.....	.....	.....	.....	.....	.....	$4,349	$33,458
Georgia	26	$208	.....	.....	113	$259	.....	.....	2,817	23,387
South Carolina	.....	.....	.....	.....	447	1,155	*b* 83	$2,185	3,328	41,038
North Carolina	1,575	182,083	.....	.....	1,278	3,781	*c* 75	1,125	243,882	597,757
Virginia	1,156	236,080	72	$1,032	.....	.....	*d* 22	805	61,953	433,480
Maryland	901	66,816	335	5,223	128	625	*c* 15	600	53,524	311,092
Delaware	4	385	.....	.....	10	40	.....	.....	11,672	44,140
Pennsylvania	.....	.....	.....	.....	51	185	*f* 30	23	36,451	81,312
New Jersey	.....	.....	245	1,964	.....	.....	.....	.....	112,728	341,912
New York	12	3,630	54	955	.....	.....	*f* 20	20	7,130	77,807
Connecticut	.....	.....	.....	.....	.....	.....	.....	.....	955	8,769
Rhode Island	3	920	.....	.....	.....	.....	.....	.....	120	1,130
Maine	133	23,340	.....	.....	.....	.....	.....	.....	6,838	45,060
Total	3,810	464,062	706	9,174	2,027	6,045	245	4,758	545,747	2,040,342

a 1 purse seine, 960 yards long, worth $350.
b 3 cast nets and 80 wheels and fall traps.
c Wheels.
d 3 hedges and 19 fall traps.
e Fall traps or fish pots.
f Spears.

Statement of the number and value of shad caught on the Atlantic coast of the United States in 1896.

States.	Drift nets.		Stake nets.		Seines.		Pound nets and weirs.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Florida	333,277	$53,677	1,689	$285	125,248	$8,627	.....	.....
Georgia	130,925	44,808	10,134	3,338	.....	.....	.....	.....
South Carolina	83,233	19,405	33,602	6,615	4,262	1,107	.....	.....
North Carolina	83,015	18,910	944,582	204.080	532,066	90,899	479,531	$90,690
Virginia	872,823	74,178	304,808	39,663	151,335	12,740	1,871,074	180,197
Maryland	695,651	68,875	129,034	14,059	223,351	24,499	449,567	52,658
Delaware	407,542	60,936	4,200	672	53,922	7,154	380	53
Pennsylvania	297,004	36,525	.....	.....	308,385	40,487	.....	.....
New Jersey	2,586,381	249,763	191,275	20,095	466,439	45,790	40,377	6,720
New York	362,062	50,938	83,775	10,449	68,345	8,991	22,550	3,641
Connecticut	55,723	10,740	.....	.....	7,472	1,073	7,093	1,060
Rhode Island	.....	.....	.....	.....	.....	.....	12,472	3,284
Massachusetts	22,080	691	.....	.....	12,442	1,390	5,300	1,155
Maine	68,427	6,701	.....	.....	45,825	2,512	252,486	21,565
Total	5,998,143	696,147	1,703,099	309,156	1,999,942	245,869	3,139,830	361,632

State.	Fyke nets.		Bow nets.		Miscellaneous.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Florida	.....	.....	.....	.....	.....	.....	460,214	$62,589
Georgia	.....	.....	2,865	$1,125	50	$18	143,974	49,289
South Carolina	.....	.....	24,816	6,089	714	220	146,627	33,436
North Carolina	.....	.....	55,710	12,284	2,000	380	2,096,804	417,243
Virginia	.....	.....	.....	.....	3,463	277	3,203,503	307,055
Maryland	13,832	$1,361	27,612	3,940	2,003	259	1,541,050	166,551
Delaware	.....	.....	2,300	445	.....	.....	468,344	69,260
Pennsylvania	.....	.....	10,500	1,893	5,400	540	621,239	79,445
New Jersey	54,008	8,688	.....	.....	.....	.....	3,338,480	340,056
New York	5,600	699	.....	.....	482	115	542,814	74,833
Connecticut	.....	.....	.....	.....	.....	.....	70,288	14,082
Rhode Island	.....	.....	.....	.....	1,060	306	13,532	3,590
Massachusetts	.....	.....	.....	.....	.....	.....	39,822	3,236
Maine	.....	.....	.....	.....	.....	.....	366,738	30,778
Total	73,440	10,748	123,803	25,776	15,172	2,115	13,053,429	1,651,443

It appears that in the number of persons employed, North Carolina ranks first among the Atlantic coast States, this position being due to the large number of bow-net fishermen in the State. Next in order are Maryland, Virginia, New Jersey, and South Carolina. In the number of shad caught New Jersey stands first, with a yield of 3,338,480, and Virginia comes second, with 3,203,503 shad. Virginia usually ranks first, with North Carolina second, but the catch in those two States in 1896 was unusually small, while it was considerably above the normal in New Jersey.

The extent by water areas.—No regular shad fisheries are prosecuted along the ocean shore of the United States, and the great bulk of this species is taken within the general coast line. With the exception of a few individuals caught incidentally in the several pound nets along Virginia Beach, no shad are reported as obtained along the ocean shore south of Barnegat, N. J. Between Barnegat Inlet and Sandy Hook Point there are a hundred or so pound nets set for menhaden, flounders, bluefish, etc., which catch 10,000 or 15,000 shad annually. The next point at which shad are taken outside the general coast line is between the eastern end of Long Island and Cape Cod, where 3,000 or 4,000 are

caught each year in pound nets. Between Cape Cod and the eastern part of Maine mackerel boats catch several thousand shad, and a few are taken in pound nets set on the coast, 97,565, being thus taken in 1896, making a total of 115,676 shad taken in 1896 along the ocean shore, against a total of 12,937,753 taken within the coast line.

The following table shows by water-courses the number of persons employed in the shad fisheries in 1896:

Statement, by water areas, of the number of men employed in each branch of the shad fisheries of the Atlantic coast in 1896.

Water areas.	Fishermen.								Shoremen.	Transporters.	Total.
	Drift-net.	Stake-net.	Seine.	Pound-net and weir.	Fyke-net.	Bow-net.	Miscellaneous.	Total, exclusive of duplication.			
St. Johns River	337	.....	110	.....	.....	.....	.....	447	31	5	483
St. Marys River	80	30	.....	.....	.....	.....	.....	110	.....	.....	110
Satilla River	7	.....	.....	.....	.....	.....	.....	7	.....	.....	7
Altamaha River	162	192	.....	.....	.....	226	.....	526	.....	.....	526
Ogeechee River	160	.....	.....	.....	.....	.....	.....	160	.....	.....	160
Savannah River	144	8	.....	3	.....	.....	6	160	.....	.....	160
Combahee River	.....	14	.....	.....	.....	.....	.....	14	.....	.....	14
Ashepoo River	.....	18	.....	.....	.....	12	.....	29	.....	.....	29
Edisto River	.....	84	35	.....	.....	159	.....	265	.....	.....	265
Cooper River	.....	4	4	.....	.....	24	.....	27	.....	.....	27
Santee River	.....	25	.....	.....	.....	110	.....	132	.....	.....	132
Winyah Bay and tributaries	522	.....	56	.....	.....	558	8	1,144	.....	.....	1,144
Cape Fear River	394	.....	173	.....	.....	368	.....	863	.....	.....	863
Pamlico Sound	.....	368	.....	82	.....	.....	.....	450	13	20	483
Neuse River	76	156	408	58	.....	1,020	.....	1,053	28	.....	1,081
Pamlico Tar River	46	24	189	16	.....	230	.....	403	.....	5	468
Croatan and Roanoke sounds	.....	86	30	76	.....	.....	.....	192	29	5	226
Albemarle Sound	.....	331	121	229	.....	.....	.....	680	519	30	1,229
Roanoke River	36	2	169	.....	.....	870	17	1,094	67	.....	1,161
Chowan River	14	.....	190	191	.....	.....	.....	395	239	.....	634
Pasquotank and Perquimans rivers	.....	32	77	38	.....	20	.....	167	35	.....	202
Chesapeake Bay	516	194	316	875	.....	.....	.....	1,891	282	69	2,242
James River and tributaries	678	166	108	12	.....	.....	3	967	.....	.....	967
York River and tributaries	599	113	62	94	10	.....	.....	870	.....	.....	870
Mobjack Bay	.....	.....	.....	96	.....	.....	.....	96	.....	.....	96
Rappahannock River	96	114	27	200	2	.....	6	453	.....	.....	453
Potomac River	477	21	334	424	.....	25	.....	1,273	70	21	1,364
Nanticoke River and tributaries	316	32	100	31	26	.....	.....	487	.....	.....	487
Choptank River and tributaries	311	68	115	143	12	.....	.....	617	.....	.....	617
Susquehanna River	98	.....	672	.....	9	51	8	834	71	.....	905
Miscellaneous	275	209	156	253	46	231	.....	1,154	.....	.....	1,154
Delaware Bay	622	14	12	4	.....	.....	.....	652	.....	3	655
Delaware River	1,668	.....	814	.....	.....	.....	30	2,507	51	37	2,595
Miscellaneous rivers	173	.....	218	.....	.....	16	.....	407	.....	.....	407
Ocean shore of New Jersey	.....	135	26	.....	11	.....	.....	168	.....	.....	168
New York Bay	120	21	.....	26	33	.....	.....	192	1	.....	193
Hudson River	583	242	250	.....	6	.....	.....	1,077	9	.....	1,086
Long Island Sound	2	.....	.....	13	.....	.....	.....	15	.....	.....	15
Connecticut River	94	.....	36	.....	.....	.....	.....	130	.....	.....	130
Miscellaneous rivers	68	.....	17	.....	.....	.....	20	83	.....	.....	83
Narragansett Bay and tributaries	.....	.....	.....	6	.....	.....	.....	6	.....	.....	6
Casco Bay	20	.....	11	.....	.....	.....	.....	31	.....	.....	31
Kennebec River and tributaries	83	.....	4	146	.....	.....	.....	219	.....	.....	219
Other Maine rivers	21	.....	.....	.....	.....	.....	.....	21	.....	.....	21
Total	8,793	2,703	4,840	3,076	155	3,926	98	23,128	1,445	195	24,768

The following table shows, by water areas, the boats, apparatus, etc., employed in the Atlantic coast shad fisheries in 1896:

Statement, by water areas, of the boats, apparatus, etc., employed in the shad fisheries of the Atlantic coast of the United States in 1896.

Water areas.	Boats.		Drift nets.		Stake nets.		Seines.		Pound nets and weirs.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
St. Johns River	221	$9,174	171	$17,050	.....	.....	24	$2,175	.....	.....
St. Marys River	95	665	80	1,200	15	$300	.....	.....	.....	.....
Satilla River	6	30	3	60	.....	.....	.....	.....	.....	.....
Altamaha River	274	1,500	80	2,000	118	1,124	.....	.....	.....	.....
Ogeechee River	84	3,200	80	5,000	.....	.....	.....	.....	.....	.....
Savannah River	83	1,953	70	4,066	25	68	.....	.....	26	$208
Combahee River	7	280	.....	.....	14	410	.....	.....	.....	.....
Ashepoo River	15	483	.....	.....	17	590	.....	.....	.....	.....
Edisto River	127	2,490	.....	.....	62	2,184	12	485	.....	.....
Cooper River	5	25	.....	.....	3	35	1	70	.....	.....
Santee River	75	225	.....	.....	32	127	.....	.....	.....	.....
Winyah Bay and tributaries	553	10,985	258	15,252	.....	.....	9	376	.....	.....
Cape Fear River	437	2,644	224	4,735	.....	.....	43	1,239	.....	.....
Pamlico Sound	235	21,650	.....	.....	24,808	30,001	.....	.....	171	13,885
Neuse River	838	12,240	38	676	3,424	3,945	110	7,153	87	10,378
Pamlico-Tar River	242	4,392	23	197	840	985	50	7,739	27	3,325
Croatan and Roanoke sounds	79	6,570	.....	.....	5,850	7,797	1	3,000	143	11,125
Albemarle Sound	319	23,622	.....	.....	21,985	29,944	4	12,500	612	56,215
Roanoke River	501	3,505	18	270	15	45	8	6,100	.....	.....
Chowan River	120	3,375	74	185	.....	.....	8	12,600	447	29,530
Pasquotank and Perquimans rivers	60	2,390	.....	.....	865	1,157	6	6,230	88	7,625
Chesapeake Bay	897	84,948	1,087	21,079	2,286	5,701	7	10,400	631	151,242
James River and tribs	540	6,917	559	9,918	3,733	3,905	19	3,385	6	585
York River and tributaries	431	8,229	592	8,145	1,043	802	10	1,110	90	16,375
Mobjack Bay	34	3,615	.....	.....	.....	.....	.....	.....	76	15,570
Rappahannock River	272	9,847	101	1,780	3,263	3,859	5	810	231	37,957
Potomac River	520	24,895	236	12,385	529	1,043	13	17,700	430	43,350
Nanticoke River and tribs	220	3,644	333	5,808	282	684	20	1,380	40	3,075
Choptank River and tribs	301	4,640	571	5,844	1,469	2,500	22	2,360	194	12,141
Susquehanna River	331	20,011	223	3,403	.....	.....	63	8,670	.....	.....
Miscellaneous	701	11,025	413	3,620	728	1,987	36	3,646	361	23,261
Delaware Bay	278	31,335	259	44,930	7	240	2	425	2	325
Delaware River	1,079	91,146	827	70,131	.....	.....	104	22,768	.....	.....
Miscellaneous rivers	231	3,420	137	1,936	.....	.....	70	2,042	.....	.....
Ocean shore of New Jersey	85	2,011	.....	.....	1,097	8,196	12	260	.....	.....
New York Bay	94	7,605	100	6,560	302	1,510	.....	.....	6	2,200
Hudson River	516	23,679	337	23,425	2,631	10,303	41	5,840	.....	.....
Long Island Sound	7	401	1	80	.....	.....	.....	.....	6	1,430
Connecticut River	59	1,200	48	3,321	.....	.....	12	863	.....	.....
Miscellaneous rivers	55	1,346	50	1,068	.....	.....	5	380	.....	.....
Narragansett Bay and tribs	3	90	.....	.....	.....	.....	.....	.....	3	920
Casco Bay	19	4,224	64	885	.....	.....	1	350	.....	.....
Kennebec River and tribs	242	7,210	124	1,745	.....	.....	1	20	133	23,340
Other Maine rivers	20	208	40	240	.....	.....	.....	.....	.....	.....
Total	11,911	472,044	7,227	276,994	75,443	119,442	719	142,076	3,810	404,062

Water areas.	Fyke nets.		Bow nets.		Miscellaneous.		Shore property.	Total investment.
	No.	Value.	No.	Value.	No.	Value.		
St. Johns River	.....	.....	.....	.....	.....	.....	$4,349	$32,748
St. Marys River	.....	.....	.....	.....	.....	.....	.....	2,165
Satilla River	.....	.....	.....	.....	.....	.....	.....	90
Altamaha River	.....	.....	113	$259	.....	.....	47	4,930
Ogeechee River	.....	.....	.....	.....	.....	.....	1,735	9,935
Savannah River	.....	.....	.....	.....	3	$7	1,718	8,020
Combahee River	.....	.....	.....	.....	.....	.....	50	740
Ashepoo River	.....	.....	6	15	.....	.....	.....	1,088
Edisto River	.....	.....	83	231	.....	.....	350	5,740
Cooper River	.....	.....	24	68	.....	.....	100	298
Santee River	.....	.....	55	138	.....	.....	20	510
Winyah Bay and tributaries	.....	.....	279	703	80	2,178	2,125	31,619
Cape Fear River	.....	.....	184	480	.....	.....	7,710	16,808
Pamlico Sound	.....	.....	.....	.....	.....	.....	4,505	70,041
Neuse River	.....	.....	529	1,461	.....	.....	45,125	80,978
Pamlico-Tar River	.....	.....	120	305	.....	.....	7,200	24,143
Croatan and Roanoke sounds	.....	.....	.....	.....	.....	.....	15,448	43,940
Albemarle Sound	.....	.....	.....	.....	.....	.....	82,495	204,776
Roanoke River	.....	.....	435	1,515	75	1,125	34,267	46,827
Chowan River	.....	.....	.....	.....	.....	.....	36,002	81,092
Pasquotank and Perquimans rivers	.....	.....	10	20	.....	.....	11,130	28,552

Boats, apparatus, etc., employed in Atlantic coast shad fisheries in 1896—Continued.

Water areas.	Fyke nets.		Bow nets.		Miscellaneous		Shore property.	Total investment.
	No.	Value.	No.	Value.	No.	Value.		
Chesapeake Bay							$51,055	$324,425
James River and tributaries					3	$45	8,042	32,797
York River and tributaries	64	$842					4,430	39,933
Mobjack Bay							1,640	20,825
Rappahannock River	8	190			19	760	3,851	59,054
Potomac River			3	$6			21,525	120,904
Nanticoke River and tributaries	143	2,495					7,185	24,271
Choptank River and tributaries	57	550					11,088	39,123
Susquehanna River			59	209	15	600	6,723	48,616
Miscellaneous	135	2,178	117	595			5,818	52,130
Delaware Bay							26,240	103,495
Delaware River					30	23	121,721	305,789
Miscellaneous rivers			10	40			5,505	12,943
Ocean shore of New Jersey	31	650					55	11,172
New York Bay	248	2,164					2,425	22,464
Hudson River	20	105					6,055	69,407
Long Island Sound							100	2,011
Connecticut River							465	5,849
Miscellaneous rivers					20	20	490	3,304
Narragansett Bay and tributaries							120	1,130
Casco Bay								5,459
Kennebec River and tributaries							6,838	39,153
Other Maine rivers								448
Total	706	9,174	2,027	6,045	245	4,758	545,747	2,040,342

It will be seen that from St. Johns River to Cape Fear River, inclusive, shad are taken principally in drift nets, with smaller catches in set nets, bow nets, haul seines, and fall traps. Of 826,130 shad caught in that region in 1896, 602,244, or 73 per cent, were taken in drift nets; 140,912 by seines; 45,425 by set nets; 36,785 by bow nets; and 764 by fall traps and cast nets. The principal shad streams are St. Johns, Altamaha, Ogeechee, Savannah, Edisto, Pee Dee, and Cape Fear. The rivers of this section empty directly into the ocean, maintaining their fluvial characteristics almost if not quite to their outlets.

Next come Pamlico Sound and its important tributaries, Albemarle and Croatan sounds, and the Neuse, Pamlico, Roanoke, and Chowan rivers, etc. There the bulk of the catch is by stake nets, pound nets, and seines, the drift-net yield being of very small extent. In 1896, 944,582 were taken in stake nets, 521,564 by seines, 478,531 by pound nets, 46,606 by bow nets, 28,206 by drift nets, and 2,000 by fall traps.

The shad fisheries of Chesapeake Bay and its tributaries are the most extensive and valuable on the coast, the yield during an ordinary year approximating nearly half the total product of the United States. Although 1896 was an "off year" in the Chesapeake, the catch aggregated 4,867,619, nearly 33 per cent of the total yield on the coast. Of this product 2,320,921 were obtained by means of pound nets, 1,597,944 by drift nets, 433,842 by stake nets, 457,502 by seines, and the remaining 57,410 by means of fyke nets, bow nets, and fall traps.

Next comes the important estuary of the Delaware, the yield in which, including its tributaries, is usually about one-half that of the Chesapeake and tributaries. In 1896, however, the yield was somewhat greater than usual, 4,017,462 shad being taken, of which 3,261,457 were secured by drift nets, 744,005 by seines, and the remaining 12,000 by spears, stake nets, fyke nets, and pound nets.

Northward from the Delaware there are only three important shad streams, viz, the Hudson, Connecticut, and Kennebec, the yield in which, in 1896, numbered 588,898, 51,690, and 290,122, respectively. In the Hudson, the most important apparatus are drift nets, stake nets, and seines; in the Connecticut, drift nets and seines only are used; and the entire yield of shad in the Kennebec is obtained in weirs and drift nets. Besides these three rivers there are numerous small streams and coastal indentations in which more or less shad are caught each year.

The following statement shows the number and value of shad caught on the Atlantic coast in 1896:

Statement, by water areas, of the number and value of shad caught in each form of apparatus employed on the Atlantic coast in 1896.

Water areas.	Drift nets.		Stake nets.		Seines.		Pound nets and weirs.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
St. Johns River	331,033	$53,297	.....	.....	125,248	$8,627	.....	.....
St. Marys River	7,609	1,313	2,584	$441	.....	.....	.....	.....
Satilla River	1,500	240	.....	.....	.....	.....	.....	.....
Altamaha River	17,310	5,803	9,202	3,168	.....	.....	.....	.....
Ogeechee River	55,425	19,514	.....	.....	.....	.....	.....	.....
Savannah River	54,299	19,196	37	14	.....	.....	.....	.....
Combahee River	.....	.....	3,090	622	.....	.....	.....	.....
Ashepoo River	.....	.....	6,400	1,254	.....	.....	.....	.....
Edisto River	.....	.....	21,967	4,281	2,634	640	.....	.....
Cooper River	.....	.....	80	25	20	7	.....	.....
Santee River	.....	.....	2,065	433	.....	.....	.....	.....
Winyah Bay and tributaries	80,250	18,527	.....	.....	1,608	460	.....	.....
Cape Fear River	54,809	13,950	.....	.....	11,402	2,747	.....	.....
Pamlico Sound	.....	.....	387,230	96,249	.....	.....	60,853	$13,478
Neuse River	18,485	3,244	26,483	4,680	114,077	21,239	22,471	3,902
Pamlico-Tar River	5,221	1,139	8,114	1,632	38,693	7,439	7,759	1,538
Croatan and Roanoke sounds	.....	.....	73,626	15,090	20,000	3,800	75,915	14,311
Albemarle Sound	.....	.....	429,590	82,664	132,213	25,401	173,380	32,094
Roanoke River	4,000	480	6,100	1,195	143,809	16,043	.....	.....
Chowan River	500	97	.....	.....	60,450	11,835	122,595	22,490
Pasquotank and Perquimans rivers	.....	.....	13,424	2,570	12,322	2,395	15,558	2,877
Chesapeake Bay	242,903	23,971	84,952	9,990	33,622	4,064	1,277,367	129,904
James River and tribs	339,628	28,091	101,700	18,324	49,509	4,341	3,119	361
York River and tribs	350,441	31,201	43,921	5,251	12,701	955	138,895	12,890
Mobjack Bay	.....	.....	.....	.....	.....	.....	140,777	13,874
Rappahannock River	40,354	3,157	104,118	8,242	9,740	973	262,504	22,916
Potomac River	279,280	23,188	11,510	1,616	123,445	9,853	269,228	28,801
Nanticoke River and tributaries	117,266	11,107	17,065	2,015	29,897	3,019	42,143	3,732
Choptank River and tributaries	120,261	12,625	35,275	3,813	67,245	7,478	115,041	11,838
Susquehanna River	35,540	3,949	.....	.....	90,444	13,832	.....	.....
Miscellaneous rivers	72,271	8,689	34,695	5,371	40,899	5,023	71,847	8,573
Delaware Bay	1,098,821	103,996	4,200	672	700	74	100	19
Delaware River	2,086,791	226,795	.....	.....	686,612	73,263	.....	.....
Miscellaneous rivers	75,845	13,508	.....	.....	56,603	7,194	.....	.....
Ocean shore of New Jersey	.....	.....	200	50	865	378	13,675	2,715
New York Bay	63,500	7,620	52,275	8,329	1,010	223	42,332	5,880
Hudson River	297,178	42,958	222,575	31,165	68,345	8,991	.....	.....
Great South Bay and Gardiner Bay	.....	.....	.....	.....	.....	.....	4,755	1,092
Long Island Sound	128	46	.....	.....	41	10	9,258	2,343
Connecticut River	45,851	8,244	.....	.....	5,839	1,264	.....	.....
Miscellaneous rivers	11,128	2,810	.....	.....	1,592	399	.....	.....
Ocean shore of Rhode Island	.....	.....	.....	.....	.....	.....	1,051	287
Narragansett Bay and tributaries	.....	.....	.....	.....	3,355	934	11,421	2,997
Buzzards Bay and Vineyard Sound	.....	.....	.....	.....	.....	.....	3,385	834
Cape Cod and Massachusetts bays	22,080	691	.....	.....	9,087	456	1,915	321
Casco Bay	6,110	355	.....	.....	40,325	2,017	18,055	1,208
Kennebec River and tribs	50,317	5,434	.....	.....	5,500	495	234,305	20,328
Penobscot and other Maine rivers	12,000	912	.....	.....	.....	.....	126	29
Total	5,998,143	696,147	1,703,090	309,150	1,999,942	245,860	3,139,830	361,032

Statement, by water areas, of the number and value of shad caught in each form of apparatus employed on the Atlantic coast in 1896—Continued.

Water areas.	Fyke nets.		Bow nets.		Miscellaneous.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
St. Johns River							456,281	$61,924
St. Marys River							10,193	1,754
Satilla River							1,500	240
Altamaha River			2,865	$1,125			29,377	10,096
Ogeechee River							55,425	19,514
Savannah River					70	$26	54,406	19,236
Combahee River							3,090	622
Ashepoo River			480	127			6,880	1,381
Edisto River			3,672	922			28,273	5,843
Cooper River			296	94			396	126
Santee River			5,244	1,114			7,309	1,547
Winyah Bay and tributaries			15,124	3,832	694	212	97,685	23,031
Cape Fear River			9,104	2,267			75,315	18,964
Pamlico Sound							448,089	109,727
Neuse River			25,536	6,002			207,052	39,067
Pamlico-Tar River			7,295	1,568			67,082	13,316
Croatan and Roanoke sounds							169,541	33,201
Albemarle Sound							735,192	140,159
Roanoke River			13,500	2,391	2,000	380	169,409	20,489
Chowan River							183,545	34,422
Pasquotank and Perquimans rivers			275	56			41,579	7,898
Chesapeake Bay							1,638,844	167,929
James River and tributaries					1,800	130	495,762	51,247
York River and tributaries					500	64	546,548	50,361
Mobjack Bay							140,777	13,874
Rappahannock River					1,073	83	417,789	35,371
Potomac River			600	150			684,063	63,608
Nanticoke River and tributaries	9,337	$795					216,308	20,068
Choptank River and tributaries	598	56					338,420	35,810
Susquehanna River			12,100	2,113	2,003	259	140,087	20,153
Miscellaneous rivers	3,897	510	25,412	3,570			249,021	31,736
Delaware Bay							1,103,821	104,761
Delaware River					5,400	540	2,778,803	300,598
Miscellaneous rivers			2,300	445			134,838	21,147
Ocean shore of New Jersey	1,500	375					16,240	3,518
New York Bay	57,308	8,889					210,425	30,941
Hudson River	800	120					588,898	83,237
Great South Bay and Gardiner Bay							4,755	1,092
Long Island Sound							9,427	2,399
Connecticut River							51,690	9,508
Miscellaneous rivers					482	115	13,202	3,324
Ocean shore of Rhode Island							1,051	287
Narragansett Bay and tributaries					1,060	306	15,836	4,237
Buzzards Bay and Vineyard Sound							3,385	834
Cape Cod and Massachusetts bays							33,082	1,468
Casco Bay							64,490	3,580
Kennebec River and tributaries							290,122	26,257
Penobscot and other Maine rivers							12,126	941
Total	73,440	10,748	123,803	25,776	15,172	2,115	13,053,429	1,051,443

It has been customary heretofore to report the yield of shad in pounds, but various causes have combined to render it advisable to report the yield according to the number. It is hoped that this sacrifice of custom will not involve any loss of clearness. The weight of these fish ranges from 1 to 10 pounds, averaging about 3¾ pounds. For convenience of those who prefer reckoning shad according to their weight, the following summary is presented, showing, by States and by sexes, the number and weight of the shad yield in 1896.

Statement of the number, weight, and value of roe and buck shad caught on the Atlantic coast of the United States in 1896.

States.	Roe.			Buck.			Total.		
	No.	Pounds.	Value.	No.	Pounds.	Value.	No.	Pounds.	Value.
Florida	171,752	677,954	$26,417	288,462	620,651	$36,172	460,214	1,298,605	$62,589
Georgia	62,604	294,641	23,953	81,370	241,986	25,336	143,974	536,627	49,289
South Carolina	70,376	405,471	19,160	76,251	266,042	14,276	146,627	671,513	33,436
North Carolina	942,843	4,804,508	246,676	1,153,961	4,038,200	170,567	2,096,804	8,842,708	417,243
Virginia	1,574,274	6,700,890	198,758	1,629,229	4,469,629	108,297	3,203,503	11,170,519	307,055
Maryland	717,523	3,295,102	101,831	823,527	2,246,397	64,720	1,541,050	5,541,499	166,551
Delaware	282,598	1,442,318	51,194	185,746	550,976	18,066	468,344	1,993,294	69,260
Pennsylvania	372,199	1,839,602	57,019	249,040	661,541	22,426	621,239	2,501,143	79,445
New Jersey	2,132,031	10,281,510	268,454	1,206,449	3,628,316	71,602	3,338,480	13,909,826	340,056
New York	324,713	1,563,783	55,354	218,101	636,763	19,479	542,814	2,200,546	74,833
Connecticut	33,495	150,811	8,623	36,793	110,379	5,459	70,288	261,190	14,082
Rhode Island	7,921	35,646	2,477	5,611	17,115	1,113	13,532	52,761	3,590
Massachusetts	19,035	64,718	1,988	20,787	49,434	1,248	39,822	114,152	3,236
Maine	172,920	820,140	19,448	193,818	584,337	11,330	366,738	1,404,477	30,778
Total	6,884,284	32,377,094	1,081,352	6,169,145	18,121,766	570,091	13,053,429	50,498,860	1,651,443

The values set forth in the aforegoing table fail in doing justice to the importance of this fishery, those figures representing merely the net price which the fishermen received, this amount being greatly increased by the time they reached the consumer. Thus the value of the 456,281 shad taken on the St. Johns River in Florida is reported at $61,924, an average of $13.57 per 100 fish. The cost of packing and expressage to New York City, for instance, approximates $10 per 100. Then comes the expenses and profit of the wholesale dealer or commission merchant and that of the retailer, which may approximate $5 and $12, respectively, per 100. This makes the cost of the fish to the consumer about $40.57 per 100. Estimated at this rate, the yield on the St. Johns in 1896 was worth $185,113, instead of the reported value, $61,924. The average value to the fishermen for the entire yield of the Atlantic coast was $12.64 per 100 fish, while the consumers probably paid $25 per 100. Assuming this basis as correct, the consumers paid $3,263,357 for the 13,053,429 shad caught in 1896.

The prices in 1896 were unusually small, and this limited the total catch considerably. During April and May the markets were glutted, and prices fell so low that many fishermen ceased operations.

The following table shows the wholesale prices of shad prevailing in New York and Philadelphia on Friday of each week during the first six months of 1896:

Week ending—	New York.		Philadelphia.		Week ending—	New York.		Philadelphia.	
	Roe.	Buck.	Roe.	Buck.		Roe.	Buck.	Roe.	Buck.
Jan. 3	$1.10	$0.50	$1.00	$0.50	Apr. 3	$0.28	$0.15	$0.25	$0.14
10	1.00	.40	1.00	.50	10	.23	.11	.25	.13
17	.90	.50	1.00	.45	17	.25	.15	.15	.07
24	.75	.37	.88	.47	24	.28	.13	.18	.08
31	.88	.30	.95	.50	May 1	.20	.11	.16	.08
Feb. 7	.75	.23	.75	.32	8	.23	.11	.20	.10
14	.75	.30	.80	.35	15	.23	.11	.14	.07
21	.80	.43	.75	.38	22	.20	.09	.18	.09
28	.80	.38	.90	.42	29	.25	.11	.20	.10
Mar. 6	.45	.23	.70	.35	June 5	.22	.10	.20	.10
13	.50	.23	.40	.20	12	.25	.12	.25	.12
20	.25	.14	.40	.20	19	.22	.10	.....	.....
27	.35	.17	.35	.18	26	.20	.09	.....	.....

COMPARISON WITH PREVIOUS YEARS.

In considering the comparative abundance of shad it is not safe to be guided by the results of the fisheries in a single locality or even in an individual river basin. The catch in each locality fluctuates under local conditions, and it is only by comparing the returns for a large area of the coast that it can be determined whether there has been an actual increase or decrease.

The season of 1880 is the earliest one for which we have accurate or even fairly reliable data relative to the yield of shad along the entire Atlantic coast or even a considerable portion of that coast. The adverse agencies tending to deplete the species had then reduced the yield to a very low point and the effect of artificial propagation had not become generally apparent. During that year the total yield of shad on the Atlantic coast approximated 5,162,315 in number, worth $995,465. The use of improved apparatus of capture and the more vigorous prosecution of the fisheries has resulted in a considerable increase in the aggregate yield since that season. The yield in 1888 was reported at 10,181,605, for which the fishermen received $1,665,176; in 1892 it was 11,094,565, valued at $1,879,688, and in 1896 it numbered 13,053,429, worth $1,651,443 at first hands.

While the yield in 1896 was by far the largest of any of the four years above noted, yet that season was scarcely representative of the last three or four years. Not only were shad less abundant than usual, but the prices were so low that many fisheries were abandoned before the season was at an end. However, in the rivers of Florida and Georgia, in Delaware River, and Connecticut River the catch in 1896 was the largest for many years. From Savannah River to the Chesapeake Bay, inclusive, the yield in 1895 and in 1897 was far in excess of that in 1896.

The following summary shows by States the yield of shad in 1880, 1888, and 1896. The returns for 1880 and 1888 were published in pounds, and in reducing them to number the average weight has been assumed to be 3½ pounds each.

State.	1880.		1888.		1896.	
	Number.	Value.	Number.	Value.	Number.	Value.
Florida	71,914	$20,136	413,714	$89,030	460,214	$62,589
Georgia	72,000	17,941	75,200	19,000	143,974	49,280
South Carolina	59,314	12,432	123,057	27,050	146,627	33,436
North Carolina	920,360	329,569	1,608,774	292,409	2,096,804	417,243
Virginia	906,272	134,496	2,316,235	376,944	3,203,503	307,055
Maryland	1,074,121	140,326	1,508,781	218,230	1,541,050	166,551
Delaware	300,000	52,500	396,019	51,999	468,344	69,260
Pennsylvania	159,885	27,980	396,340	76,942	621,239	79,445
New Jersey	214,285	35,000	1,863,842	307,411	3,338,480	340,056
New York	781,028	136,680	984,468	150,882	542,814	74,833
Connecticut	376,581	65,902	104,553	23,786	70,288	14,082
Rhode Island	13,743	2,405	4,971	1,213	13,532	3,590
Massachusetts	47,007	8,226	51,316	5,312	39,822	3,236
Maine	165,805	11,876	242,835	24,368	366,738	30,778
Total	5,162,315	995,465	10,181,605	1,665,176	13,053,429	1,651,443

It appears that since 1880 there has been an increase in the yield in every State south of New York, and from that point northward there has been a decrease in each State except Maine. The greatest increase has occurred in New Jersey, the yield of shad in that State in 1880 numbering 214,285, which was increased in 1888 to 1,863,842, and in 1896 to 3,338,480. Virginia ranks next with an increase from 906,272 in 1880, to 2,096,804 in 1896. The largest decrease has occurred in Connecticut, where the catch in 1880 numbered 376,581, and in 1896 only 70,288.

The yield for the entire coast shows an increase of 97 per cent in the eight years from 1880 to 1888, and from 1888 to 1896 the increase was 28 per cent. The value of the shad, however, does not show so great an increase. Indeed, comparing the returns for 1888 with those of 1896, we find that while the total number of shad increased 2,871,824, the value decreased $13,733. The average price received by the fishermen for shad in 1880 was $19.28 per hundred; in 1888, $16.35, and in 1896, $12.65 per hundred.

In considering the recent yield of shad with that prior to 1880, few data exist on which to base satisfactory conclusions. It is well to guard against placing too great confidence in estimates as to the early abundance of these fish. In the report of the Maine Fish Commission for 1867, the yield of shad on the Penobscot during the preceding season was estimated at 2,500,000 in number, but a careful survey of the fisheries of that river during the following season, made by the same commissioners, showed that the number of shad caught approximated only 5,000. If this correction had not been made, the former number would doubtless have prevailed as the basis for comparisons of the former and present abundance of shad in Penobscot River. In the Gazetteer of Virginia, published in 1835, is an account of the fishery resources of Potomac River, which includes the remarkable statement that in a good season of six weeks the catch of shad on that river numbered 22,500,000, while the alewives caught annually reached the remarkable number of 750,000,000. And this estimate has been used by many writers as a basis for lengthy discussions of the decrease of shad in the Potomac.

True, there are numerous records, kept with great accuracy, showing the yield of shad at individual fisheries, and even for entire river basins, for periods of 20, 40, and even 60 or more years prior to 1880, but they can not be taken as a basis for determining the abundance or comparative yield of this species all along the coast. Great changes have occurred in manner of prosecuting the fisheries and even in the fishing-grounds during the past half century. Formerly the great bulk of shad were caught by means of seines, while at present the large catches made by drift nets, stake nets, pound nets, etc., leave a comparatively small number to be caught in the original form of apparatus. Also the large increase in the amount of apparatus employed results in a much smaller average catch for each individual apparatus. If only 20 seines or pound

nets are used in a certain water-course, it is to be expected that the average catch per net will be greater than if that number be increased to 100. And while probably in many of the water areas along the coast the average catch of shad per net is less at present than formerly, yet it is equally probable that the present aggregate yield of shad is much greater than ever before.

An account of the comparative abundance of shad in each water area will be found in the latter half of this report, containing a discussion of the fisheries of each separate locality.

We must not overlook the great length of water-courses formerly abounding in shad from which these fish are now excluded by means of dams and other obstructions. But to offset this there has been a great extension of the fisheries into water areas in which no shad whatever were caught half a century ago. Formerly the great bulk of the yield was obtained from the middle and upper sections of the rivers, while at present nearly all the catch is obtained in the lower section and in the salt water of the estuaries. The extension of the fisheries into the estuaries is of recent origin, dating only from the middle of the present century, and their development has been principally during the past twenty years. It requires large and costly apparatus to prosecute the fisheries there, and forms suitable have come into use only quite recently.

With the exception of drift nets in Delaware Bay, New York Bay, and one or two less important places, and the mackerel purse seines, which take a few shad on the New England coast, pound nets and stake nets are the only forms of apparatus employed in catching shad in salt water.

Over 90 per cent of the shad caught in salt water of the Chesapeake region are taken in pound nets, yet the use of that apparatus there dates only from 1865, and not until 1875 were they extensively employed. Stake nets and pound nets, which catch practically all the shad taken in the salt water of North Carolina, have been used in that region only since 1865. It thus appears that, while the up-river fisheries are decreasing, a very large area is being added to the fishing-grounds. At present nearly half of the total shad yield on the Atlantic seaboard is obtained in salt water, and those fisheries are becoming more extensive each year.

The following summary shows, approximately and in comparative form for each water area, the number and value of the shad caught in 1896 and the number and percentage of those taken in salt water. The line of demarcation between the salt and fresh water of the estuaries being indefinite and variable, this table is only approximately correct for certain regions, but the percentage of error is too small to materially affect the general result.

Table showing the number and value of shad taken in 1896, and the number and percentage of those taken in salt water.

Water areas.	Total yield.		Yield in salt water.	
	Number.	Value.	Number.	Per cent.
St. Johns River	456,281	$61,924	.....	.....
St. Marys River	10,193	1,754	.....	.....
Satilla River	1,500	240	.....	.....
Altamaha River	29,377	10,096	.....	.....
Ogeechee River	55,425	19,514	.....	.....
Savannah River	54,406	19,236	.....	.....
Combahee River	3,090	622	.....	.....
Ashepoo River	6,880	1,381	.....	.....
Edisto River	28,273	5,843	.....	.....
Cooper River	396	126	.....	.....
Santee River	7,309	1,547	.....	.....
Winyah Bay and tributaries	97,685	23,031	.....	.....
Cape Fear River	75,315	18,964	.....	.....
Pamlico Sound	448,089	109,727	448,089	100
Neuse River	207,052	39,067	82,238	39.72
Pamlico-Tar River	67,082	13,316	18,873	28.13
Croatan and Roanoke sounds	169,541	33,201	169,541	100
Albemarle Sound	735,192	140,159	186,290	25.34
Roanoke River	169,409	20,489	.....	.....
Chowan River	183,545	34,422	.....	.....
Pasquotank and Perquimans rivers	41,579	7,898	.....	.....
Chesapeake Bay	1,638,844	167,929	1,428,327	87.15
James River and tributaries	495,762	51,247	100,379	20.25
York River and tributaries	546,548	50,361	182,375	33.37
Mobjack Bay	140,777	13,874	140,777	100
Rappahannock River	417,789	35,371	194,067	46.45
Potomac River	684,063	63,608	210,480	30.76
Nanticoke River and tributaries	216,308	20,668	42,405	19.60
Choptank River and tributaries	338,420	35,810	136,972	40.47
Susquehanna River	140,087	20,153	.....	.....
Miscellaneous	249,021	31,736	29,851	11.98
Delaware Bay	1,103,821	104,761	1,103,821	100
Delaware River	2,778,803	300,598	976,669	35.13
Miscellaneous rivers	134,838	21,147	.....	.....
Ocean shore of New Jersey	16,240	3,518	13,765	84.75
New York Bay	216,425	30,941	213,925	98.84
Hudson River	588,898	83,237	.....	.....
Great South Bay and Gardiner Bay	4,755	1,092	4,755	100
Long Island Sound	9,427	2,399	9,427	100
Connecticut River	51,690	9,508	.....	.....
Miscellaneous rivers	13,202	3,324	.....	.....
Ocean shore of Rhode Island	1,051	287	1,051	100
Narragansett Bay and tributaries	15,836	4,237	2,163	13.66
Buzzards Bay and Vineyard Sound	3,385	834	3,385	100
Cape Cod and Massachusetts bays	33,082	1,468	33,082	100
Casco Bay	64,490	3,580	64,490	100
Kennebec River and tributaries	290,122	26,257	55,087	19.30
Penobscot and other Maine rivers	12,126	6,941	6,000	49.48
Total	13,053,429	1,651,443	5,859,184	45.26

The preceding summary shows that in 1896 45 per cent of the total shad yield was caught in regions which half a century ago yielded none whatever, this in some measure compensating for the 3,700 miles of river course from which they are now wholly excluded and the lengths from which the exclusion is partial. It thus appears that the principal change in the fisheries during the past fifty years has been one of location rather than extent of the total yield, the great increase in the estuaries compensating for the decrease in the headwaters. This change in the fishing-grounds results in a large portion of the fish being taken before they reach the spawning areas in fresh water, thereby preventing them from adding their quota to future supply almost as effectually as though they were excluded therefrom by means of dams or otherwise. But the same result is accomplished when the fish are caught after reaching those areas, and before spawning. Furthermore,

moving the seines and other apparatus of capture over the spawning-grounds disturbs and drives away the fish from those areas and destroys many of the eggs and young shad already there.

The construction of dams has excluded shad from a large portion of the spawning-grounds, notwithstanding the erection of fishways in those obstructions. Sawdust, chemicals, and other refuse, and agricultural operations, have greatly impaired the utility of the spawning areas even now available, and the extensive fisheries have very largely decreased the number of shad reaching those areas. These adverse agencies have reduced natural reproduction to almost an insignificant factor in keeping up a supply ample to maintain the present fisheries, rendering artificial propagation essential to their prosperity. They so affected the abundance of shad that during the Seventies the returns of the fisheries reached a minimum. Then the results of artificial propagation began to appear, not only maintaining an equilibrium, but greatly increasing the abundance. While the increased yield was preceded by an increase in the quantity of apparatus used, yet it was made possible by the greater abundance of shad due to artificial propagation. Comparing 1880 with 1896, it is observed that the increase in the yield numbered 7,891,114. At 25 cents each (the average paid by consumers), this represents an increase of $1,972,778 in the value, over sixty times the expenditure for shad propagation, a result probably unsurpassed in any other line of fish-culture.

The general condition of the shad fisheries along the entire coast having been noted we now proceed to a description of the fisheries of each individual water area, those areas being grouped according to States, beginning with the southernmost and proceeding northward.

THE SHAD FISHERIES OF FLORIDA.

The extent by water areas of each branch of the shad fisheries of Florida in 1896 is presented in the following series of three tables, showing (1) the number of persons employed, (2) the boats, apparatus, etc., used, and (3) the number and value of shad taken. There are but two rivers in this State which support commercial shad fisheries, viz, the St. Johns and the St. Marys.

Statement, by water areas, of the number of persons employed in each branch of the shad fisheries of Florida in 1896.

Waters.	Fishermen.				Shoremen.	Transporters.	Total.
	Drift-net.	Set-net.	Seine.	Total.			
St. Johns River:							
From sea to Jacksonville	292	.....	.....	292	16	2	310
Palatka section	38	.....	.....	38	7	.....	45
Upper St. Johns	7	.....	110	117	8	3	128
St. Marys River	20	20	.....	40	.....	.....	40
Total	357	20	110	487	31	5	523

Statement, by water areas, of the boats, apparatus, etc., employed in the shad fisheries of Florida in 1896.

Waters.	Boats.		Drift nets.			Set nets.		
	No.	Value.	No.	Length.	Value.	No.	Length.	Value.
				Yards.			*Yards.*	
St. Johns River:								
From sea to Jacksonville	146	$7,720	146	83,500	$15,625	.....	.....	.....
Palatka section	21	394	22	5,250	1,260	.....	.....	.....
Upper St. Johns	54	1,060	3	1,400	165	.....	.....	.....
St. Marys River	30	210	20	1,400	300	10	850	$200
Total	251	9,384	191	91,550	17,350	10	850	200

Waters.	Seines.			Shore property.	Total investment.
	No.	Length.	Value.		
		Yards.			
St. Johns River:					
From sea to Jacksonville	.....	.....	.....	$3,614	$26,959
Palatka section	.....	.....	.....	400	2,054
Upper St. Johns	24	7,150	$2,175	335	3,735
St. Marys River	.....	.....	.....	.....	710
Total	24	7,150	2,175	4,349	33,458

Statement by apparatus of the yield of shad in the waters of Florida in 1896.

Waters.	Drift nets.		Set nets.		Seines.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
St Johns River:								
From sea to Jacksonville	291,116	$47,720	.....	.....	.....	.....	291,116	$47,720
Palatka section	37,300	5,222	.....	.....	.....	.....	37,300	5,222
Upper St. Johns	2,617	355	.....	.....	125,248	$8,627	127,865	8,982
St. Marys River	2,244	380	1,689	$285	.....	.....	3,933	665
Total	333,277	53,677	1,689	285	125,248	8,627	460,214	62,589

ST. JOHNS RIVER.

St. Johns River has its sources in the swamps and marshes of eastern Florida, flows nearly parallel with the coast a distance of 375 miles, and enters the ocean near the northeastern corner of the State. It is navigable to a point about 300 miles from the mouth, and steamers ascend regularly as far as Sanford, 230 miles by the river course from the sea. It is very broad, the width in the lower 100 miles being from 1 to 5 miles, and for two-thirds of its length it is over a mile wide, often expanding into spacious lakes. There are no permanent obstructions to the passage of fish, and shad ascend nearly to the sources of the river. The St. Johns differs from all other streams on the Atlantic coast of the United States in that its sources are in warmer latitudes than its entrance into the ocean. All the other streams run south and east, and the water flowing therein is much cooler during the winter and spring than the sea water. The effect of this peculiar condition is thus described by the late Marshall McDonald:

In the St. Johns River, Florida, shad appear several months before the spawning time, and although this is not largely in advance of the same season in rivers as far north as certain tributaries of the Chesapeake, yet by reason of their early presence in the St. Johns the fisheries are prosecuted during the entire winter. They do not enter the river at this time for the purpose of spawning. By reference to tables giving

the temperature of the St. Johns River at Jacksonville, it is seen that the temperature of the water gradually descends, reaching 60° F. at Jacksonville about the last of November. This date is coincident with the first appearance of shad in the St. Johns. * * * In all other streams on the Atlantic coast the fish appear to wait until the temperature of the river has risen above that of the salt-water area into which the river empties before they ascend in the spring. The migration of shad into the St. Johns River is clearly not for the immediate purpose of spawning, as that operation is not performed for months, but in order that they may keep within the limit of the hydro-isothermal area appropriate to them. We must suppose that the temperature of the ocean waters, on the continental plateau outside the coast line, is higher than 60° F., and although uncongenial to the fish, yet they must necessarily remain in that temperature until the waters of the St. Johns, cooling as the winter advances, have fallen below the temperature of the outside waters. As soon, therefore, as water of a lower temperature than that in which they are commingles with the ocean water it serves as an incentive—as it were, the signal—for their migration into the estuary of the St. Johns.—(Natural History of Aquatic Animals, pp. 599-602.)

Shad fishing on the St. Johns is of recent origin. Indeed, it is claimed by some persons that shad have run up this river during the last forty years only, but this is doubtless erroneous, the absence of extensive fisheries before the Sixties being due to inadequate shipping facilities and insufficient local enterprise. Drift nets were introduced here about 1860, and their use increased quite rapidly, most of them being operated by fishermen from Connecticut and New Jersey. The war interrupted all fishing except for local use, but at the close of hostilities the operation of drift nets was renewed and greatly increased. It is reported that, in 1873, 94,000 shad were caught with 30 nets operated from New Berlin, about 10 miles from the mouth of the river, and that in 1876, when shad were unusually abundant, the average catch at New Berlin was 5,000 per net. At Palatka, 100 miles from the mouth of the river, drift nets were first used in 1872, and 7 nets in 1876 caught 66,000 shad, the largest yield in any one net numbering 11,000.

In a letter from Jacksonville, dated in January, 1874, Dr. Charles Koch says:

From the bar at the mouth of the St. Johns River up to Palatka 75 to 80 nets are fished during the shad season. These nets are 200 yards long and 10 feet deep and are set in from 10 to 12 feet of water. In 1873 the product of the shad fisheries amounted to 250,000 shipped or consumed. The average price at Jacksonville was 15 cents apiece.

Mr. R. E. Earll estimated that in 1877-78 there were 80 drift nets on the river and that the average catch was 2,500 each, making a total of 200,000 shad for that season. He further states that the yield for the previous season approximated 280,000, and for 1875-76 the yield was about 160,000 or less. The Tenth Census reports the yield in 1879-80 at 251,700 pounds, but it does not appear what basis has been used in reducing the number to pounds. No mention is made in those estimates of the use of seines.

The yield of shad on the St. Johns in 1890 was the largest for many years, numbering 872,074. During the four years following the catch gradually decreased; but in 1895 it was somewhat better, and this

increase was continued in 1896. In the last-named year the entire yield was 170,252 roes and 286,029 bucks, a total of 456,281, of which 331,033 were taken in drift nets and 125,248 in seines. Comparing the number of fishermen in 1890 and 1896, it appears that the yield of 872,074 shad in the former year was obtained by 442 men, whereas the 456,281 shad in 1896 were secured by 447 fishermen, an increase of 1 per cent in the number of fishermen and a decrease of nearly 50 per cent in the number of shad secured. The catch in 1890 was made with 191 gill nets and 10 seines, while in 1896 there were used 171 gill nets and 24 seines.

From the foregoing it appears that the yield of shad on the St. Johns during the years noted has been as follows:

Year.	No. of shad.	Year.	No. of shad.
1864	None reported.	1878	200,000
		1880	71,914
1873	250,000	1890	872,074
1876	160,000	1896	456,281
1877	280,000		

Shad enter this river late in November and remain till the following May or June. The legal season extends from December 1 to the end of the following March, with close time "between sundown on Saturday afternoon and sunrise on Monday morning of each week." Actual fishing operations begin at the opening of the legal season, fully a month before shad are caught in any other water on the coast, and end about the second or third week of March. According to Dr. Goode:

> The spawning time is apparently from the middle of March to the latter part of April. * * * The fishermen say that the shad spawn at the very head of the river, but I have no doubt that many deposit their eggs on convenient grounds nearer the sea. The fishermen also have a notion that shad that have well ascended the river never return, for they say they have never known a spent fish. This they account for by the theory that they are devoured by the alligators and catfish, the shad being weak and helpless after spawning.

An interdiction exists against the use in this State of "any gill nets for the capture of shad with a mesh less than 5 inches from knot to knot measured lengthwise, that is to say, a mesh when brought to a square, the sides of which are not less than 2½ inches" or any seine with a mesh less than 3 inches.

There are three distinct geographical sections in the shad fisheries of the St. Johns, viz, (1) from the mouth of the river to Jacksonville; (2) the Palatka region from Bridgeport to Welaka, and (3) from Lake George to Lake Harney. Of the 456,281 shad taken on the river in 1896, 291,116, valued locally at $47,720, were caught in the first section; 37,300, worth $5,222, in the second, and 127,865, worth $8,982, in the third section. The fisheries of each of these regions will be described in succession.

From the sea to Jacksonville.—In the lower section of the river, from the sea to Jacksonville, a distance of 28 miles, situated wholly within Duval County, the drift net is the only form of apparatus used in

taking shad. These range in length from 500 to 600 yards, averaging about 575 yards, with 5-inch mesh and from 40 to 50 meshes deep. They are heavily leaded, the leads weighing 2 ounces each and placed 2 or 3 feet apart. The average cost of the nets approximates $125, and 2 men are required for each. They are set directly across the current, one end being buoyed and the other attached to the boat, and are allowed to drift with the current. They are operated during both ebb and flood tides, but usually the flood tides yield larger returns.

The number of drift nets operated in this section in 1896 was 146, aggregating 83,500 yards in length and $15,625 in value, and requiring the services of 292 men. Comparatively few of these men are natives of Florida, many of them coming from Connecticut and New Jersey and residing in Florida only during the shad season. The catch, which was unusually large, consisted of 125,346 roe shad and 165,770 bucks, valued locally at $47,720. Nearly all of these fish were shipped to New York City and other distant markets.

From Jacksonville to Bridgeport, a distance of 46 miles, the river is from 2 to 5 miles in width and quite sluggish, so as to preclude the use of drift nets, and no fisheries are operated.

The Palatka section.—The second division of St. Johns River extends from Bridgeport to Welaka, a distance of 35 miles, located wholly within Putnam County. Drift nets exclusively are used in this stretch of the river, and the fishery is centered at Palatka, a town of 3,000 inhabitants. These nets are much shorter than those used below Jacksonville, averaging in length about 240 yards each, with a scant 5-inch mesh, and costing about $60. The number used in 1896 was 22, each net requiring the services of one boat and usually of two men, although in a few instances a single man operated one net. The water was unusually low, retarding the ascent of fish beyond Welaka, and the yield in this portion of the river was the largest since 1890, the total catch in the 22 drift nets numbering 9,550 roe shad and 27,750 bucks, valued locally at $5,222.

The Palatka fishermen complain considerably of the injury caused by the presence of a species of water hyacinth (*Piaropus crassipes*) in the river. This plant was introduced into the St. Johns in 1890 from a small pond at Edgewater, near Palatka. It becoming desirable to clean the pond, the plants were thrown into the river, where they flourished luxuriantly, producing masses of flowers and adding an attractive feature to the river scenery. It does not become fixed to the soil, and its movements are governed by the wind and current. During the past three or four years it has increased so abundantly and its range has been so extended as to seriously impede the operations of the fishermen, being distributed quite generally from Bridgeport to Lake George and existing to some extent as far down the river as Jacksonville. Several of the drift-net reaches in the vicinity of Palatka have been seriously injured by the plant, which gets entangled in the nets and causes much trouble and loss of twine. Occasionally, under favorable

conditions of wind and tide, the fishermen of certain reaches are prevented from operating their nets for several days at a time by reason of the mass of vegetation covering the water. Should the plant spread during the next few years as it has during the past six, drift-net fishing in the Palatka section will necessarily be abandoned.

From Lake George to Lake Harney.—This portion of the river, known as the Upper St. Johns, consists of a series of connected lakes, the most important being Lakes George, Dexter, Monroe, and Harney. Sanford, a town of 3,000 inhabitants, on the shore of Lake Monroe, is the center of the shad fisheries. This town is practically the head of navigation on the river, daily steamers connecting it with Jacksonville, over 200 miles distant.

Seines are the principal apparatus used in this section, the only other apparatus employed being a very few drift nets. Of the 127,865 shad taken in 1896, 125,248 were obtained in seines and 2,617 by drift nets. An interdiction exists against the use of seines in the lakes forming part of the St. Johns; consequently most of the seine fishing is confined to the channels connecting the lakes. Drift nets can, of course, be used only in the channels, and the extent of the seine fishery there restricts the use of drift nets.

There were only three drift nets reported from the Upper St. Johns in 1896. Two of these were each 600 yards in length and the third was 200 yards long, the mesh in all being 5-inch. The catch numbered 1,445 roe shad and 1,172 bucks, valued locally at $355.

The seines range in length from 200 to 700 yards, 50 to 100 meshes deep, with 3 or 4 inch mesh. They cost from $60 to $300, and require from 4 to 10 men each, according to the length of the seine and the strength of the current. The 24 seines used in 1896 aggregated 7,150 yards in length and $2,175 in value, and required the services of 110 fishermen and 50 small boats, worth $1,000, in addition to which 1 steam launch, worth $2,000, was used in transporting the fish to Sanford. The catch numbered 33,911 roe shad and 91,337 bucks, valued locally at $8,627. Among the bucks are included 53,807 "skips," which average in weight about 1 pound each. In the early part of the season shad are sold to the Palatka shippers as high as 50 cents each, but the price falls rapidly, and when the season is at its height the price is frequently less than $7.50 per 100.

ST. MARYS RIVER.

St. Marys River has its source in the Okefenokee Swamp, whence it forms the boundary line between Florida and Georgia for a distance of 175 miles to its entrance into the Atlantic. It is narrow, but deep and tidal nearly the whole length, and is navigable for steamboats as far as Traders Hill, 45 miles from the ocean. There are several small steamer landings on the river, but the only settlement of considerable size is St. Marys, a town of 700 inhabitants on the Georgia side of the river near the mouth. Owing to its proximity to the St. Johns, and the

greater abundance of fish in that stream, as well as to the meager shipping facilities on the St. Marys, very little attention has been given to catching shad in the latter river. The fisheries are confined to the use of a few drift nets and stake nets by men living between Crandall and Kings Ferry, most of the catch being landed at Oakwell, Ga., and Kings Ferry, Fla., whence it is carted to the nearest railroad station and shipped to distant markets. Some few shad are also taken for home use by means of bow nets, but this fishery is of little consequence and no data are at hand to show its actual extent. Seine fishing is scarcely practicable on the St. Marys, as the stream is so narrow and the tidal current so strong that seines could be hauled only during slack water.

The number of men employed in the shad fisheries of the St. Marys in 1896 was 110, 40 of whom lived on the Florida side of the river and 70 on the Georgia side. They commenced fishing about the 1st of January and continued until some time in April, 80 using drift nets and 30 using set nets. The drift nets numbered 80, with an aggregate length of 5,600 yards and valuation of $1,200. On account of the numerous snags and the narrowness of the river, the longest nets used are only 90 yards, and some are only 40 yards in length. The mesh is generally 5 inches and the depth about 14 feet. The stake nets numbered 15, with a length of 1,275 yards and valued at $300. By the drift nets 3,363 roe shad and 4,246 bucks, worth $1,313, were taken, while the set nets caught 1,062 roe shad and 1,522 bucks, valued locally at $441, making a total of 10,193 shad, worth $1,754, caught on St. Marys River, of which 3,933 were taken by men living on the Florida side and 6,260 by residents of Georgia.

THE SHAD FISHERIES OF GEORGIA.

Although requiring a greater number of fishermen the shad fisheries of Georgia are not so extensive as those of Florida as regards the value of boats, apparatus, etc., and the quantity and value of shad taken, as appears from the following series of tables showing the extent of the fisheries of Georgia by water-courses:

Statement, by water areas, of the number of persons employed in each branch of the shad fisheries of Georgia in 1896.

Waters.	Fishermen.				Total, exclusive of duplication.
	Drift-net.	Set-gill-net.	Bow-net.	Fall-trap.	
St. Marys River	60	10	.....	.....	70
Satilla River	7	.....	.....	.....	7
Altamaha River	162	128	30	.....	320
Ocmulgee River	.....	14	36	.....	36
Oconee River	.....	50	160	.....	170
Ogeechee River	160	.....	.....	.....	160
Savannah River	115	8	.....	3	125
Total	504	210	226	3	888

Statement, by water areas, of the boats, apparatus, etc., employed in the shad fisheries of Georgia in 1896.

Waters.	Boats.		Drift nets.			Set nets.			Bow nets, etc.		Shore property.	Total.
	No.	Value.	No.	Length.	Value.	No.	Length.	Value.	No.	Value.		
				Yards.			*Yards.*					
St. Marys River	65	$455	60	4,200	$900	5	425	$100	....	.....	.....	$1,455
Satilla River	6	30	3	450	60	....	....	....	....	.....	.....	90
Altamaha River	165	955	80	4,000	2,000	60	2,000	900	15	$45	$47	3,947
Ocmulgee River	19	95	....	.....	.....	8	80	24	18	54	.....	173
Oconee River	90	450	....	.....	.....	50	500	200	80	160	.....	810
Ogeechee River	84	3,200	80	10,667	5,000	....	.....	.....	....	.....	1,735	9,935
Savannah River	66	1,838	57	17,677	3,828	25	283	68	a26	208	1,035	6,977
Total	495	7,023	280	36,994	11,788	148	3,288	1,292	a26 113	208 259	2,817	23,387

a Fall traps.

Statement of the number and value of shad caught by each form of apparatus in the fisheries of Georgia in 1896.

Waters.	Drift nets.		Set nets.		Bow nets.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
St. Marys River	5,365	$933	895	$156	.....	.....	6,260	$1,089
Satilla River	1,500	240	.....	.....	.....	.....	1,500	240
Altamaha River	17,310	5,803	7,010	2,270	710	$229	25,030	8,302
Ocmulgee River	.....	.....	892	368	610	264	1,502	632
Oconee River	.....	.....	1,300	530	1,545	632	2,845	1,162
Ogeechee River	55,425	19,514	.....	.....	.....	.....	55,425	19,514
Savannah River	51,325	18,318	37	14	a 50	18	51,412	18,350
Total	130,925	44,808	10,134	3,338	a 50 2,865	18 1,125	143,974	49,289

a Fall traps.

SATILLA RIVER.

The shad fisheries of St. Marys River, between Florida and Georgia, have been described in the chapter on the fisheries of Florida. The most southerly river in Georgia is the Satilla, which rises in Irwin County, flows 200 miles through a level sandy region, and enters the ocean 18 miles north of the outlet of St. Marys River. It is navigable for 100 miles from the mouth, a small steamer plying between the river landings and Brunswick.

The commercial shad fisheries of the Satilla are of very recent origin, dating only from 1894, although prior to that year many shad were taken by the river men for their home use. Between Woodbine, 35 miles from the mouth of the river, and Baily Mills, 30 miles above, 3 drift nets were operated in 1896, each 150 yards long, with 5-inch mesh, and the catch approximated 650 roe shad and 850 bucks, valued locally at $240.

The catch in 1895 was about equal to that of 1896, while the yield in 1894 was only about one-half as much as in 1895 or 1896. Except sufficient for local use, all of the shad taken on this stream are sent by boat to Brunswick, Ga.

ALTAMAHA RIVER.

This river is formed by the junction of the Ocmulgee and Oconee rivers, on the line between Appling and Montgomery counties, and, after flowing a distance of 150 miles, empties into the ocean a few miles below the town of Darien, the river, with its many tributaries, being situated entirely within Georgia. The Altamaha is the most southerly stream flowing into the Atlantic whose sources are above the escarpment line, its two principal tributaries rising in the hills of northern Georgia. The total fall of the river from the junction of its head tributaries to Darien approximates 83 feet, an average of 7.6 inches per mile, this slope being nearly uniform. Its width varies from 150 to 800 feet, averaging about 300. It is navigable for vessels of 5 feet draft from the mouth to the junction of its two principal tributaries.

Although shad are quite abundant in the Altamaha, yet the shipping facilities are so unsatisfactory that the fisheries have never been developed, only enough for local use being obtained. These local fisheries extend from the mouth of the river to the junction of its two principal tributaries, but are most extensive in the vicinity of Darien and Doctor Town. The season is much later in the Altamaha than in the rivers south thereof, since the temperature of the water is generally lower, the Altamaha having its sources in the mountains, whereas the other streams rise in the sand hills and swamps near the coast. The forms of apparatus used are drift nets, set nets, and bow nets, named in the order of their importance as determined by the number of shad taken in 1896. Of 25,030 shad caught during that year, 17,310 were obtained in drift nets, 7,010 in set nets, and the remaining 710 in bow nets.

Drift nets are operated principally in the lower part of the river below Doctor Town, although a few are used above that settlement. Most of these are owned by Darien and Brunswick fishermen. In 1896 there were 162 drift-net fishermen on the river, using 80 nets, with a total length of 4,000 yards and valuation of $2,000, and the catch numbered 7,835 roe shad and 9,475 bucks, valued locally at $5,803.

The set nets on the Altamaha are used between Doctor Town and Seward, near the junction of the two tributary streams. These nets are each from 30 to 35 yards in length, with 5½-inch mesh, cost about $15, and require one boat, worth about $5, and 2 men. The total number of nets used in 1896 was 60, and the number of shad taken by them was 3,335 roes and 3,675 bucks, valued locally at $2,270.

Bow nets or skim nets are used in the upper reaches of the river above Doctor Town. Fifteen of these were operated by 30 men in 1896, the catch of shad numbering 310 roes and 400 bucks, worth $229, making the total yield on the Altamaha River in 1896 11,480 roes and 13,550 bucks, valued locally at $8,302.

Ocmulgee River.—This river is formed by the union of South and Yellow rivers about 20 miles below Covington, and thence flows about 300 miles to its union with the Oconee. The head of navigation was formerly at Macon, but at present navigation by steamboats with a draft

of 5 feet or more is confined to that portion below Hawkinsville, a length of about 150 miles. The descent of the river from Macon to its union with the Oconee is nearly 200 feet. At Macon it crosses the fall line in a shoal several miles in length, and above that city there are numerous shoals but no falls of great height until the extreme upper section of the river is reached. Shad ascend the Ocmulgee as far as Macon, but few are taken above Hawkinsville, and nearly all those caught on the rivers are obtained below Abbeville. The catch in 1896 is reported at 1,502, valued at $632, of which 892, worth $368, were taken in set nets, and 610, worth $264, in bow nets.

Oconee River.—This river rises among the hills of northeastern Georgia, the main stream being formed by the union of North and Middle forks, which unite below the town of Athens, at a height of 500 feet above sea level, whence it flows 280 miles to its union with the Ocmulgee. At present steamboats ascend to the crossing of the Oconee and Western Railroad, a distance of 108 miles; but the stream is navigable as far up as Milledgeville, 180 miles from the mouth, where it crosses the escarpment line at a height of 221 feet above sea level. On the Oconee shad are occasionally seen as far up as Milledgeville, but very few are caught above the town of Dublin, 108 miles above the mouth. Below Dublin they are obtained by means of set nets and bow nets, the reported catch in 1896 by the former being 600 roe shad and 700 bucks, worth $530, and by the latter form of apparatus 620 roe shad and 925 bucks, worth $632, a total of 2,845 shad, valued locally at $1,162.

OGEECHEE RIVER.

This river, the only one of importance between the Altamaha and Savannah, is located entirely in Georgia, rising in Greene County, and, after flowing a distance of 350 miles, empties into the Atlantic 38 miles above the entrance of the Altamaha and 16 miles below the mouth of the Savannah. It is navigable for vessels of 16 feet draft for a distance of 25 miles from the mouth, and 10 miles farther for vessels drawing 5 feet. Nearly the whole of the Ogeechee is located below the escarpment line, and it drains extensive swamps. Consequently it is not subject to sudden freshets, and the temperature of the water is generally much higher for corresponding dates than in the two adjacent streams, the Altamaha and the Savannah, which have their sources in the mountains. At the Shoals of Ogeechee, 200 miles from the ocean, where the river crosses the escarpment line, there is a wooden dam 225 feet long and 8 or 9 feet high, used in connection with a gristmill, and 4 miles above is a second wooden dam 280 feet long and 15 feet high, developing 150 horse-power for running a cotton factory. The foot of these shoals is the uppermost limit of the shad range, and very few pass above Millen, 100 miles from the sea.

The Ogeechee ranks first among the shad streams of Georgia, surpassing even the Savannah in the number and value of shad taken and yielding nearly twice as many as the Altamaha and tributaries. Owing

to the higher temperature of the water, shad run up the Ogeechee somewhat earlier than in case of the Altamaha or Savannah, but later than in the St. Johns, the fishing season beginning about the first week in January and continuing until the end of March. Practically all the commercial fishing is carried on with drift nets in the lower 22 miles of the river, the best fishing being near Harvey's Cut, about 10 miles from the sea. Most of the fishermen are non-residents of the river basin, many coming from Savannah and New England and living in house boats during the shad season. Savannah is the headquarters for the fishermen and the principal market for the catch.

The drift nets used on this river range from 200 to 600 feet in length, with 5 to 5¼ inch mesh, and cost from $40 to $135 each. Occasionally they are operated as set nets, being fastened across the current during a flood tide. The number in use in 1896 was 80, aggregating 10,667 yards in length and $5,000 in value. Eighty fishing boats, worth $2,800, and 4 house boats, worth $400, were used, and the catch numbered 22,225 roe shad and 33,200 bucks, valued locally at $19,514.

Several small set nets and bow nets are operated in the middle sections of the river in taking shad for local consumption, but no data are available with which to show the extent of the product.

SAVANNAH RIVER.

The Savannah has its sources in the mountains of western North Carolina, but the river proper is formed by the union of the Tugaloo and the Seneca rivers at Andersonville, S. C., and for a distance of 325 miles it forms the boundary line between Georgia and South Carolina, emptying into the sea a short distance below the city of Savannah. It is navigable for steamboats as far as Augusta, where it crosses the escarpment line. The difference in elevation at this point and at the city of Savannah is 108 feet and the distance 202 miles, giving a mean slope of 0.53 foot per mile. Between Savannah and Augusta there are no villages or considerable collections of houses, except at Pureysburg, S. C., about 23 miles above Savannah. The river averages about 300 feet in width in the lower 170 miles; thence to Augusta the width ranges from 500 to 900 feet. The bed of the stream is of sand, with coarse gravel and rock in limited quantities.

Seven miles above Augusta, where the river crosses the fall line, there is a large dam, developing one of the most important water-powers in the South. When originally constructed, in 1847, the dam was 5 feet high. In 1875 it was enlarged, the height varying from 6 to 15 feet, averaging 10.63, built of stone on a foundation of rock. It extends diagonally up stream for 1,000 feet, thence 720 feet directly across, and is provided with 4 waste weirs, 3 of them 20 feet wide and the other one 15 feet, which may be closed by needles. The dam is overflooded during freshets, the water sometimes standing 7 or 8 feet above its crest. Between the base of this obstruction and Augusta the river descends by a series of falls or rapids a vertical distance of 45 or

50 feet in 4 miles. Because of its injurious effect on the fisheries, this dam has caused much complaint from the residents of the river basin above Augusta. In 1883 a fishway was constructed in the South Carolina end of the obstruction, but its efficiency has never been apparent.

Shad enter Savannah River about the first week of January, and by January 20 the fishing season is well opened and continues until the middle of April, when shad become scarce and garfish so numerous and destructive to the nets that the fishery is abandoned. The commercial fisheries are prosecuted almost wholly by means of drift nets, the only additional apparatus being a few set nets, fall traps, and cast nets, which are operated mainly for other species of fish. Of the 51,412 shad taken by fishermen from the Georgia side of the river in 1896, 51,325 were caught in drift nets, 37 in set nets, and 50 in fall traps. In addition to the above, residents of South Carolina caught 2,974 shad by drift nets and 20 by cast nets, making a total catch in Savannah River of 54,406 shad, worth $19,236.

The principal fishery is in the lower portion of the river along the Georgia shore, and tributary to the city of Savannah, where there were 50 drift nets operated in 1896. These averaged 350 yards in length and 30 feet in depth, with 5¼-inch mesh, and cost about $75 each, requiring one boat, worth $35, and two men for each net. The catch averaged 1,000 shad to the net, this being greater than in any previous season during the past twenty years. The yield in 1895 was an increase over previous years, but the returns for 1896 were much greater than for 1895. Some fishermen attribute this increase to the building of the Government jetty at the mouth of the river, contending that the jetty breaks the force of the freshets and also, to some extent, prevents the fish from passing by the mouth of the Savannah and on to the streams further north. The channel over the bar has also been deepened considerably, and this may have had some beneficial effect. However, it should be noted that in all the streams of Georgia and Florida the catch in 1895 was somewhat larger than during the two or three years immediately preceding, and that the yield in 1896 was also greater than in 1895.

From the northern limit of the Savannah fisheries to the Augusta dam, a distance of 175 miles, the fisheries are prosecuted mainly for local consumption. Very few shad are taken in this length by residents of Georgia, only 23 fishermen being reported for 1896, using 7 drift nets, 25 stake nets, and 26 fall traps, and catching 1,412 shad. From the South Carolina side of the river 13 small drift nets were operated in 1896, yielding 2,974 shad, valued locally at $878. An interdiction exists against fishing with drift nets "from the rising of the sun each Thursday until the rising of the sun on each Monday," but no special effort is made to enforce this regulation.

A few cast nets, of the type common along the southern coast, are used immediately below the Augusta dam. They are operated only in comparatively shallow water where the bottom is free from snags and

bowlders, for if there be rocks or snags the net will "hang," permitting the fish to escape. The use of these nets has considerably decreased; in 1880 12 were reported, whereas in 1896 there were only 3, yielding but 20 shad.

The fall traps used in the rapids immediately below the Augusta dam are made by placing stones in two straight converging lines in the form of a V, but not meeting by 6 or 8 feet, thus constituting breakwaters and preventing the fish from passing except through the opening therein. Within this opening there is constructed a framework of wooden slats with high sides, the up-river end of which rests on the bottom, while the lower end is raised 5 or 6 feet. When the fish come within the influence of the current passing through this apparatus they are forced up on the slatwork and kept there by the strength of the current, the high sides preventing them from flopping over. The space between the slats is about 1 inch wide, permitting small fish to pass through. When the river is low it is difficult for shad to pass these obstructions, but during freshets, which are frequent in the shad season, the traps are submerged and the fish readily pass over them. The scarcity of shad during recent years has resulted in a decrease in the use of this form of apparatus and the profitableness of those now in the river results principally from the capture of catfish. In 1879 there were 110 fall traps, whereas in 1896 only 26 were reported, with an aggregate yield of 50 shad. In 1873 the average catch for each trap was reported at about 10 per day, and it was then stated to be very much less than several years before.

Several valuable seine fisheries formerly existed on the Savannah below Augusta, but none have been operated during the past twenty years. Compared with twenty or more years ago, the yield of shad in the Savannah is small, except in the extreme lower end of the river. A part of this decrease may be ascribed to the large amount of drift-net fishing in the vicinity of Savannah, where the stream is quite narrow and the amount of twine used therein almost completely obstructs the passage of fish. A second cause for the decrease is found in the limitation of the available spawning areas. The quantities of muddy water render the lower length of the stream unfavorable for spawning purposes, and the dam near Augusta prevents utilization of the area above that point, thus limiting the spawning-grounds to a few miles just below the Augusta dam, and within this restricted area the eggs are quickly eaten by the predaceous fish attracted thither.

The Savannah above the Augusta dam.—Above the Augusta dam there are several shoals, but the ascent is slight, being 109 feet in the 51 miles to Petersburg, Ga., an average of 2.1 feet per mile. Omitting Long Shoals Fall, where the river descends 53 feet in 10½ miles, the average for the remaining 40½ miles is less than 18 inches per mile. From Petersburg to Andersonville, S. C., a distance of 55 miles, the current is very swift, the total ascent between the two points being 288 feet. At Trotters Shoals there is a fall of 74.88 feet in 7 miles, and at

several other places falls of over 10 feet per mile occur, with very great velocity of current. In the early part of the present century shad annually migrated in quantities to the headwaters of the Savannah and throughout the Tugaloo, 49 miles in length, and for a distance of 10 miles up the Tallulah, an important tributary of that stream, where their farther progress was barred by Tallulah Falls, 384 miles by the river course from the sea. Since 1846 the dam above Augusta has acted as a barrier to the farther ascent of most of the shad that find their way to that point. The few that pass through the sluices are not sufficiently numerous to warrant commercial fisheries, but they are occasionally taken in apparatus set primarily for other species a distance of 80 or more miles above Augusta.

THE SHAD FISHERIES OF SOUTH CAROLINA.

The following tables show, by water-courses, the extent of each branch of the shad fisheries of South Carolina in 1896. The unusually large number of persons employed for the small number of shad caught is very noticeable, the average yield per man being less than 100 shad:

Statement of the number of men employed in the shad fisheries of South Carolina in 1896.

Waters.	Fishermen.					Total, exclusive of duplication.
	Drift-net.	Stake-net.	Seine.	Bow-net.	Miscellaneous.	
Savannah River	29	.....	.....	.....	*a* 6	35
Combahee River	.....	14	.....	.....	.....	14
Ashepoo River	.....	18	.....	12	.....	29
Edisto River	.....	84	35	159	.....	265
Cooper River	.....	4	4	24	.....	27
Santee River	.....	25	.....	110	.....	132
Winyah Bay and tributaries:						
Winyah Bay and Waccamaw River	518	.....	.....	.....	.....	518
Pee Dee River	4	.....	56	336	*b* 8	404
Lynch River	.....	.....	.....	50	.....	50
Black River	.....	.....	.....	130	.....	130
Sampit Creek	.....	.....	.....	42	.....	42
Total	551	145	95	863	14	1,646

a Cast-net fishermen. *b* Wheel and fall-trap fishermen.

Statement of the apparatus, etc., employed in the shad fisheries of South Carolina in 1896.

Waters.	Boats.		Drift nets.			Stake nets.		
	No.	Value.	No.	Length.	Value.	No.	Length.	Value.
				Yards.			*Yards.*	
Savannah River	17	$115	13	475	$238	.....	.....	.....
Combahee River	7	280	.....	.....	.....	14	907	$410
Ashepoo River	15	483	.....	.....	.....	17	1,297	590
Edisto River	127	2,490	.....	.....	.....	62	4,253	2,184
Cooper River	5	25	.....	.....	.....	3	200	35
Santee River	75	225	.....	.....	.....	32	1,733	127
Winyah Bay and tributaries:								
Winyah Bay and Waccamaw River	254	9,906	254	85,344	15,240	.....	.....	.....
Pee Dee River	188	746	4	128	12	.....	.....	.....
Lynch River	25	75	.....	.....	.....	.....	.....	.....
Black River	65	195	.....	.....	.....	.....	.....	.....
Sampit Creek	21	63	.....	.....	.....	.....	.....	.....
Total	799	14,603	271	85,947	15,490	128	8,390	3,346

Statement of apparatus, etc., employed in the shad fisheries of South Carolina—Cont'd.

Waters.	Seines.			Bow nets.		Miscellaneous.		Shore property.	Total value.
	No.	Length.	Value.	No.	Value.	No.	Value.		
		Yards.							
Savannah River	....	.....	.....	.....	.....	*a* 3	$7	$683	$1,043
Combahee River	....	.....	.....	.....	.....	....	.....	50	740
Ashepoo River	....	.....	.....	6	$15	....	.....	.....	1,088
Edisto River	12	973	$485	83	231	....	.....	350	5,740
Cooper River	1	42	70	24	68	....	.....	100	298
Santee River	....	.....	.....	55	138	....	.....	20	510
Winyah Bay and tributaries:									
Winyah Bay and Waccamaw River	....	.....	.....	.....	.....	....	.....	1,200	26,346
Pee Dee River	9	800	376	168	422	*b* 80	2,178	925	4,659
Lynch River	....	.....	.....	25	63	....	.....	.....	138
Black River	....	.....	.....	65	164	....	.....	.....	359
Sampit Creek	....	.....	.....	21	54	....	.....	.....	117
Total	22	1,635	931	447	1,155	....	2,185	3,328	41,038

a Cast nets. *b* Wheel and fall traps.

Statement of the yield of shad in each form of apparatus employed in the fisheries of South Carolina in 1896.

Waters.	Drift nets.		Stake nets.		Seines.		Bow nets.		Miscellaneous.		Total.	
	No.	Value.	No.	Val.	No.	Val.	No.	Val.	No.	Val.	No.	Val.
Savannah River	2,074	$878	.....	.....	.....	.....	.....	.....	*a* 20	$8	2,094	$886
Combahee River	.....	.....	3,090	$622	.....	.....	.....	.....	.....	.....	3,090	622
Ashepoo River	.....	.....	6,400	1,254	.....	.....	480	$127	.....	.....	6,880	1,381
Edisto River	.....	.....	21,967	4,281	2,034	$640	3,672	922	.....	.....	28,273	5,843
Cooper River	.....	.....	80	25	20	7	296	94	.....	.....	396	126
Santee River	.....	.....	2,065	433	.....	.....	5,244	1,114	.....	.....	7,309	1,547
Winyah Bay and tributaries:												
Winyah Bay and Waccamaw River	80,069	18,454	.....	.....	.....	.....	.....	.....	.....	.....	80,069	18,454
Pee Dee River	190	73	.....	.....	1,608	460	7,759	1,984	*b* 694	212	10,251	2,729
Lynch River	.....	.....	.....	.....	.....	.....	820	236	.....	.....	820	236
Black River	.....	.....	.....	.....	.....	.....	5,825	1,439	.....	.....	5,825	1,439
Sampit Creek	.....	.....	.....	.....	.....	.....	720	173	.....	.....	720	173
Total	83,233	19,405	33,602	6,615	4,262	1,107	24,816	6,089	714	220	146,027	33,436

a Cast nets. *b* Wheels and fall traps.

COMBAHEE AND ASHEPOO RIVERS.

The small shad fisheries operated from the South Carolina side of Savannah River have been described in the chapter on the fisheries of Georgia.

Between the Savannah and Edisto rivers there are several small streams, of which only two are entitled to extended notice in connection with the shad fisheries—the Combahee or Salkiehatchie and the Ashepoo. The former rises in Aiken County and is navigable for rafts and light flatboats from the sea to Tobys Creek, near Barnwell, a distance of 110 miles. The second of these streams, the Ashepoo, is situated entirely within Colleton County and has a length of about 60 miles. It was formerly navigable for rafts as far as Walterboro, but the exhaustion of the turpentine forests and the completion of the railroad have reduced navigation to a minimum, resulting in the channel being badly obstructed by brush and driftwood.

Shad ascend Combahee River to Walker and Ashepoo River as far as Walterboro, a distance of 85 and 50 miles, respectively, but the fisheries are centered at the crossings of the Charleston and Savannah Railroad. The shad season in these two streams corresponds with that on the Edisto, running from January 15 to March 31, and the forms of apparatus are similar. The number of set gill nets and stake nets on the Combahee in 1896 was 14, and on the Ashepoo 17 nets were used. The catch by the former was 3,090 shad and by the latter 6,400.

The following shows, for a series of years, the number of shad taken by an average gill-net boat on the Combahee and the Ashepoo rivers, respectively:

Years.	Combahee River.	Ashepoo River.	Years.	Combahee River.	Ashepoo River.
1889	.....	1,190	1893	356	978
1890	.....	806	1894	552	1,006
1891	538	1,404	1895	462	1,133
1892	368	1,044	1896	531	936

In addition to the foregoing 480 shad are reported as having been taken by means of bow nets in the upper reaches of Ashepoo River, where the narrowness of the channel causes the fish to ascend almost in single file. Some shad are taken by the same form of apparatus in the upper portion of the Combahee, but the difficulties of ascending that stream, at the time of my visit to the lower portion, precludes a statement of the extent of that small fishery. The bow net used on these rivers consists of a frame of light but tough wood, bent and secured in a long oval shape, the longest diameter of which is 10 to 14 feet. Within this frame is loosely fitted a shallow bag of hemp twine, the entire cost of the frame and twine being about $2.50. Two men are required for each net, one of whom propels the boat, while the other, stationed in the bow, manipulates the net.

A few shad are taken on New, Colleton, and Coosawhatchie rivers by the resident planters and timbermen, using bow nets and an occasional gill net, the catch being small and consumed locally. The small extent of the shad fisheries of those streams (the total yield probably not exceeding 1,000 shad) did not warrant a personal investigation.

EDISTO RIVER.

Edisto River, the second in rank among the shad streams of South Carolina, lies wholly within the limits of that State. It is formed by the junction of North and South Forks in the southern part of Orangeburg County, and thence to the ocean it measures 183 miles, although in a straight line this distance is not over 75 miles. The channel is encumbered with drift logs, overhanging trees, and shoals of loose, shifting sand, occasionally varied by hard clay. There are no falls of note on the Edisto, and aside from the trees and shoals there are no obstructions to the ascent of fish from the mouth of the stream to Davis Bridge on the South Fork, and on the North Fork to Jones Bridge, a distance

of 49 miles above Orangeburg and 98 miles from the junction of the two streams. The rafting of timber on this stream, as on many other Southern rivers, exerts a beneficial influence by tending to keep an open passageway for the ascent of fish through the driftwood, overhanging brush, etc.

The commercial shad fisheries on the Edisto extend from near the mouth of the river to Orangeburg on the North Fork, yet they are most extensive near Jacksonboro, at the crossing of the Charleston and Savannah Railroad. They are prosecuted largely by negroes from Charleston, but the number of natives engaged has increased during recent years. The set-gill net is the principal apparatus used, and a few bow nets and seines are employed, especially in the upper reaches of the river, the latter forms of apparatus being used mainly by the natives. The principal gill-net grounds extend from 12 miles below Jacksonboro to 2 miles above that station.

The gill nets are made of No. 40 twine, with 5¼ to 5½ inch mesh, and cost about $35 each. At each end of the net is a rod several feet in length, anchored at one end to keep it upright, and attached by means of a rope bridle to a fixed stake or tree trunk on the shore. The size of the nets varies, but averages about 35 fathoms long "in gear," and 40 meshes deep. They are made, however, to fit the channel of the river, stretching almost from bank to bank and reaching to the bottom, forming a serious impediment to the passage of fish. On account of the clearness of the water fishing can be carried on only at night, thus leaving a free passage for shad during the daytime. The nets are usually not less than 300 yards from each other. In the lower part of the river, where the tide-current is strong, they are put out at three-fourths flood and taken in at one-fourth ebb. The season opens about January 10 and closes the end of March, the greater portion of the catch being made in February. By a State law the time for fishing with gill nets is further restricted to four days of the week, from the rising of the sun each Monday to the setting of the sun each Thursday.

In 1896, 84 men engaged in the gill-net fishery on the lower portion of the Edisto, using 42 boats, worth $2,130, and 62 nets, worth $2,184. The catch amounted to 11,132 bucks and 10,835 roe shad, with a local valuation of $4,281, and in addition thereto 5,258 hickory shad were taken. In 1880 the number of net fishermen was reported at 150 and the catch of shad at 90,000 pounds. In 1890, 48 nets took 30,100 shad. The following record of the catch of one gill-net boat on the Edisto River, from 1885 to 1896, inclusive, is presented as a fair showing of the relative abundance of shad during that period:

Year.	No. of shad.	Year.	No. of shad.
1885	568	1891	1,981
1886	1,180	1892	1,376
1887	1,559	1893	1,095
1888	1,325	1894	1,133
1889	1,702	1895	740
1890	2,036	1896	1,150

In addition to the gill-net fishery, a number of shad are taken on the Edisto by means of small seines and bow nets. In 1896 there was 1 seine operated about 10 miles below Jacksonboro and 8 between that station and Branchville. These seines are 35 to 70 yards long, 3-inch mesh, of No. 9 cotton, and worth on an average from $30 to $45 each. Their catch of shad numbered 2,040, of which 1,080 were bucks. In addition to these, a quantity of hickory shad, striped bass, bream, perch, herring, etc., were taken. Above Branchville 3 seines were used, taking 594 shad in 1896. Hickory shad are caught in considerable numbers at Gibham Ferry and at other points below Branchville, but above that village none are reported.

Bow nets are used by the native planters and woodsmen all along the river from the mouth to the upper limits of Orangeburg County. In 1896 83 were used, by means of which 3,672 shad and 500 hickories were taken, the shad selling at 20 to 40 cents each and the hickories at 5 and 10 cents each. This fishery is carried on generally at night, beginning between 7 and 10 o'clock. Some of the catch is sent to Columbia, but the greater proportion is sold for local use.

CHARLESTON HARBOR AND TRIBUTARIES.

Between the Edisto and Santee rivers are several streams having a common outlet at Charleston, the most important being Cooper, Ashley, and Wando, each of which is small and navigable only for short distances from Charleston. A few shad ascend each of these rivers, but the fisheries are extremely local and limited in extent. Near Monks Corner, at the entrance of the Santee Canal into the west branch of Cooper River, and at several other places on the same river a few shad are taken each year by bow nets, pump nets, gill nets, and seines. In 1896 the total number of shad taken on that stream was 396, of which 216 were caught by pump nets, 80 by bow nets, and the remainder by means of gill nets and seines.

The pump net resembles the bow net somewhat in the principle of its operation, and it is also similar to the contrivances operated from the piers at Chicago. A pole 20 feet long, having suspended from its outer end a pair of cross-sticks, to which is fastened a net 10 feet square and with 2½-inch mesh, is "pumped," like a well sweep, on a forked post fixed on the bank of the river.

A few shad are taken in the East Branch of Cooper River and in the lower section of the Wando and Ashley, but the catch is so small as to not warrant an extended investigation in those streams.

SANTEE RIVER AND TRIBUTARIES.

The Santee is formed by the junction of the Congaree and Wateree at a distance from the ocean of 90 miles in a straight line, but, following the sinuosities of the stream, a distance of 184 miles. The river is navigable its entire length, the width at low water varying from 200 to 500 feet, and the fall being less than half a foot per mile. There are

no villages nor considerable collections of houses along the river, the banks being lined with extensive swamps and forests.

On account of the lack of transportation facilities and the limited population in the vicinity, the fishery resources of the Santee have never been developed. The planters and woodsmen along the banks of the stream catch a few shad with bow nets and set gill nets for local use, and near the crossing of the Northeastern Railroad at St. Stephen there is some fishing for distant markets, but the business is inconsiderable. During the year 1896 the shad taken on the river below Wright Bluff, 120 miles from the ocean, numbered 7,309, of which 5,244 were taken by bow nets and 2,065 by gill nets. The small extent of the fisheries did not warrant ascending the river above Wright Bluff, and no reliable account exists of the small catch between that point and the junction of Congaree and Wateree rivers.

Wateree or Catawba.—This river, the principal tributary of the Santee, rises among the Blue Ridge Mountains of North Carolina and follows a winding course of over 400 miles before its union with the Congaree. Shad ascend the Wateree in some numbers as far as Camden, 252 miles from the ocean, and a few are at times taken at the foot of Great Falls, 20 miles farther up, where, in a distance of 8 miles, the fall of the river aggregates 173 feet. It does not appear that shad ever passed above Great Falls in large numbers, if at all. The steep slope of the Wateree above that point, its comparatively small volume of water, and its numerous falls and shoals would seriously impede the progress of shad even if provision were made for their passage above that obstruction.

Congaree River.—The Congaree is formed by the junction of Broad and Saluda rivers, 49 miles above its union with the Wateree. Shad were formerly taken on this river in considerable numbers in the shoals near Columbia, and some ascended each of the main tributaries many miles farther. On Broad River a few stragglers ascended as far as Green River, 141 miles above Columbia and 28 miles above the boundary line between North and South Carolina, or 374 miles from the ocean. The elevation of the mouth of Green River is about 758 feet above sea level, and of the Congaree at Columbia about 135 feet. At present the dam at Columbia appears to be the upper limit of the shad run. No reliable data exists as to the number of shad taken on Wateree and Congaree rivers in 1896, but it was probably less than 2,000.

In 1883 a fishway was constructed over the Columbia dam, consisting of 3½ sections, 36 feet long, with a total rise of 9 feet. It is substantially built and is of the type known as the McDonald Fishway, consisting of two sets of buckets, straight-wooden buckets to receive the water in its downward flow and curved-iron buckets to direct this water back up stream, thus affording a comparatively quiet waterway. It is fairly efficient for certain species when kept free of trash, but shad do not appear to use it.

WINYAH BAY AND TRIBUTARIES.

Winyah Bay, the confluence of Waccamaw, Pee Dee, Black, and Sampit rivers, is one of the principal shad-producing regions of the Southern States. This bay possesses characteristics to be found at the mouths of many of the large streams in the South. The length approximates 12 miles, the width ranging from ¾ to 4 miles, and the bottom is of shifting sand, in which numerous channels have been washed by the tide.

From the outer entrance of the harbor to Georgetown, a distance of 14 miles, also for 30 miles up the Waccamaw and at the mouths of Sampit and Black rivers, the water is well filled with drift nets from the middle of January to the end of March, this being the only apparatus used for taking shad. In 1896, 254 drift nets were used in the waters tributary to Georgetown, the length ranging from 200 to 600 yards, with mesh from 5⅛ to 5¾ inches, and depth from 40 to 60 meshes. Two men are required for each boat, the men being mainly negroes, many of whom find employment during the rest of the year in the rice fields or the turpentine woods.

The season begins usually during the second week in January and continues until some time in April, with the weekly close times operative in this State.

The catch in 1896 numbered 40,411 roe shad and 39,658 bucks, the local value being $18,454. In addition, 14,246 hickory shad were taken, worth $1,068. Most of the latter were females, the large mesh of the nets permitting the buck hickories to escape. This fishery has not been profitable for several years, the total receipts barely paying for the twine used.

The season in 1896 closed earlier than usual, the low prices in the Northern markets not warranting shipments after the first week of April. In the first part of the season the buck shad largely outnumber the roes, but later the proportion is reversed, resulting in about an equal division between the two. The following shows the number of each sex handled monthly by one Georgetown firm in 1896:

Month.	Buck shad.	Roe shad.	Per cent of bucks.	Per cent of roes.
January 11–31	2,939	452	86.67	13.33
February	12,603	5,232	70.66	29.34
March	3,133	17,345	31.92	68.08
April 1–3	30	152	16.48	83.52
Total	23,705	23,181		

The shad fisheries of Winyah Bay are of comparatively recent development, being the result of the tendency in the fisheries on all of the Atlantic coast streams toward concentration at points nearest the mouth possessing the most convenient shipping facilities, and yet where the river is sufficiently narrow to render very costly apparatus unnecessary.

The following summary shows, for certain years, the number of drift nets and the total and average catch of shad per net in the vicinity of Georgetown:

Year.	Number of nets.	Number of shad taken.	Average per net.
1880	30	26,000	867
1889	220	90,000	409
1890	150	86 719	578
1896	254	80,069	315

The tributaries of Winyah Bay are Waccamaw, Pee Dee, Black, and Sampit rivers, all having shad fisheries of more or less importance, and which will be described successively.

Waccamaw River.—Waccamaw River has a total length of 149 miles, the lowest 26 of which forms the main channel of Pee Dee River, and is of considerable size. For the succeeding 24 miles, to Conway, it is navigable for vessels of 7 feet draft, while steam navigation with 3 feet draft is carried on 68 miles farther, to Reeves Ferry, N. C., 31 miles from Lake Waccamaw, the head of the river.

In its lower portion, below Brook Green, the shad fisheries of the Waccamaw are of much importance, a large number of drift nets being used. These are tributary to Georgetown, and have already been noted in the description of the fisheries of Winyah Bay. The nets are from 200 to 300 yards long, 16 to 20 feet deep, with 5¼ to 5½ inch mesh. In 1896 the season began January 18 and ended somewhat later than in Winyah Bay. It was noticed during that season that the greater part of the shad were taken near the ends of the nets, the fish crowding the river banks rather than following the channel.

Above Brook Green shad are taken by means of bow nets by the planters and woodsmen living along the stream as far up as Conway, and occasionally at Red Bluff, 30 miles farther; and a few are sometimes taken even beyond the North Carolina line, over 100 miles from Georgetown by the river course. Other than that tributary to Georgetown, the shad fisheries of Waccamaw River are of small importance, and the inconvenience of ascending the river at the time of my visit renders it impracticable to present an exact statement of their extent. It is probable, however, that not exceeding 500 shad annually are taken on this stream above Brook Green.

PEE DEE RIVER AND TRIBUTARIES.

This is a river of many names. The lower 26 miles is known as Waccamaw River; next comes a length of 25 miles known as Bull Creek, the name Pee Dee being given to a series of small creeks and ponds from the head of Bull Creek to Winyah Bay. The succeeding 250 miles, from Bull Creek to the Narrows, is known as Pee Dee River, or the Great Pee Dee, to distinguish it from one of its tributaries called the Little Pee Dee. The name Yadkin River is applied to the 210 miles of

length above the Narrows. In this report the name Pee Dee is applied to the entire stream above Waccamaw River.

The Pee Dee is one of the principal streams on the southern coast. It rises on the eastern slope of the Blue Ridge in Watauga County, N. C., and before its entrance into Waccamaw River flows a distance of about 485 miles, of which 213 miles are in South Carolina and 272 miles in North Carolina. It is navigable for steamers of 3½ feet draft for a distance of 230 miles above Georgetown, two steamers running regularly and going as high as Cheraw when practicable. In discussing the fisheries of this stream it is natural to divide it into three sections—(1) the lower 204 miles of the river, being from the Waccamaw to the lowest dam near Cheraw, covering the navigable portion; (2) from Cheraw to the Narrows, a distance of 71 miles, containing numerous dams and other obstructions to the passage of fish; and (3) the 210 miles above the Narrows, known as the Yadkin.

From the Waccamaw to Cheraw.—The lower portion of the Pee Dee possesses the usual characteristics of South Carolina streams. The banks are low and swampy, occasionally varied by bluffs; the width varies from 150 to 300 feet at low water, and the slope averages 0.279 foot per mile. The course is extremely winding, being almost a continuous series of semicircular curves, requiring 203 miles to traverse from the Waccamaw to Cheraw, whereas in a straight line the distance is less than 100 miles.

Shad are obtained throughout this length of the Pee Dee, but in no great abundance at any point. From the Waccamaw to Mars Bluff they are at present taken only by means of bow nets; drift nets have been used to some extent, but the numerous logs and snags in the river prevent the successful prosecution of that form of fishery. From Hunt Bluff to Cheraw, a distance of 50 miles, seines and drift nets are employed. During 1896 the total number of shad taken on this length of the river was 8,967, of which 7,759 were taken by bow nets, 1,018 by seines, and 190 by drift nets.

The bow nets are employed most extensively at Smith Mills, Dunham Bluff, Savage Landing, Stone Landing, Drewit Bluff, Birch Ferry, and Crawford Landing. The season begins about February 10 and lasts generally 2½ months, the catch ranging from 20 to 200 shad per boat. It is said that twenty years ago the boats usually caught 20 to 40 shad each per night. In 1890 the average catch per boat for the entire season approximated 114, and during 1896 the average for the 168 bow nets used between the Waccamaw and Mars Bluff was 46 for the season. The catch in 1895 was considerably more than in 1896, but in 1894 it was somewhat less than in 1895 on account of the prevalence of low water in this portion of the river.

Between Hunt Bluff and Cheraw there were formerly numerous seine fisheries, but on account of the increased scarcity of shad these have been greatly reduced, both in number and in size. The lowest is at Hunt Bluff, 15 miles below Society Hill, where two small seines

were used in 1896, yielding 152 shad. About 10 miles above Hunt Bluff is another seine bar, where two short seines were used in 1896, the catch approximating 56 shad and 1,000 hickories. Just above Douglass Falls and about 3 miles below Society Hill a small seine was used, catching 22 shad and 280 hickories. About 4½ miles above Society Hill and 17 miles below the lowest fishing dam a double-seine fishery was operated, the catch numbering 790 shad, of which 470 were bucks. The season was quite short, extending only from March 1 to April 5. It thus appears that in 1896 there were but 4 seine fisheries operated below Cheraw, yielding 1,018 shad, of which 594 were bucks. If the present scarcity of shad continues, even these fisheries will doubtless soon be abandoned.

In the neighborhood of Society Hill there are 4 drift nets, used by as many negroes, in the capture of shad. These nets are 32 yards long and have 5½-inch mesh. On account of the clearness of the water it is necessary that the fishery be carried on at night instead of during the daytime. The season begins March 1 and lasts about six weeks, the men fishing about four nights each week. In 1896 190 shad were taken, of which 103 were bucks. Between Society Hill and Cheraw shad are first taken by both seines and drift nets about six weeks later than in the vicinity of Georgetown, and as the distance is 230 miles, it appears that they travel about 5½ miles per day.

From Cheraw to the Narrows.—The second of the three sections into which it has been found convenient to divide Pee Dee River extends from Cheraw to the Narrows, a distance of 71 miles.

Throughout this length of the river the current is quite swift, the descent being about 355 feet, an average of 5 feet to the mile, but in places exceeding 20 feet to the mile. There are numerous fishing-dams along this stretch of the river, with from 1 to 2 feet fall. The dams are constructed of rough stone masonry, or by filling a log cribbing with rocks, at convenient points where the river is narrow and shoal, the cost ranging from $100 to $1,500 each. While these dams frequently extend across the stream, there are generally thoroughfares around them, and at high water, which usually prevails during the shad season, they are partly submerged, permitting many fish to pass over. Numerous sluices are left for the passage of water, in which are placed the fall traps and wheels for catching the fish.

The fall traps differ little from those in use in many of the Atlantic coast streams, and, being placed so as to catch the fish going down the river, take very few shad during the upward run. They are 25 to 30 feet long, 6 to 8 feet wide, with a descent of about 5 feet, and cost from $20 to $60 each.

The wheels, which are intended especially for shad, are somewhat similar to those used in the Columbia River salmon fisheries. They are said to have been introduced in the Pee Dee about 1846, antedating by over thirty years those used on Columbia River. They consist of two or more curved wings, 5 to 7 feet long, attached to a rotary shaft

fixed in the sluiceway. The wings consist of wooden frames covered with small slats or twine and so arranged that, the wheel being fixed in the sluice and rotated by the downward current of water, the fish ascending the stream are caught and carried up by the wings and shunted into a box or barrel placed at the side of the wheel, whence they may be removed at leisure. The entire apparatus is constructed quite cheaply, costing about $6. In addition to shad these wheels take suckers, catfish, redhorse, white perch, carp, etc., the value of the annual catch being from $50 to $300 at each fishery.

The lowest of the fishing-dams on Pee Dee River is about 1 mile above Cheraw and consists of 1 wheel and 3 fall traps, the length of the dam being 280 yards. The catch at this fishery in 1896 was 100 shad. About 2 miles farther up is a dam 100 yards long containing 2 wheels and 2 fall traps, yielding 96 shad in 1896. Each of these fisheries is small and only imperfectly obstructs the passage of fish.

About 4 miles above the lowest dam is a seine fishery, at which two seines, each 100 yards in length and with 2-inch mesh, are operated in the spring. In 1896 they were hauled from March 15 to April 30, about 18 times each per day during five days of each week, catching shad, redhorse, carp, fat-backs, suckers, etc. The yield of shad was 280 roe and 310 buck, against a total of 300 in 1895.

Three miles above this seine bar is a fishery, which yielded 120 roe and 136 buck shad in 1896. In 1895 it consisted of 14 wheels only, but in 1896 it had 23 wheels and 3 fall traps. A mile or so above the preceding, is the Pollock fishery, containing 23 wheels and 7 fall traps. In 1896 it yielded 102 roe and 108 buck shad. Less than 2 miles above is the Pegues fishery, a half mile below the North Carolina State line, and containing 13 wheels and 3 fall traps which yielded in 1896 18 roe and 14 buck shad. These fish-dams make pools above them 2 feet deep, and back the water up about half a mile.

One mile above the North Carolina line is the Manship fishery, entirely crossing the river, containing 22 wheels and 7 fall traps, and yielding 5 roe and 7 buck shad in 1896, and about 95 shad in 1895. The Dockery fishery, containing 14 dippers and 2 fall traps and yielding 1 roe and 1 buck shad in 1896, and about 60 shad in 1895, is located a short distance below the Carolina Central Railroad bridge, 8 miles above the South Carolina line.

Six miles above the railroad bridge comes the Ingram fishery, consisting of 10 wheels and 3 fall traps. The dam at this fishery entirely crosses the river proper, but fish may ascend by a small thoroughfare which passes around an island at this point. No shad were taken here in 1896; in 1895 the catch approximated 125, of which about 40 per cent were roe. This fishery was established about 1865, it originally containing but 8 dippers, the catch at that time averaging about 5,000 shad annually, selling at from 5 to 6 cents each. From 1890 to 1894 the annual yield was about 300 shad.

Next comes the Grassy Island fishery, 17 miles above the South Carolina line and 25 miles above the lowest dam near Cheraw. This contains 25 wheels and 2 fall traps, the yield in 1895 being 305 shad, but only 2 in 1896, both of which were bucks. This appears to be the highest point to which shad ascended the Pee Dee in 1896. The catch during the first season following the establishment of this fishery, about 1875, approximated 17,000 shad. A short distance above the Grassy Island fishery is the Upper fishery or the Grassy Island Upper fishery, consisting of 14 dippers and 3 fall traps. There is a small island in the river at this point and 12 of the dippers and 2 traps are located in the main channel of the stream, and 2 dippers and 1 trap in the side channel. These caught 192 shad in 1895, but none whatever in 1896.

Joseph Aldman's fishery, 50 miles above Cheraw and 21 miles below the Narrows, containing 2 wheels and 2 fall traps, has yielded no shad since 1894, when it caught 1 buck. Ten to twelve years ago this fishery yielded about 100 shad each season. A number of fishing-dams in this vicinity have been permitted to go to waste on account of the scarcity of fish. Sampson Parker has a fishery 13 miles below the Narrows and 58 miles above Cheraw which contains 3 wheels and 1 fall trap, the dam entirely blocking the river. This fishery took no shad in 1896 and only 2 buck shad in 1895. This is the highest point on the river at which shad have been taken since 1892. Six miles below the Narrows is Kirk's fishery, consisting of a dam partly blocking the river, containing 2 fall traps, which have taken no shad during the last five years.

At the Great Falls or the Yadkin Falls, 2 miles below the Narrows, there are 3 dippers, which have yielded no shad since 1892. A fishery of 2 or 3 dippers, about 1 mile below the Narrows, has taken no shad since 1891. In the case of the two latter there are no artificial dams, the dippers or wheels being located in the favorable sluices in the rocky course of the river, and in no case do they entirely block the channel. Numerous other dams formerly existed in this length of the river, especially between Grassy Island and Great Falls, but the unprofitableness of the fishery has led to their abandonment.

It thus appears that from Cheraw to the Narrows, a distance of 71 miles, there are at present 16 wheel and fall-trap fisheries, which more or less effectually obstruct the free passage of fish. All of these were originally constructed for catching shad, but in 1896 not a single shad was taken in the upper six fisheries, only 4 in the next three, and the total yield of shad in the 16 was but 710, of which 342 were females. In 1895 the catch in the same apparatus was 2,229 shad. The decrease was especially apparent above the Broach and Quick dam, the catch above that point being 258 in 1896 against 1,469 in 1895. The catch from the Broach and Quick dam to the lowest dam, including Sherrel's seine bar, was 1,042 shad in 1896 and 1,060 in 1895. It should be noted that the Broach and Quick dam was enlarged in 1895 so as to

extend quite across the stream. and that the lowest dam was not completed until 1896.

The Narrows is a remarkably picturesque series of rapids confined between high cliffs, with a length of about 4 miles and a total descent of 105 feet. Forty years ago Judge Locke had six or eight fishing "stands" in the Narrows each year, which are reported as having yielded on certain days as high as 300 shad each. Many of these were sold fresh to hucksters, who disposed of them in the neighboring settlements, and the rest were salted for use on the plantations.

Mr. Wesley K. Littleton has maintained a fishery there since 1880, having in that year 2 dippers or wheels, which caught about 300 shad in the season, lasting during March, April, and May. The catch has decreased constantly since 1880. In 1892 only 2 shad were taken, and none whatever since then, although the fishery has been increased to 7 dippers.

From the Narrows to the headwaters.—From the head of the Narrows to the Richmond and Danville Railroad bridge near Salisbury, a distance of 43 miles, the Pee Dee has a width of 500 to 1,800 feet, a depth usually of less than 3 feet, and an average slope of over 5 feet per mile, and contains a dozen or more shoals with plunges from 1 to 6 feet. Prior to 1890 shad were occasionally taken in the numerous fish-dams located in this length of the river, but I have learned of none whatever being taken since that date. The catch consists principally of redhorse, suckers, carp, fatbacks, etc.

From the Richmond and Danville Railroad bridge to the foot of Bean Shoals, a distance of 64 miles, the river has an average slope of a little over 2 feet per mile, the elevation at the foot of Bean Shoals being 725 feet above sea level. In this stretch there are numerous fish-dams, several occupying the full width of the river, and a number of shoals, none of which have a vertical fall of more than 2½ feet. From the foot of Bean Shoals to Wilkesboro, a distance of 57 miles, the slope approximates 3 feet per mile. This stretch of the river contains 25 or more old fish-dams, and but few vertical falls of more than 1 foot. The elevation of the river at Wilkesboro is about 931 feet above sea level. Col. John A. Holt, of Salisbury, N. C., reports that thirty or forty years ago shad were caught in considerable numbers at the various fisheries between Salisbury and Bean Shoals, occasionally at Bean Shoals, and rarely at Wilkesboro. Needless to state, they have not been seen in these waters for many years, the extensive fisheries and the numerous dams below preventing their ascent.

Lynch River.—Of the numerous tributaries of the Pee Dee, Lynch River affords the longest run for shad. This river rises in Union County, N. C., and after flowing a distance of 200 miles enters the Pee Dee about 86 miles above Georgetown. The stream is quite shallow and narrow and its drainage small; at one point near its mouth it is but 20 feet in width, and at numerous other points the water is not over 1 foot deep. A small skiff can not navigate the river without

frequently stopping to haul over obstructions. Notwithstanding the adverse physical conditions, Lynch River is well adapted to shad, and those fish ascend as far up as Tilley Ferry, 125 miles above the mouth, and are taken in considerable numbers at Cartersville and lower points. Bow nets only are used, and as there are no important settlements on the river the fisheries are of small extent, the number of shad obtained below Cartersville in 1896 being 820, the nets used numbering 25.

Little Pee Dee River.—Little Pee Dee River, one of the principal tributaries of Pee Dee River, rises in the southern part of North Carolina, and after flowing 75 miles enters the Pee Dee about 56 miles above Georgetown. So far as could be learned, no shad whatever are caught on this stream, nor have they ever been obtained there in large numbers, due, probably, to the fact that the Little Pee Dee is sluggish, with abundant seepage, the river course broadening in many places into small lakes.

Black River.—Black River has its sources in Kershaw and Sumter counties, flows over 150 miles, and enters Winyah Bay near Georgetown. From the mouth to Pine Tree Landing, a distance of 45 miles, the river is deep and navigable for vessels of 10 feet draft. Thence to Potato Ferry, 11 miles distant, it is shoal, averaging not over 3 feet in depth, and the bottom rocky. Above Potato Ferry the water is less than 1 foot in depth at low stages.

Shad are taken on this stream as far up as Mouzans, over 130 miles from Georgetown, and considerable fisheries exist below Harpers, especially in the neighborhood of Pine Tree and Pitchkettle. Except in the extreme lower end, bow nets only are used, the number employed in 1896 being 65 and the catch amounting to 5,825 shad, of which 3,545 were roes. The yield on the Black River has very much decreased in recent years, as is also the case with most of the rivers tributary to Winyah Bay. Twenty years ago 25 to 30 shad were nightly taken by each bow net, whereas in 1896 the average catch was but 2 to 4 per night. The catch in 1896 was much less than in 1895.

The shad season on the Black River begins about February 10, one month later than in Winyah Bay. Several drift nets are used near the mouth of the Black River, but these have been included with the fisheries of Winyah Bay.

Sampit River.—The Sampit is a small stream rising in Sampit Swamp and entering Winyah Bay just below Georgetown. In the lower part a few drift nets are used by Georgetown fishermen, but these have been listed with the Winyah Bay fisheries. The planters and woodsmen for a distance of 20 miles up the river use bow nets, taking sufficient shad for local use, the catch in 1896 numbering 720, of which 60 per cent were bucks. Mr. D. B. Bourne, of Sampit, reports that shad are as abundant in this stream at present as they ever were.

The fisheries of Winyah Bay and tributaries have been described with much detail, as they represent the modified conditions that are more or less in evidence in most of the Atlantic coast streams, the cor-

rect understanding of which is quite important. Formerly the shad fisheries of these waters extended as far up as Bean Shoals, on the Upper Pee Dee, a distance of 382 miles from the ocean. There was no concentration at any particular point, and the local demand that existed in any section did not warrant the prosecution of the fisheries so vigorously as to cut off the run of shad at points above. About 1846 the use of dams for catching shad was introduced in this river, and during the first few years following the adoption of this form of apparatus large catches were made. It is reported that 17,000 shad were taken at one dam during the season immediately following its construction, and it is probable that prior to 1860 the catch in that portion of the Pee Dee located above the North Carolina line numbered over 100,000 annually. The multiplication of dams resulted in shutting off the fish from the upper reaches of the river, where the best spawning-grounds are located, and the run so decreased that in 1896, as already shown, only 16 shad were taken in that section.

A no less important change has occurred in the lower half of the river. The profits derived from shipping fish to northern markets have resulted in a concentration of the fisheries at the point nearest the mouth of the river where the most convenient shipping facilities exist. This not only secures the shad much earlier than if the fisheries were prosecuted at a distance from the mouth, but it affords an unobstructed passage from the ocean, the run not being cut off by other fisheries. Of the 97,685 shad taken in Winyah Bay and tributaries in 1896, 82,500, or 85 per cent, were caught within 30 miles of the ocean, practically none of which had spawned. Of the remaining 15,185 taken at a greater distance from the ocean, the percentage that had spawned is, indeed, very small. This has so reduced natural reproduction as to make it almost an insignificant factor in keeping up the supply, and renders artificial propagation essential to the prosperity of the fisheries.

The inquiry on the Pee Dee was begun at Salisbury, N. C., the writer traveling the banks of the river to the ocean. Many of the fishermen living between Salisbury and the Narrows were strongly of the opinion that a wire net was stretched across the river near Grassy Island, so as to prevent the further ascent of shad. The fishermen of Grassy Island were no less emphatic in their assertion as to the existence of the wire net, but its alleged location was near Cheraw. At Cheraw and for many miles below that city statements as to the wire net were heard, but the location was fixed near the mouth of the river. When that point was reached it was found that the much-talked-of obstruction had no existence except in the imagination of the fishermen. Although the wire net does not exist, yet the stream is so narrow that it is almost completely obstructed by an amount of twine which would have little appreciable effect in retarding the run of shad up the broad tributaries of the Chesapeake or up the Delaware.

THE SHAD FISHERIES OF NORTH CAROLINA.

As determined by the number of persons employed, the amount of capital invested, and the value of the catch the shad fisheries of North Carolina are the most important on the Atlantic coast. The following tables show the extent of the fisheries by water-courses:

Statement, by water areas, of the number of persons employed in each branch of the shad fisheries of North Carolina in 1896.

Waters.	Number of fishermen.						Transporters.	Shoresmen.	Total, exclusive of duplication.
	Drift-net.	Stake-net.	Seine.	Pound-net.	Bow-net.	Wheel.			
Cape Fear River and tributaries:									
Below Black River	222	.....	.....	.....	.....	.....	.....	.....	222
Above Black River	148	.....	20	.....	248	.....	.....	.....	399
Black River	.....	.....	82	.....	120	.....	.....	.....	148
North East River	24	.....	71	.....	.....	.....	.....	.....	94
Pamlico Sound	.....	368	.....	82	.....	.....	20	13	483
Neuse River and tributaries:									
Below Contentnea River	76	86	315	58	360	.....	.....	28	911
Above Contentnea River	.....	2	45	.....	490	.....	.....	.....	517
Contentnea River	.....	68	40	.....	138	.....	.....	.....	209
Little River	.....	.....	8	.....	38	.....	.....	.....	44
Pamlico River	46	24	149	16	44	.....	5	.....	260
Tar River	.....	.....	40	.....	186	.....	.....	.....	208
Croatan Sound	.....	82	30	72	.....	.....	5	29	218
Roanoke Sound	.....	4	.....	4	.....	.....	.....	.....	8
Albemarle Sound	.....	331	121	229	.....	.....	30	519	1,229
Pasquotank River	.....	2	47	9	20	.....	.....	20	98
Perquimans River	.....	36	30	29	.....	.....	.....	15	104
Roanoke River	36	2	169	.....	870	17	.....	67	1,161
Chowan River	14	.....	190	191	.....	.....	.....	239	634
Total	506	999	1,357	690	2,514	17	60	930	6,947

Statement, by water areas, of the boats, apparatus, etc., employed in the shad fisheries of North Carolina in 1896.

Waters.	Boats.		Drift nets.			Stake nets.			Pound nets.	
	No.	Value.	No.	Length.	Value.	No.	Length.	Value.	No.	Value.
Cape Fear River and tributaries:				*Yards.*			*Yards.*			
Below Black River	111	$1,403	113	21,010	$3,634	.....	.....	.....	.....	.....
Above Black River	218	732	99	2,602	691	.....	.....	.....	.....	.....
Black River	79	358	.....	.....	.....	.....	.....	.....	.....	.....
North East River	29	151	12	1,520	410	.....	.....	.....	.....	.....
Pamlico Sound	235	21,650	.....	.....	.....	24,808	458,524	$30,001	171	$13,885
Neuse River and tributaries:										
Below Contentnea River	423	10,983	38	4,280	676	3,240	64,809	3,686	87	10,378
Above Contentnea River	269	858	.....	.....	.....	6	132	18	.....	.....
Contentnea River	127	337	.....	.....	.....	178	1,804	241	.....	.....
Little River	19	62	.....	.....	.....	.....	.....	.....	.....	.....
Pamlico River	134	4,050	23	2,300	197	840	16,800	985	27	3,325
Tar River	108	342	.....	.....	.....	.....	.....	.....	.....	.....
Croatan Sound	75	6,210	.....	.....	.....	5,625	108,420	7,516	140	10,825
Roanoke Sound	4	360	.....	.....	.....	225	4,500	281	3	300
Albemarle Sound	319	23,622	.....	.....	.....	21,985	432,488	20,944	612	56,215
Pasquotank River	24	590	.....	.....	.....	100	1,800	125	17	1,550
Perquimans River	36	1,800	.....	.....	.....	765	14,295	1,032	71	6,075
Roanoke River	501	3,505	18	1,440	270	15	300	45	.....	.....
Chowan River	120	3,375	74	1,440	185	.....	.....	.....	447	29,530
Total	2,831	80,388	377	34,682	6,063	57,787	1,103,872	73,874	1,575	132,083

Boats, apparatus, etc., employed in North Carolina shad fisheries—Continued.

Waters.	Seines.			Bow nets.		Wheels.		Shore and accessory property.	Total value.
	No.	Length.	Value.	No.	Value.	No.	Value.		
		Yards.							
Cape Fear River and tributaries:									
Below Black River								$1,960	$6,997
Above Black River	5	346	$322	124	$330			1,450	3,525
Black River	21	630	436	60	150			2,100	3,044
North East River	17	902	481					2,200	3,242
Pamlico Sound								4,505	70,041
Neuse River and tributaries:									
Below Contentnea River	86	18,880	6,361	185	530			39,300	71,914
Above Contentnea River	12	826	331	257	705			3,000	4,912
Contentnea River	10	623	383	70	178			2,375	3,514
Little River	2	130	78	17	48			450	638
Pamlico River	40	18,025	6,933	22	66			4,900	20,456
Tar River	10	1,246	806	98	239			2,300	3,687
Croatan Sound	1	2,300	3,000					15,378	42,929
Roanoke Sound								70	1,011
Albemarle Sound	4	10,000	12,500					82,495	204,776
Pasquotank River	4	4,650	3,630	10	20			5,880	11,795
Perquimans River	2	2,300	2,600					5,250	16,757
Roanoke River	8	6,059	6,100	435	1,515	75	$1,125	34,267	46,827
Chowan River	8	9,740	12,600					36,002	81,692
Total	230	76,658	56,561	1,278	3,781	75	1,125	243,882	597,757

Statement, by water areas and apparatus, of the number of shad taken in North Carolina in 1896.

Waters.	Drift nets.		Stake nets.		Seines.	
	No.	Value.	No.	Value.	No.	Value.
Cape Fear River and tributaries:						
Below Black River	45,372	$11,333				
Above Black River	5,375	1,584			668	$200
Black River					3,745	958
North East River	4,062	1,033			6,989	1,589
Pamlico Sound			387,236	$96,249		
Neuse River and tributaries:						
Below Contentnea River	18,485	3,244	23,118	3,811	105,210	19,222
Above Contentnea River			824	208	6,108	1,340
Contentnea River			2,541	661	2,573	633
Little River					186	44
Pamlico River	5,221	1,139	8,114	1,632	32,178	6,161
Tar River					6,515	1,278
Croatan Sound			68,626	14,006	20,000	3,800
Roanoke Sound			5,000	1,084		
Albemarle Sound			429,599	82,664	132,213	25,401
Pasquotank River			1,000	190	4,642	893
Perquimans River			12,424	2,380	7,680	1,502
Roanoke River	4,000	480	6,100	1,195	143,809	16,043
Chowan River	500	97			60,450	11,835
Total	83,015	18,910	944,582	204,080	532,966	90,899

Waters.	Pound nets.		Bow nets.		Wheels.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Cape Fear River and tributaries:								
Below Black River							45,372	$11,333
Above Black River			6,719	$1,658			12,762	3,442
Black River			2,385	609			6,130	1,567
North East River							11,051	2,622
Pamlico Sound	60,853	$13,478					448,089	109,727
Neuse River and tributaries:								
Below Contentnea River	22,471	3,902	12,250	2,901			181,534	33,080
Above Contentnea River			11,067	2,599			17,999	4,147
Contentnea River			1,919	437			7,033	1,731
Little River			300	65			486	109
Pamlico River	7,759	1,538	1,010	209			54,282	10,679
Tar River			6,285	1,359			12,800	2,637
Croatan Sound	73,834	13,925					162,460	31,731
Roanoke Sound	2,081	386					7,081	1,470
Albemarle Sound	173,380	32,094					735,192	140,159
Pasquotank River	2,840	460	275	56			8,757	1,599
Perquimans River	12,718	2,417					32,822	6,299
Roanoke River			13,500	2,391	2,000	$380	169,409	20,489
Chowan River	122,595	22,490					183,545	34,422
Total	478,531	90,690	55,710	12,284	2,000	380	2,096,804	417,243

CAPE FEAR RIVER AND TRIBUTARIES.

The Cape Fear River is formed by the confluence of Haw and Deep rivers, in Chatham County, North Carolina, at a distance, following the river course, of over 200 miles from the sea. It is navigable for light-draft steamers as far as Fayetteville, 145 miles from the ocean. By means of locks and dams it was formerly navigable to the junction of Haw and Deep rivers, but these aids have long since been abandoned. From the sea to Fayetteville the slope is about 10 feet, whereas from Fayetteville to the foot of Smiley Falls, a distance of 42 miles, the slope is 35 feet. Below Smiley Falls there were formerly four dams, ranging in height from 5 to 15 feet, but these have not been in existence for many years. The lowest obstruction at present is Battle Dam, about 12 miles above Smiley Falls, built of wood, 11 feet high and 500 feet long, extending directly across the river. Two miles farther up is Buckhorn Dam, 3 or 4 feet high and about 1,000 feet long, which formerly backed the water up to the junction of Haw and Deep rivers, a distance of 8 miles. Each of these dams is now in bad condition, being broken down in several places. Haw and Deep rivers, which form the Cape Fear, rise in Guilford County, 80 miles above their confluence. They are small streams, with considerable descent, averaging about 7 feet per mile each, and with numerous shoals and falls, which present absolute barriers to the upward passage of shad.

There are two distinct geographical sections in the Cape Fear shad fisheries: (1) The Wilmington section, from the mouth of the river to the entrance of Black River, 15 miles above Wilmington, in which drift nets exclusively are used; (2) thence to Smiley Falls, 42 miles above Fayetteville, in which bow nets, drift nets, and seines are employed. Each of these will be described separately.

The Wilmington section.—The drift nets in the Wilmington section are operated from Deep Water Point to Dollison, 1½ miles below the mouth of Black River. The length of those in the lower reaches ranges from 150 to 425 yards each, the depth averaging 50 meshes, and the size of mesh being 5¼ and 5½ inches. The nets between Wilmington and Dollison vary in length from 100 to 135 yards each; otherwise they are similar to those operated below Wilmington. Occasionally a net is used in one of the lower reaches during the early part of the season and then cut in half and used as two nets in the upper reaches during the rest of the season. About 20 short nets were drifted in Brunswick River in 1896. This river or thoroughfare is about 12 miles long, leaving the Cape Fear River 4 miles above Wilmington and reentering it 4 or 5 miles below that city. The Brunswick nets are from 100 to 120 yards in length, with a valuation of about $21 each. In North East River, a tributary entering the Cape Fear at Wilmington, there are several nets operated between the mouth and Three Cypresses, the men living between Wilmington and Castle Hayne. These nets range in length from 120 to 150 yards, the depth and mesh conforming to those on the Cape Fear between Wilmington and Dollison.

The total catch of shad in 1896 in the Cape Fear below Dollison, in Brunswick River, and in Northeast River below Three Cypresses, numbered 49,434, of which 21,316 were roes. The legal season extends from January 1 to May 15, but actual fishing began January 21 and ceased April 18, a close time operating from 6 p. m. Saturday to 6 p. m. Monday and from 6 p. m. Tuesday to 6 p. m. Wednesday of each week. The length of the season is determined largely by the temperature and flow of the waters. A warm March and April shortens the season and low water has the same effect, each causing the fish to pass rapidly upstream. There were more shad caught in 1896 than in 1895, the season being longer. There have not been so many shad taken in this vicinity during recent years as formerly. The catch in 1891 was 55,976; in 1890, 60,695, and in 1889, about 70,000. In 1890 108 nets were employed; 115 in 1891, and 125 in 1896. This gives an average per net of 562 shad in 1890; 487 in 1891, and 363 in 1896.

During the early portion of the season three-fourths or more of the catch consists of buck shad. As the season progresses the proportion is more evenly divided, and toward the end the roes greatly outnumber the buck shad. During the season of 1896 roe shad constituted 43 per cent of the total catch. Ripe shad are not found until near the end of March, and they are most numerous about May 1; consequently, the fisheries yield few eggs suitable for fertilization, as they cease before the end of April. One Wilmington dealer, who handled 15,007 shad in 1896, reports that not over 12 of them had spawned.

From Black River to Smiley Falls.—In the second section of Cape Fear River the bow net is the principal form of apparatus employed. Indeed, this is the only apparatus used in the lower 35 miles, except two 30-yard drift nets at Indian Wells, which took 200 shad during the past season. Bow nets are used all along this stretch of the river, the number operated in 1896 being 124, which yielded 6,719 shad, valued at $1,658. This is said to have been the smallest yield ever known. The catch during 1895 was also extremely poor, the yield previous to that time running from 100 to 400 to the net. A number of hickories are also caught in the bow nets, the total yield in 1896 being 2,920.

From Kelley Cove to Elizabethtown, a distance of 35 miles, drift nets are used almost exclusively, the only exceptions being the two bow nets at Browns Creek and one bow net at Elizabethtown. There are also two drift nets at Indian Wells, and 61 between Harrison Creek and Fayetteville. These nets are 20 to 45 yards long, 7 feet deep, 5½ to 5⅝ inch mesh, and cost about $5 each. The season begins a week or more earlier than in the bow-net fishery and closes about the end of April. The catch in 1896 was very small, only 5,375 shad being taken by the 99 boats. The conditions of the water and river were favorable for a good run, but the fish did not make an appearance. Drift nets have been used in this length of the river only during the last ten years, bow nets being employed exclusively prior to that time. The change in form of apparatus is due largely to the removal of snags and

brush from the channel of the river, and also to the decreased run of shad, rendering improved forms of apparatus necessary.

The lowest seine beach on Cape Fear River in 1896 was operated at Prospect Hall, 22 miles below Fayetteville, by Mr. William Whitedge, using two seines 50 yards long, 6 to 11 feet deep, and with 3-inch mesh. The season extended from March 29 to May 14, and 123 shad were caught, the highest catch in one day by the two seines being 16. Near Fayetteville three seines were operated in 1896, catching 545 shad and 3,065 hickories. The seines are from 75 to 90 yards in length, 12 to 15 feet deep, with 3-inch mesh, and require the services of 4 men each. The lowest is located about 9 miles below Fayetteville, and 5 miles above comes William Field's seine beach, new in 1896. A short distance above Fayetteville is E. P. Power's beach, established thirty years ago, and catching 5,500 shad during the first season. In 1867, according to Mr. Powers, the catch of shad in the vicinity of Fayetteville amounted to about 22,000. The season at Fayetteville begins the last week in February, about one month later than at the mouth of the river. The distance between the two points being 145 miles, it appears that shad move up the river at the rate of about 5 miles per day.

Smiley Falls is practically the limit of the shad run on Cape Fear River, and the few fish that pass those falls find an impassable barrier 12 and 14 miles above at Battle and Buckhorn dams. The fisheries on this river are prosecuted so vigorously, however, that few shad now pass above Kyle Landing, 12 miles above Fayetteville. In Smiley Falls several finger traps take some shad each season, but fish are becoming so scarce as to render their use unprofitable.

Black River.—Black River, which flows into the Cape Fear about 15 miles above Wilmington, is of considerable importance as a shad stream. It is quite narrow, ranging in width from 350 feet near the lower end to 100 feet 50 miles above. About 56 miles from its mouth it receives a tributary somewhat larger than itself, the South or South Black River. This branch is slightly deeper and longer than the main river above this point, but it is reported that few shad ascend it. About 30 miles above the mouth of South River, Black River receives the Six Runs, a somewhat important shad stream. This is the head of navigation during high water, and ordinarily very little navigation exists above Point Caswell, 36 miles from the Cape Fear. There are no falls whatever on Black River, and shad may ascend to the uppermost limits. Most of the fish are taken between Point Caswell and Clinton, and on the Six Runs below the Clinton and Warsaw Railroad bridge, seines and bow nets being employed.

It is unlawful to fish with seines in Black River "from Cape Fear River to the mouth of Great Coharie, also in the Six Runs to where the Atlantic Coast Line Railroad crosses said stream, except on Tuesdays, Wednesdays, and Saturdays of each week from 1 o'clock a. m. to 11.45 o'clock p. m. on each of the days above mentioned, * * * from the 1st day of March to the 15th day of June in each and every year."

The seines are 20 to 55 yards long, 1½-inch mesh, and with depth from 10 to 12 feet. They are frequently hired out by the day to farmers or timbermen desirous of securing a supply of shad for home use, the usual compensation being $2 per day and the same amount per night. Because of the distance from markets and the desultory manner in which the fishery is carried on, the catch is not large for the number of seines employed. In 1896, 21 seines were used, of which 12 were located on the Six Runs and 9 on Black River. On the Six Runs the seine shores are between the mouth of the river and the crossing of the Clinton and Warsaw Railroad. Very few shad, however, are taken above Taylor's Bridge, not a single shad being reported above that point in 1890. The catch in the 21 seines in 1896 numbered 3,745, of which 1,985 were bucks. Sixty bow nets were reported in 1896, mostly on the Six Runs, below Taylor's Bridge, the total yield amounting to 2,385 shad. Very few shad from Black River and tributaries are sent to distant markets, most of them being used in the homes of the fishermen.

North East River.—This river rises in the northeast portion of Duplin County, and after flowing 120 miles through a swampy section empties into the Cape Fear at Wilmington. It is navigable for small steamboats a distance of 75 miles, to Hallsville. From that point to Kornegay, 15 miles, it is shallow and narrow—20 to 100 feet in width—with low banks. In the extreme lower portion of North East River some shad are taken by Wilmington drift-net fishermen, as already noted. In addition thereto, a number of men living about Castle Hayne use drift nets, sending their catch to Wilmington. Twelve boats were used in this fishery in 1896, the catch being 1,942 roes and 2,120 bucks.

The principal shad fishery of North East River is the seine fishery, which is prosecuted from Sandy Hill, 30 miles above the mouth of the river, to Kornegay, a distance of 83 miles. In this section there are about 30 seine beaches, but a decrease in the abundance of shad has caused the abandonment of many of them. The seines range in length from 30 to 100 yards, the depth from 8 to 20 feet, the mesh from 2 to 3 inches, and 3 to 5 men are required to each fishery. In 1896, 17 seines were operated, the total catch by which approximated 6,989 shad, of which 3,320 were roes. In 1890, an unusually good season for recent years, 27 seines were used and 18,135 shad were taken. In 1891, 29 seines were used and the catch amounted to 13,455. The reduced catch in 1891 and in 1896 was due to heavy freshets, causing a short season all along the middle and lower end of the river, and this also explains why the catch above Hallsville was larger in 1891 than in 1890. An interdiction exists against fishing for shad in North East River "from the 23d day of February to the 1st day of July each year, between the hour of 12 o'clock midnight on Saturday nights and 6 a. m. on Wednesdays of each week." The shad on this stream are very large, individuals of 7 or 8 pounds being occasionally taken, and the average weight of the females probably exceeds 5 pounds. Formerly most of the North East

River shad were shipped by rail to distant markets, but the small catch of recent years has not furnished a surplus above the local demand.

In New River, Stone Bay, and other estuaries between Cape Fear River and Cape Lookout no especial attention is given to shad, but several hundred are taken annually in the mullet fisheries. The number thus caught is increasing, and doubtless profitable fisheries could be established.

Cape Lookout marks a distinctive change in the physical characteristics of the Atlantic coast streams. Below that cape all the rivers empty directly into the ocean, maintaining their fluvial characteristics almost, if not quite, to the mouth. From Cape Lookout to Cape Cod the streams empty into large sounds or bays, as Pamlico, Albemarle, and Long Island sounds, and Chesapeake, Delaware, New York, and Narragansett bays. The river mouths are usually broad estuaries, resembling arms of sounds and bays rather than rivers. The Neuse and the Pamlico rivers, in North Carolina, and the James, Rappahannock, Potomac, and Choptank, of Chesapeake Bay, are examples of this type. Other streams north of Cape Lookout possess this characteristic to a greater or less extent. This physical change affects the shad fisheries in three important particulars, viz: (1) The use of fixed apparatus of capture, as stake nets and pound nets, is made practicable; (2) the excessive concentration of the fisheries near the mouth is restricted; and (3) the beginning of the season is delayed several days.

PAMLICO SOUND.

Pamlico Sound is an irregular body of water, covering about 1,660 square miles and separated from the sea by a long, narrow sand beach known as "The Banks." At the north end it communicates with Albemarle Sound through Roanoke and Croatan sounds, and on the south it joins Core Sound, much of the waters of those sounds passing through Pamlico Sound, and two large rivers, the Neuse and Pamlico, enter from the west. The waters of Pamlico Sound and its tributaries communicate with the sea through Ocracoke, Hatteras, New, and Oregon inlets, each less than half a mile across.

The shad fisheries of this sound, like those of most of the salt-water estuaries of the Atlantic coast, are of comparatively recent development, originating about 1873 and receiving their greatest development during the past ten years. They are located in the northeast third of the sound, east of a line drawn from Hatteras Inlet to Sandy Point, and nearly 90 per cent are above a line drawn from Sandy Point to New Inlet. The principal fishing stations are the marsh islands and points at the extreme upper end of Pamlico Sound, the most important of which are Roanoke Marshes, Hog Island, Buck Island, Stumpy Point, Sandy Point, and Old Point. Most of these stations are inhabited only during the fishing season, the men returning to their homes on the uplands at the end of the season. In addition to the above-named

stations, shad fishing is carried on by men living at Chicamicomico or Rodanthe, Clarks, and Hatteras, on the banks. Stake nets and pound nets are used, set in the same general vicinity, but the latter usually inshore of the former. At present the stake nets greatly outnumber the pound nets, but the latter form of apparatus is rapidly increasing in popularity.

The stake nets measure 16 to 18 yards in length, 6 to 16 feet deep, with 5¼ to 5½ inch mesh, and from 50 to 500 are set in a string. They are made of cotton twine and cost, with necessary appliances, about $125 per 100 nets, the twine being renewed each season. Some of the nets are placed in very shoal water, as on Duck Island Flats, where the depth averages about 3 feet, and in many places so shoal that the fishermen are compelled to jump overboard and shove the boat along while overhauling the nets. The nets frequently remain in the water from the beginning of the season to the close, whereas when set in fresh water they must be taken up and cleaned every week. The 24,808 stake nets set in Pamlico Sound in 1896 required the services of 184 boats, worth $18,785, and of 368 men. The season began the first week in February and continued until about the middle of April. The total catch numbered 387,236, of which 207,736 were roes and 179,500 bucks, the total valuation being $96,249.

The stake-net catch at the various stations is affected largely by the prevailing winds both preceding and during the fishing season, the former determining to a certain extent the salinity of the water. The temperature of the water and of the atmosphere also influences the yield on the various reefs. On the Duck Island Flats in 1896 the water was low and quite salty, causing many fishermen who usually occupy those grounds to set their nets in Croatan and Albemarle sounds. Contrary to expectations, shad were more numerous on the Duck Island Flats than for many years previous, and the few fishermen operating there obtained large results. At Hog Island, one of the most important fishing stations, and which is separated from Roanoke Island only by small creeks, the yield of shad was exceptionally large, over 90,000 being taken. The catch in 1895 was nearly as good; but 1894 and 1893 were poor seasons, the former being the worst during recent years. On Long, Pingleton, and Gibbs shoals the catch was only about two-thirds as great as in 1895, and the yield in the nets set by the "Bank" fishermen from Chickamicomico to Hatteras was also unusually small.

The pound nets operated in Pamlico Sound are of the type known as "Dutch nets," costing from $80 to $1,100 each. The "pound" is generally 10 yards square, the "heart" 45 yards on each side, and the "leader" from 100 to 350 yards long. The mesh in the "pound" is 2¼ inches, in the "heart" 3 inches, and in the "leader" 4 inches. They are set along the shore across the current in strings containing from 1 to 11 nets each. The number used in Pamlico Sound is constantly increasing and they are gradually superseding the stake nets. They are set

about the 1st of February and remain in the water until late in the spring, the bulk of the catch being obtained from February 15 to March 15. In 1896 there were 171 pound nets, with an aggregate value of $13,885. Of these, 11 were near Hatteras Inlet and the others in the upper portion of the sound. The yield consisted of 30,812 roe and 30,041 buck shad, with a local valuation of $13,478.

There are several interesting features in connection with the shad resources of this body of water in addition to the fisheries at present operated. It will be seen that the only communication between the sea on one side and Neuse and Pamlico rivers and Albemarle Sound and its numerous tributaries on the other, is through Pamlico Sound, the outlets of which are Ocracoke, Hatteras, New, and Oregon inlets, whose total cross-section does not exceed 1½ miles. Through these narrow inlets the entire yield of shad taken in Pamlico Sound and tributaries, exceeding 2,000,000 annually, must pass. An impression exists that shad winter in these sounds, and in substantiation of this theory it is contended that if they passed into the sound from the sea through any one or all of the four inlets they would be taken in the seines which have at times been operated in those narrow passageways. This result would not necessarily follow, however, for when the shad enter from the sea they are not schooling, but moving as individuals, and avoid the fishing apparatus. In comparatively few of the coast waters are shad taken as easily near the sea as farther inland. It will be observed that the large quantities of fish taken in Albemarle Sound and tributaries must pass through Croatan and Roanoke sounds, and yet only a small percentage are taken in the numerous pound nets and stake nets located in those bodies of water. If the fish remained in the sound during the winter they would doubtless be discovered, even if they kept near the bottom; furthermore, those nets set on the shoals near Hatteras Inlet catch shad several days sooner than those in the upper portion of the sound, indicating that the fish are traveling from the direction of the inlet.

NEUSE RIVER AND TRIBUTARIES.

The Neuse, the most important shad stream between the St. Johns and the James rivers, is formed in Durham County, N. C., by the junction of the Eno, Flat, and Little rivers, and from that point to New Berne it measures in its sinuosities a distance of 260 miles. Below New Berne its fluvial characteristics disappear and it becomes a broad arm of Pamlico Sound, 40 miles long. The head of navigation is at Smithfield, 150 miles above New Berne, at an elevation of about 100 feet above sea level. In addition to the tributaries forming its source, the Neuse receives the waters of Trent, Contentnea, and Little rivers, and some minor streams. Shad formerly ascended Neuse River to its uppermost limits, and extensive fisheries are said to have existed near Raleigh, 190 miles from New Berne. At present they ascend in small numbers some distance above Raleigh, probably as far as Fishdam, in Durham County, and local fisheries exist above Smithfield. The bulk

of the catch, however, is obtained within 22 miles below and above New Berne. For convenience of description, the shad fisheries of the Neuse are divided into two geographical sections, viz: (1) the lower 72 miles, from Pamlico Sound to Contentnea River, and (2) from Contentnea River to the headwaters.

From the mouth to Contentnea River.—Below Contentnea River the Neuse flows through a low, swampy, timbered section, the banks rising from a few inches to 4 or 5 feet above low water, and large areas adjacent being covered during slight freshets, which, however, are rarely sudden or violent. The width of the stream from Pamlico Sound to New Berne ranges from 6 to 1½ miles, and from New Berne to the Contentnea it is from 250 to 80 feet at low water.

The forms of apparatus used in the shad fisheries of this section of Neuse River are seines, drift nets, bow nets, stake and pound nets, the first-named being the most important. There are three branches of this fishery, viz.: (*a*) the large seines below New Berne, requiring the use of horses; (*b*) the seine beaches above New Berne, and (*c*) the so-called drag nets, which are small seines without permanent beaches, hauled in such places as, from time to time, present favorable inducements.

(*a*) The large seines below New Berne, 5 in number, are located on the south side of the river from 3 to 6 miles below the city. It is reported that the first haul seine was operated here in 1846 by Richard Felton, a fisherman from Albemarle Sound. These seines are from 800 to 1,200 yards in length, 15 to 18 feet in depth, with mesh from 2½ to 2⅞ inches, the value ranging from $300 to $450 each. Six men, two horses, and two boats are usually required, and the rental of the shores is from $50 to $100 each annually. Seining begins about the first week in February and continues until the second or third week in April. The total catch by the five seines in 1896 was 5,688 roe shad and 5,954 bucks, with a local valuation of $2,192. In addition to shad, these seines catch quantities of alewives and striped bass.

(*b*) The seines used at the beaches between New Berne and Contentnea River are from 80 to 240 yards long, with 2¼ to 3 inch mesh, 50 to 70 meshes deep, and cost from $30 to $75 each. An average of 3 men and 1 boat is required for each seine. At New Berne the season begins about February 10, but near the Contentnea it is from two to three weeks later. In 1896 there were 28 seine beaches, which yielded 82,512 shad, of which 49,987, or 60 per cent, were bucks. Fishing is carried on every day except Sunday, and even on that day when shad are running plentifully. The catch varies considerably from year to year, the height of the water being the most important factor. The banks are so low that during freshets many of the beaches are overflooded and fishing is suspended for several days or even weeks. Since the above cause permits the shad to pass the seines down the river, it naturally follows that the best seasons in the upper reaches are coincident with high water in the lower part of the river. A few beaches, however, are so situated as to make their best hauls during high water.

(c) The third class of seines, known as drag nets, are used at such places on the river as may appear most desirable from day to day, no specially prepared seining beach being necessary, the nets being "footed up" in the water. They are used from the mouth of the river up to Pitchkettle Creek, 22 miles above New Berne, and also to some extent in Trent River, near its mouth. The maximum depth of water suitable for operating them is 12 feet for beginning the haul and 4 feet for "footing up" the net. They average in length about 225 yards, and 50 meshes deep, the mesh being about 2½ inches. Three men and one boat are required for each, the value of the net averaging about $75 and the boat $45. It is stated that this form of apparatus was introduced here about 1840 by Capt. Isaac Lewis. Their success does not depend entirely on the catch of shad; indeed, that species constitutes but a small portion of the yield, the aggregate yield in 1896 being 4,951 roes and 5,095 bucks. The other fish taken are herring, white perch, suckers, pickerel, striped bass. black bass. etc. The use of these nets is increasing.

The stake nets in Neuse River are set in 8 to 10 feet of water and in strings of from 30 to 60 nets each on the sides of the channel of the river from Northwest Creek, 5 miles below New Berne, to Great Island, 11 miles above that town. They are about 20 yards long, 10 feet deep, with 5¼-inch mesh, and, with the necessary stakes, etc., cost about $115 per hundred. Generally 70 nets are used by each boat, the latter costing about $50 and requiring the services of two men. This is the earliest branch of the shad fishery on the river, the season beginning each year about January 25 and ending about the first week in April. The stake-net fishery is most profitable during periods of high water. In 1896 47 boats engaged in this fishery, using 3,240 nets, and the catch numbered 10,262 roe shad and 12,856 bucks, the local valuation being $3,811. An interdiction exists against this form of fishery, but it is not enforced. Most of the men using stake nets are residents of Carteret and Pamlico counties, hailing from Cedar Island and Hunting Quarter in the former, and from Goose Creek to Bay River in the latter county.

Drift nets are operated from a short distance above the New Berne wharves to 12 miles down the river. These nets are from 100 to 120 yards long, 5¼-inch mesh, and cost about $18 each. The season begins about the second or third week of February and closes the first week in May. In 1896 38 drift nets were used, the yield being 8,360 roe shad and 10,125 bucks, with a local valuation of $3,244.

Notwithstanding an interdiction against pound nets in the Neuse, the employment of this form of apparatus is increasing each year. It was introduced here about 1878, and in 1880 6 were reported. In 1889 and in 1890 the regulation against their use appears to have been enforced, no pound nets being reported in the returns for those years. But a few were introduced into the lower part of the river, where local sentiment was favorable, and the evasion of the law gradually extended. In 1896 87 pound nets were set between Trent River and Adams Creek,

34 on the north side of the river and 53 on the south side, in depths of water ranging from 6 to 12 feet. The leaders average 200 yards in length, and the mesh in the trap is from 2 to 1½ inches. The average value of the pound nets is about $120, many of them being constructed of twine used previously in seines. The season begins about August 15 and continues until early in May. Shad constitute only about 20 per cent in value of the total pound-net catch, the other species taken being herring, striped bass, sea trout, croakers, white perch, drum, pickerel, etc. The catch of shad in 1896 was 22,471, of which 12,972 were bucks, and of herring 1,146,280 were obtained.

While comparatively few shad caught by means of bow nets reach New Berne, yet the use of that form of apparatus between New Berne and Contentnea River is quite extensive, especially in the vicinity of Spring Garden, Cowpens, and Pitchkettle. They are used to the best advantage during high water, as then most of the seining operations are suspended by reason of the beaches being overflooded, leaving a greater number of shad to be taken in other apparatus, and for the further reason that the shad are less cautious during the muddy-water period and are more easily netted. The number of bow nets in use between New Berne and the Contentnea in 1896 approximated 185, requiring 180 boats, worth $620, and 360 men, and the yield approximated 5,800 roe shad and 6,450 bucks, valued at $2,901.

From Contentnea River to headwaters.—The apparatus used in the shad fisheries of Neuse River from the entrance of Contentnea River to Smith Mills, a distance of 125 miles, consists of bow nets, seines, and stake nets. Bow nets are used throughout the length of the river; seines are operated between the entrance of Contentnea River and Bear Creek, 37 miles, and stake nets are operated at the railroad bridge, a short distance below Kinston, 17 miles above the Contentnea.

The seines range in length from 50 to 80 yards, the depth averages 12 feet, and the mesh about 2½ inches. The season begins usually the first week of February and ends the second or third week of May, the annual rental being about $20 for each beach. The catch of shad by each seine in 1896 ranged from 25 to 1,350 in number. It is stated that the present catch in these seines is not one-fourth of the yield twenty years ago. The Bear Creek seine-hole, the uppermost beach operated at present, caught only 200 shad in 1896, whereas from 1880 to 1890 the average catch was about 1,000 each season. Until quite recently there were several seines on the Neuse between Bear Creek seine-hole and Smithfield, but unprofitable fishing led to their abandonment. In 1896 two seines were operated 50 miles above Bear Creek seine-hole, but on Little River, a tributary entering Neuse River near Goldsboro.

Bow nets are operated from the entrance of the Contentnea to Wilson Mills, the total number employed in 1896 being 257 and the yield of shad numbering 11,067. The distance from Wilson Mills to New Berne is 156 miles, and as New Berne is 80 miles distant from the ocean it follows that the shad taken at Wilson Mills have traversed at least 236

miles since leaving the sea. This is one of the most distant points from the ocean at which commercial shad fisheries are now prosecuted. It appears that the season in the upper portion of the river does not begin until the end of February, four weeks later than at the lower end of the river. The distance being about 135 miles, the progress of the shad up the river shows an average of 4 or 5 miles per day. There are probably a few bow nets operated above Wilson Mills, but the small extent of the fishery did not warrant an extension of the inquiry above that point.

The six stake nets operated on Neuse River above the Contentnea were set near the Kinston railroad bridge. The length of the nets was 22 yards each, the depth 35 meshes, and the size of mesh 5⅞ inches. Two men and two boats were engaged; the catch by one boat was 774 shad and 7 rockfish, and by the other boat 50 shad were taken.

Trent River.—The Trent, the largest tributary of the Neuse, is of considerable width and depth, but draining only a small area of territory the current is sluggish. The drag-net and drift-net fishermen of New Berne operate in the lower end, but with this exception few shad are taken in this stream. It appears that they do not run far up the Trent in large numbers, probably on account of the sluggishness of the water and the consequent accumulation of drift and other refuse matter.

Contentnea River.—About 32 miles above New Berne the Neuse receives the waters of Contentnea River, sometimes called Moccasin River, the shad fisheries of which are almost as important as those of the Neuse above this point. This river flows about halfway between Neuse and Tar rivers. It is about 140 miles long and it is navigable as far as Stantonsburg, 63 miles above the mouth. Above Stantonsburg it is full of narrow rapids and abrupt falls, forming a barrier to the further ascent of fish as well as to navigation. The apparatus used in taking shad consists of seines, stake nets, and bow nets, the total yield on the river in 1896 being 7,033, of which 3,222 were roes. Of this catch, 2,573 were taken in seines, 2,541 in stake nets, and 1,919 in bow nets.

The length of the seines ranges from 30 to 80 yards, the mesh 2 to 3½ inches, and the number of men required four to each seine. The beaches rent for $20 to $40 annually. In the lower part of the river the season begins about the last of February, but it is a week or more later above Snow Hill. During 1896 the catch was unusually small, owing to low water permitting the shad to be taken on the lower Neuse, the total yield in the 10 seines on the Contentnea being 2,573 in number. The Tingle Beach, 3 miles above the mouth of the Contentnea, caught 2,400 shad in 1895 and only 410 in 1896. The number of seines on this river is much less than formerly, there being 25 or more ten years ago. In addition to shad, the seines take herring, hickories, perch, bream, etc.

The stake gill nets used on Contentnea River are from 18 to 40 feet in length, with 5½-inch mesh, and cost on an average about $1.50 each. From two to five nets are used by each boat. The season begins

about the end of February and closes the second week of May. The catch in the 178 stake nets set in 1896 was 1,499 roe shad and 1,042 bucks. Seventy bow nets were used on the Contentnea between the mouth and Stantonsburg, yielding 609 roe shad and 1,310 bucks. These bow nets differ in no particular from those used in taking shad in other Atlantic coast streams.

Little River.—About 2 miles above Goldsboro the Neuse receives the waters of Little River, which is nearly 100 miles in length. Shad ascend as far as Whitley Mills, about 15 miles from the mouth, the numerous milldams obstructing their further passage. In the length below Whitley Mills a few shad are taken by means of seines and bow nets, the season beginning about the end of February and ending during the second or third week of May. In 1896 two 65-yard seines were used on Little River, one 6 miles and the other 11 miles above the Neuse, the yield of shad being 186, of which 60 per cent were bucks. Bow nets are used at various points below Whitley Mills, the total number reported in 1896 being 17, with a catch of 300 shad.

PAMLICO-TAR RIVER.

Pamlico and Tar rivers are different sections of a single stream, the name changing near the town of Washington, N. C. The lower portion, Pamlico River, has a length of 37 miles, and the upper portion, Tar River, is 180 miles long, giving a total length of 217 miles. The Pamlico length is really an arm of Pamlico Sound, whereas Tar River has all the usual fluvial characteristics. Tarboro, 49 miles above Washington, is the present head of navigation. Above that town the river is 90 to 200 feet in width with a gentle slope, affording ample passage for the ascent of shad 36 miles to Rocky Mount, where further progress is barred by a natural fall of about 20 feet, utilized for mill purposes, the site of the first cotton mill in North Carolina, erected in 1817. The shad fisheries of Pamlico-Tar River extend from the mouth to a short distance below Rocky Mount, the yield in 1896 being 32,601 roe shad and 34,481 bucks. The apparatus used consists of seines, stake nets, drift nets, pound nets, and bow nets, the first named yielding nearly 60 per cent of the total product

Seines are operated from Core Point, 16 miles below Washington, to Pillsboro Landing, 33 miles above that town. Those below Washington range in length from 450 to 1,000 yards, and above that town the length of the seines is from 50 to 200 yards, one or two seines being used at each beach. The mesh is from 2 to 2½ inches in the bunt, and from 4 to 9 men are required for each seine. The season begins usually during the first week of February below Washington, and about two weeks later in the upper portions of the river. The catch in 1896 was the smallest for several years, the yield at the 32 beaches on the river being only 38,693 shad, while 30 seines are reported as taking 108,728 shad in 1890. The weather was unfavorable for an early start and high water limited the operations at many of the beaches. Of the yield

in 1896, 32,178 shad were obtained in Pamlico River and 6,515 in the Tar.

Stake nets are set along both sides of the channel of this stream from the mouth to the town of Washington. They average 20 yards in length, 10 to 12 feet deep, with 5⅜ to 5½ inch mesh, and are made of cotton twine, which must be renewed annually. In 1896 840 nets were used, set in strings of from 10 to 40 nets each. The season began the second week of February and closed about the end of April, yielding 4,260 roe shad and 3,854 bucks, with an aggregate value of $1,632.

During heavy freshets a number of drift nets are used in the river from 1 mile below Washington to the same distance above that town. These nets are about 100 yards in length, with 5⅜-inch to 5½-inch mesh, and cost $10 or $12 each. Two men are required for each net, and the boats used are worth $10 to $15 each. The catch is small, as these nets are used only when the water is high. In the 23 nets operated at times in 1896 the yield of shad was 5,221, of which 2,867, or 55 per cent, were roes.

The bow-net fisheries are operated at various points from Washington to 25 miles above Tarboro, the total number of nets in 1896 being 120, of which 22 were operated in Pamlico River and 98 in the Tar. In the lower part of the river two men are required for each net, but in the upper portion a few of the nets are operated by one man each. The catch in 1896 by those in the Pamlico end was 1,010 shad and in Tar River 6,285. Most of these shad are consumed by the families of the fishermen and their neighbors.

The few pound nets or Dutch nets in Pamlico River are set near the mouth of Pungo River, a short tributary of the former, from September until the following May, and in these some shad are taken. An interdiction exists against the use of this form of apparatus, resulting in restricting but not entirely prohibiting the fishery. In 1896 27 of these nets were used, aggregating in value $3,325, being set in strings with from two to four nets each. The catch of shad numbered 7,759, of which 3,926 were roes.

CROATAN AND ROANOKE SOUNDS.

These sounds, separated from each other by Roanoke Island, form the channel of communication between Pamlico Sound and Albemarle Sound, all the waters of the latter, including its numerous tributaries, passing through them. Croatan Sound is 10 miles long, 2½ to 4 miles wide, and averages 8 to 10 feet deep, the bottom being very uneven and broken. Roanoke Sound has the same length as Croatan Sound and is 1 to 2 miles wide and very shoal except in a narrow channel skirting the shore of Roanoke Island, where the depth averages from 8 to 12 feet. The bulk of the shad passing from Pamlico Sound traverse Croatan Sound, in which there are consequently important fisheries. In Roanoke Sound very little twine is set, and the experience of the fishermen indicates that few shad pass through that body of water.

Except one seine in the extreme upper end of Croatan Sound, stake nets and pound nets are the only apparatus used in these two water areas, and these catch almost an equal number of shad each.

The stake nets differ in no particular from those in use in the extreme northern part of Pamlico Sound. From 75 to 600 nets are set in a string, the nets averaging in length nearly 20 yards each. The strings are placed generally north and south, so as to present the least surface of resistance to the strong currents caused by prevailing winds. In Roanoke Sound there was but one string in 1896, containing 225 nets and set in the northern part above Dalby Point. In the Croatan 16 strings containing 3,220 nets were set in the eastern half, and 14 strings containing 2,405 nets in the western half. The number of men and value of boats and apparatus employed in each sound are shown in the tables. The catch of shad by 225 nets in Roanoke Sound was 5,000, of which about two-thirds were roes, and in Croatan Sound the stake-net yield was 37,598 roe shad and 31,028 bucks, with a local valuation of $14,006.

The pound nets average in value from $75 to $100 each and are set near the shores. In Roanoke Sound there were but 3 pound nets in 1896, while 140 nets were in Croatan Sound. Four men and a boat worth $150 were used to operate the former, and 72 men, with 34 boats valued at $1,530, were required in Croatan Sound. The catch by the former approximated 1,350 bucks and 731 roes, and by the latter the yield was 44,769 buck and 29,065 roe shad. The pound nets also caught 866,500 alewives and quantities of striped bass, squeteague, bluefish, mullet, etc.

In the extreme northern end and on the western shore of Croatan Sound a 2,300-yard seine was operated in 1896, requiring the services of 30 fishermen, 29 shoresmen and preparators, 1 open flatboat, and 2 steam scows. The size of mesh was from 2 to 3½ inches, the depth of water from 4 to 12 feet, and the yield of shad approximated 20,000, of which two-thirds were bucks.

It appears that the total catch of shad in these two sounds in 1896 by means of stake nets was 73,626, of which 56 per cent were roes; whereas the catch by pound nets and seines aggregate 95,915 shad, of which only 38 per cent were roe shad. This difference is due in a large measure to the size of the mesh in the gill nets, failing to hold many of the small buck shad, leaving a greater proportion to be taken in the pound nets. Except sufficient for local use, the fish are delivered by boat at the Old Dominion Wharf on Roanoke Island, and thence sent to Norfolk, where they are distributed to northern markets.

ALBEMARLE SOUND.

Albemarle Sound is formed at the confluence of Roanoke and Chowan rivers, extends eastward a distance of 60 miles, and connects with the northern end of Pamlico Sound through Croatan and Roanoke sounds. The characteristics of this sound differ little from those of the broad estuaries forming the lower end of Neuse, Pamlico, James, Rappahan-

nock, and Potomac rivers. It is a bay rather than a sound, receiving the latter designation from its association with other waters of this portion of the coast. The water is fresh except during periods of excessively dry weather or of prevailing southerly winds, when it becomes somewhat brackish at the eastern end near Croatan Sound. It is considered the largest coastal body of fresh water in the world, the width averaging 7 or 8 miles and the area approximating 450 square miles. It is remarkably free from strong currents and tides, except those of infrequent occurrence resulting from gales, and the depth of the bottom is quite uniform, averaging from 16 to 20 feet.

The shad fisheries of Albemarle Sound are among the most important on the Atlantic coast, stake nets, pound nets, and seines being extensively employed. Of the 735,192 shad caught in this body of water in 1896, 429,599 were taken by means of stake nets, 173,380 by pound nets, and 132,213 by seines. The principal fishing centers are Edenton, with 197 fishermen; Peter Mashew's Creek, 90 fishermen; Mackey Ferry and vicinity, 70 fishermen, and Pear Tree Point, 36 fishermen. Numerous other stations employ from 5 to 20 fishermen and a number of shoresmen and preparators. Elizabeth City and Edenton are the principal shipping centers.

The stake-net fishery is by far the most important, the yield exceeding by 40 per cent the aggregate catch in all other forms of apparatus. The nets average about 20 yards each in length and from 10 to 14 feet in depth, with from 5⅛ to 5½ inch mesh. The total value of the 21,985 used in 1896, including stakes, ropes, etc., was $29,944, and 331 men were required to operate them. From 50 to 500 nets are set in each string, the general direction of the strings being at right angles to the current. They are located at various points throughout the sound, but are most numerous at the extreme eastern end, near the entrance into Croatan Sound. In an area of 25 square miles in that region there were 46 strings in 1896, containing 7,785 nets, 35 per cent of the total number in the sound. From this section to the mouth of the Roanoke River stake nets are set less numerously and at irregular intervals, but the number in the western end of the sound has greatly increased during the last two years. The catch in 1896 aggregated 185,701 roe shad and 243,898 bucks, valued at $82,664. The season began about the first of February and lasted until the middle of April. Most of the catch is carried to some station on the Norfolk and Southern Railroad and thence shipped to northern markets, Elizabeth City receiving the bulk of the catch, with Edenton a close second.

The pound nets in Albemarle Sound differ in no particular from those in the neighboring waters on the south. A few are located near Peter Mashew's Creek in the extreme lower end of the sound, but the greater portion are in the upper half, within the limits of Chowan and Washington counties. They are set along the shores with from 1 to 25 nets on each string. This fishery is of comparatively recent development, originating about 1870.

The following summary shows by counties its location and extent in 1896:

Counties.	No. of men.	Pound nets.		Boats.		Shad caught.		
		No.	Value.	No.	Value.	No. of roes.	No. of bucks.	Value.
Dare	28	a 42	$4,800	15	$2,200	11,490	17,220	$5,236
Tyrrell	16	b 33	2,625	8	510	2,947	4,730	1,447
Washington	61	163	15,230	62	1,558	10,668	19,046	5,484
Bertie	9	30	3,000	6	370	4,372	6,105	2,009
Currituck	4	2	200	2	100	200	253	88
Camden	2	c 8	800	1	40	1,050	2,000	550
Pasquotank	2	2	200	1	75	50	250	51
Perquimans	27	72	6,300	16	620	5,657	7,845	2,592
Chowan	80	254	23,060	64	3,729	28,101	51,396	14,637
Total	229	612	56,215	175	9,202	64,535	108,845	32,094

a Includes six nets in Alligator River. b Includes four nets in Little Alligator River.
c Located in North River.

Haul seines were the only apparatus of capture employed in the shad fisheries of Albemarle Sound until about 1860, and until quite recently they have been the principal apparatus. At the present time, however, they play a minor part in the shad fisheries of this region, only 4 being operated—3 on the shore of Chowan County and 1 in Bertie County. They average in length about 2,500 yards each and in depth 12 to 16 feet, with 2-inch mesh in the bunt and 3-inch in the wings. From 25 to 35 men are required at each fishery, and steamers or steam flats are used in hauling each seine. The catch of these four seines in 1896 was 69,857 roe shad and 62,356 bucks, with a local valuation of $25,401. In addition to shad, 4,235,324 alewives were taken, the value being $11,655. A very small quantity of striped bass, perch, and sturgeon are also caught in the seines.

To illustrate the comparative abundance of shad during the last half century, the following statement is presented, showing for a series of years the yield of shad at the Greenfield seine fishery on Albemarle Sound:

Year.	No. of shad.	Average for 5 years.	Year.	No. of shad.	Average for 5 years.
1852	13,849		1876	17,919	
1853	25,552		1877	14,603	
1854	36,979	33,419	1878	10,485	17,185
1855	54,910		1879	17,225	
1856	35,806		1880	25,692	
1857	26,344		1881	19,777	
1858	36,242		1882	21,000	
1859	37,818	36,609	1883	16,894	19,091
1860	49,427		1884	17,011	
1861 a	33,213		1885	20,774	
1866	43,862		1886	21,038	
1867	49,249		1887	22,600	
1868	37,566	41,746	1888	29,484	22,514
1869	44,695		1889	22,791	
1870	33,358		1890	16,655	
1871	31,991		1891	15,861	
1872	42,694		1892	26,163	
1873	40,245	40,639	1893	26,352	23,805
1874	54,870		1894	23,245	
1875	33,394		1895	27,403	
			1896	46,522	

a Fishing interrupted during 1862–65 on account of war.

The John Wood seine has made the following catches of shad and alewives each year since 1891:

Year.	No. of shad.	No. of alewives.
1892	25,521	1,513,873
1893	30,479	1,417,254
1894	16,630	1,404,596
1895	25,853	2,007,992
1896	38,000	1,300,000

The yield of shad in Albemarle Sound depends largely on the currents, especially on those flowing from the mouth of the Roanoke. That river brings down large quantities of muddy water, forming a decided contrast to the otherwise comparatively clear water of the sound. The strong winds sometimes drive this muddy water back and forth, seriously injuring the pound-net and seine fisheries covered by it. This was especially true in 1896, and to some extent in 1895. It is claimed that this muddy water is rather beneficial to the stake-net fishery, and it appears that in certain localities covered by it in 1896 the stake nets made good catches while few shad were taken in the pound nets in the same section. This is tending to increase the popularity of stake nets, and that form of apparatus is superseding the pound nets and seines.

Pasquotank River.—This is really an arm of Albemarle Sound, extending 15 miles inland, with an average width of 2 miles and depth of 10 or 12 feet. In 1896 8,757 shad were obtained in this river, of which 4,642 were caught by 4 seines, 2,840 by 17 pound nets, 1,000 by 100 stake nets, and 275 by 10 bow nets.

Perquimans River.—This is also an arm of Albemarle Sound, 12 miles long, and averaging over a mile in width, with 10 or 12 feet of water. The apparatus used consisted of stake nets, seines, and pound nets. Of the 12,424 shad taken in the stake nets, 60 per cent were bucks; of the 7,680 caught in seines, 53 per cent were bucks, and 60 per cent of the 12,718 taken in pound nets were of the same sex. The shad season in the Perquimans, as in the Pasquotank, is from the middle of February to the second week of May.

ROANOKE RIVER.

The Roanoke, the principal tributary of Albemarle Sound, is a narrow, rapid stream, formed by the confluence of the Dan and Staunton in Mecklenburg County, Va., whence it flows through a winding course, a distance of 198 miles, to its outlet. It is navigable for vessels of 10 feet draft from the mouth to Hamilton, 62 miles, thence for 5 feet draft 67 miles further to Weldon. The Roanoke differs from other large rivers emptying into the North Carolina sounds in that the fluvial characteristics continue quite to the mouth, the width below Weldon being only 100 to 200 yards. Excepting a few rocky places, the bed of the river is of sand, with generally an alluvial deposit over the sand near the banks. At Eton Falls, near Weldon, the river crosses the escarpment line, descending over 100 feet in a distance of 13 miles above that town, the

channel being very tortuous and the bed of the river interspersed with rocks and islands, most of which are submerged at high water. Above Eton Falls to the head of the river, a distance of 56 miles, the depth of water varies from 2 to 10 feet at low water, and the fall aggregates 146 feet, an average of 2.6 feet per mile. This portion of the river is navigated only by pole boats, and, while a few fish are found in it, there are no established shad fisheries.

The commercial shad fisheries of the Roanoke are confined to the extreme lower end, from the mouth to Williamston. The forms of apparatus employed are seines, bow nets, stake nets, drift nets, and wheels, named in the order of their importance; 80 per cent of the total yield being obtained by seines. The fisheries are centered principally at Plymouth, Jamesville, and Williamston, in addition to which there are numerous minor fishing stations.

Eight seines were employed in 1896, with an aggregate length of 6,050 yards and valuation of $6,100. Four of these were operated between Plymouth and the mouth of Cashie River, two a short distance above Plymouth, and two at Jamesville, 17 miles from the mouth of the river. The men required to operate these seines numbered 169; 30 boats, worth $1,815, were used, and the value of the shore property utilized aggregated $33,247. During the season herein reported the fish were late in coming up the river, resulting in a small catch and low prices. In 1895 one seine caught 11,000 shad in one week, three times as many as were taken in any one seine during the best week in 1896. The yield in 8 seines in 1896 was 96,369 bucks and 47,440 roes, with a local valuation of $16,043. This large proportion of bucks was due chiefly to the large size of mesh used in stake nets between the mouth of the river and the sea, permitting small fish to pass through.

The gill-net fisheries of Roanoke River are of little importance, owing to the rapidity of the current and the crookedness of the stream. A string of stake nets is set at the junction of the Cashie River with the Roanoke, near the mouth of the latter. Fifteen 20-yard nets, with 5⅜-inch mesh, were used there in 1896, the catch aggregating 6,100 shad. For a distance of 2 miles above and the same distance below Plymouth 18 80-yard drift nets, with 5-inch mesh, were operated in 1896. These required two men each, only one net being used to each boat. The catch was small, approximating 4,000 shad, most of which were consumed in the homes of the fishermen and their neighbors.

The bow nets used on the Roanoke below Palmyra numbered 435, requiring the services of twice that number of men. These nets are about 20 feet long, 8 feet wide, the bag having about a 5-foot hang. They had a poor season, taking only 13,500 shad, an average of 31 per net. Most of the catch by these nets is used locally.

In the lower end of Roanoke River a number of wheels are used, their form of construction (for a description of which I am indebted to Mr. John N. Cobb) being somewhat similar to those on Pee Dee River. The principal difference is that on the Pee Dee the wheels are fixed in

sluice-openings in dams, whereas navigation on the Roanoke prevents the construction of dams, and the fishermen secure two flat-bottomed, square-sided boats parallel to each other and about 6 or 8 feet apart, the boats being held in the current by means of a long sapling projecting from the bank. A strong axle is placed in a bearing on each boat, the ends of the axle projecting about 2 feet beyond the farther side. To one end of this axle, and sometimes to both, is attached a paddle wheel of rough boards, and in the middle of the axle and occupying the full space between the boats is fixed a large curved scoop of twine or latticed strips of wood, the scoop being so constructed as to shunt the fish into one or both of the boats when they are dipped up by the current acting upon the paddle wheels, whence they are removed at the leisure of the fishermen. The cost of each apparatus is about $15. In 1896 there were 75 of these wheels in the lower Roanoke, which were owned and operated principally by farmers living near the river banks. The catch aggregated 2,000 shad and also large quantities of hickories and alewives.

CHOWAN RIVER.

The Chowan is formed by the junction of the Blackwater and Nottoway rivers nearly on the line between North Carolina and Virginia, whence it flows with a sluggish current a distance of 55 miles to its entrance into Albemarle Sound. For the lower 20 miles the river averages 1½ miles in width and 15 to 20 feet in depth. Above Holiday Island the width gradually contracts to about 500 feet near the head of the river. The water is dark and clear, in marked contrast to the muddy water from Roanoke River. The shad fisheries of Chowan River are somewhat greater in extent than those of the Roanoke, and there is a remarkable difference in the forms of the apparatus used. Bow nets, stake nets, and wheels are not reported, and two-thirds of the catch is obtained by means of pound nets, in addition to which seines are the only important apparatus used. Most of the fisheries are prosecuted between the mouth of the river and Harrellsville.

There were formerly a large number of seines on Chowan River, but the unprofitableness of the fishery has led to the abandonment of many of them. In 1896 only eight were used, with an aggregate length of 9,740 yards and valuation of $12,600, requiring the services of 190 fishermen. Seven of the seines were hauled on the west side of the river and one on the east. The most important is the one used at the Willow Branch fishery, situated just above the mouth, on the west side, the annual catch by which frequently exceeds 35,000 shad and 1,500,000 alewives. The services of 23 fishermen and two steam flats are required to operate it, and 25 shoresmen take care of the catch. The yield of this seine in 1896 was 34,300 shad and 1,500,000 alewives. Of the remaining seven seines, two were operated at Coleraine in Bertie County, one below Canons Ferry in Chowan County, and two above Harrellsville, one at Winton and one at Mount Gallon, in Hertford County. The two last-named seines are short, averaging 200 yards each; the others range in length from 2,300 to 750 yards each. The catch in 1896, by the eight

seines above noted, was 60,450 shad, valued at $11,835, of which 28,150 were roes and 32,300 bucks. The catch of alewives during the same season amounted to 6,772,000. The season begins usually about March 12 and ends the second week of May, the maximum run being about the first half of April.

Chowan River has the most important pound-net fishery of the rivers south of Virginia, the number of those nets in 1896 being 447. They are small, averaging in value about $70 each. Several of them are constructed with a small heart inside of the usual one, but the value of this addition is not generally recognized. The pound nets are located from the mouth of the river to Mount Gallon and mostly on the east side, 311 being on that side in 1896, while 136 were on the west side of the river. They are set usually in strings containing from 2 to 20 nets, only 5 nets being set singly during the last season. The depth of the water ranges from 6 to 20 feet, and the season runs from about the second week of March to the middle of May. The yield of shad in 1896 numbered 122,595, valued locally at $22,490, of which 47,576 were roes and 75,019 bucks.

Above the railroad bridge at Tunis there were 13 rowboats engaged in drifting gill nets, 1,440 yards of twine with 5½-inch mesh being used. The catch was small, amounting to only 500 shad, which were used principally in the families of the fishermen. The water of the Chowan appears to be too clear for the profitable employment of gill nets.

THE SHAD FISHERIES OF VIRGINIA.

The following series of three tables shows by water areas the extent of each branch of the shad fisheries of Virginia during the season covered by the present report:

Statement, by water areas, of the number of persons employed in each branch of the shad fisheries of Virginia in 1896.

Waters.	Number of fishermen.					Total, exclusive of duplication.	Transporters.	Shoremen.	Total.
	Stake-net.	Drift-net.	Seine.	Pound-net.	Miscellaneous.				
Chesapeake Bay:									
Eastern shore	.....	.....	.....	109	.....	109	8	.....	117
Western shore	29	.....	.....	618	.....	647	48	11	706
Mobjack Bay	.....	.....	.....	96	.....	96	.....	.....	96
James River and tributaries:									
Below Chickahominy River	152	.....	18	12	.....	184	.....	.....	184
Between Chickahominy and Appomattox rivers	14	340	27	.....	.....	379	.....	.....	379
Above Appomattox River	.....	128	.....	.....	.....	128	.....	.....	128
Chickahominy River	.....	160	43	.....	a3	206	.....	.....	206
Appomattox River	.....	50	20	.....	.....	70	.....	.....	70
York River and tributaries:									
York River	107	.....	6	94	b10	211	.....	.....	211
Pamunkey River	6	293	17	.....	.....	314	.....	.....	314
Mattaponi River	.....	306	39	.....	.....	345	.....	.....	345
Rappahannock River:									
Below Deep Creek	.....	.....	.....	116	.....	116	.....	.....	116
Deep Creek to Leedstown	114	18	13	112	b2	215	.....	.....	215
Leedstown and above	.....	78	14	32	c6	122	.....	.....	122
Potomac River:									
Below Mattox Creek	2	.....	.....	207	.....	209	8	.....	217
Above Mattox Creek	19	236	247	101	.....	595	9	31	635
Total	443	1,609	444	1,497	21	3,946	73	42	4,061

a Hedge. b Fyke-net. c Fall-trap.

Statement, by water areas, of the boats, apparatus, etc., employed in the shad fisheries of Virginia in 1896.

Waters.	Boats.		Stake nets.		
	No.	Value.	No.	Length.	Value.
				Yards.	
Chesapeake Bay:					
Western shore	369	$26,505	810	12,740	$1,340
Eastern shore	57	3,995	.....	.....	.....
James River and tributaries:					
Below Chickahominy River	93	2,311	3,498	34,898	3,681
Between Chickahominy and Appomattox rivers	181	2,225	235	2,440	224
Above Appomattox River	64	610	.....	.....	.....
Chickahominy River	172	1,406	.....	.....	.....
Appomattox River	30	365	.....	.....	.....
York River and tributaries:					
York River	110	5,157	990	6,461	764
Pamunkey River	159	1,530	53	378	38
Mattaponi River	162	1,542	.....	.....	.....
Mobjack Bay	34	3,615	.....	.....	.....
Rappahannock River:					
Below Deep Creek	74	7,011	.....	.....	.....
From Deep Creek to Leedstown	142	2,218	3,263	27,164	3,859
Leedstown and above	56	618	.....	.....	.....
Potomac River:					
Below Mattox Creek	84	6,455	8	400	28
Above Mattox Creek	241	11,495	521	5,733	1,015
Total	2,028	77,058	9,378	90,214	10,949

Waters.	Drift nets.			Seines.		
	No.	Length.	Value.	No.	Length.	Value.
		Yards.			*Yards.*	
James River and tributaries:						
Below Chickahominy River	.....	.....	.....	2	1,400	$730
Between Chickahominy and Appomattox rivers	225	59,727	$6,220	4	1,450	1,025
Above Appomattox River	128	11,020	1,535	.....	.....	.....
Chickahominy River	160	28,842	1,775	8	2,425	1,155
Appomattox River	46	6,720	388	5	1,225	475
York River and tributaries:						
York River	.....	.....	.....	1	475	220
Pamunkey River	330	51,341	4,209	2	780	500
Mattaponi River	262	46,601	3,036	7	986	390
Rappahannock River:						
From Deep Creek to Leedstown	18	3,712	335	2	1,250	515
Leedstown and above	83	13,080	1,445	3	770	295
Potomac River:						
Above Mattox Creek	118	67,000	6,155	8	13,600	13,700
Total	1,370	298,043	25,998	42	24,361	19,005

Waters.	Pound nets.		Miscellaneous.		Shore property.	Total value.
	No.	Value.	No.	Value.		
Chesapeake Bay:						
Western shore	404	$116,118	.....	.....	$26,915	$170,878
Eastern shore	50	14,900	.....	.....	650	19,545
James River and tributaries:						
Below Chickahominy River	6	585	.....	.....	1,045	9,252
Between Chickahominy and Appomattox rivers	.....	.....	.....	.....	2,560	12,254
Above Appomattox River	.....	.....	.....	.....	700	2,845
Chickahominy River	.....	.....	*a* 3	$45	2,187	6,568
Appomattox River	.....	.....	.....	.....	650	1,878
York River and tributaries:						
York River	90	16,375	*b* 64	842	2,015	25,373
Pamunkey River	.....	.....	.....	.....	1,220	7,497
Mattaponi River	.....	.....	.....	.....	1,195	7,063
Mobjack Bay	76	15,570	.....	.....	1,640	20,825
Rappahannock River:						
Below Deep Creek	100	23,462	.....	.....	1,050	32,423
From Deep Creek to Leedstown	100	12,500	*b* 8	190	1,305	20,922
Leedstown and above	31	1,995	*c* 19	760	596	5,709
Potomac River:						
Below Mattox Creek	157	24,925	.....	.....	900	32,308
Above Mattox Creek	142	10,250	.....	.....	15,525	58,140
Total	1,156	236,080	94	1,837	61,953	433,480

a Hedges. *b* Fyke nets. *c* Fall traps.

Statement, by water areas, of the yield of shad in each form of apparatus employed in the fisheries of Virginia in 1896.

Waters.	Stake nets.		Drift nets.		Seines.	
	No.	Value.	No.	Value.	No.	Value.
Chesapeake Bay:						
Western shore	43,553	$6,230	.....	.....	.....	.....
James River and tributaries:						
Below Chickahominy River	91,778	16,680	.....	.....	5,482	$480
Between Chickahominy and Appomattox rivers	9,928	1,644	162,655	$14,706	18,208	1,770
Above Appomattox River	.....	.....	33,385	2,709	.....	.....
Chickahominy River	.....	.....	131,643	9,589	17,510	1,297
Appomattox River	.....	.....	11,945	1,087	8,309	794
York River and tributaries:						
York River	42,640	5,132	.....	.....	250	25
Pamunkey River	1,281	119	180,642	14,911	2,334	175
Mattaponi River	.....	.....	169,799	16,200	10,117	755
Rappahannock River:						
From Deep Creek to Leedstown	104,118	8,242	7,580	571	6,792	678
Leedstown and above	.....	.....	32,774	2,586	2,948	295
Potomac River:						
Below Mattox Creek	600	58	.....	.....	.....	.....
Above Mattox Creek	10,910	1,558	142,400	11,729	79,385	6,471
Total	304,808	39,663	872,823	74,178	151,335	12,740

Waters.	Pound nets.		Miscellaneous.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Chesapeake Bay:						
Western shore	1,071,841	$102,803	.....	.....	1,115,394	$109,033
Eastern shore	36,408	4,085	.....	.....	36,408	4,085
James River and tributaries:						
Below Chickahominy River	3,119	361	.....	.....	100,379	17,521
Between Chickahominy and Appomattox rivers	.....	.....	.....	.....	190,791	18,120
Above Appomattox River	.....	.....	.....	.....	33,385	2,709
Chickahominy River	.....	.....	a1,800	$130	150,953	11,016
Appomattox River	.....	.....	.....	.....	20,254	1,881
York River and tributaries:						
York River	138,895	12,890	b590	64	182,375	18,111
Pamunkey River	.....	.....	.....	.....	184,257	15,205
Mattaponi River	.....	.....	.....	.....	179,916	17,045
Mobjack Bay	140,777	13,874	.....	.....	140,777	13,874
Rappahannock River:						
Below Deep Creek	194,067	17,579	.....	.....	194,067	17,579
From Deep Creek to Leedstown	51,575	3,923	b1,015	75	171,080	13,489
Leedstown and above	16,862	1,414	c58	8	52,642	4,303
Potomac River:						
Below Mattox Creek	167,870	18,237	.....	.....	168,470	18,295
Above Mattox Creek	49,660	5,031	.....	.....	282,355	24,789
Total	1,871,074	180,197	3,463	277	3,203,503	307,055

a Hedges. *b* Fyke nets. *c* Fall traps.

CHESAPEAKE BAY IN VIRGINIA.

In Chesapeake Bay and tributaries are located the principal shad fisheries of America, the annual yield approximating 5,000,000 in number, 40 per cent of the product on the entire Atlantic coast. This large aggregation of shad, as well as many more of which we have no evidence, annually passes through the 12-mile entrance between Capes Charles and Henry, sending a detachment of 500,000 or more up James River, an equal quantity up the York, nearly as many up the Rappahannock, 1,250,000 in the meantime being caught on the shores of the bay below Smith Point, thus reducing the number to 2,250,000 by the time the mouth of the Potomac is reached. That river attracts about 750,000, leaving 1,500,000 to pass into the middle and upper waters of Chesapeake Bay and tributaries. Each of these water areas or river

basins and its fisheries will be separately described, leaving for the present a notice of that portion of the bay proper located in Virginia.

Shad appear to pass up this water-course mainly along the western shore, attracted, doubtless, by the fresh water from the large tributaries entering on that side, over 90 per cent of the total catch being obtained on that shore. If conditions are such that during the early season the waters of the rivers are warmer than those of the Chesapeake, large runs of shad occur up the rivers. But if rains and melting snows send down cold waters during April and May, then the shad remain longer in the bay and large catches are made there. In this section of the Chesapeake shad are taken almost exclusively by means of pound nets, this being the location of the most extensive pound-net fishery on the Atlantic coast. Within an area 70 miles long and 10 miles wide, covering the western side of the bay and the mouths of the tributaries from the James to the Potomac rivers, there were set in the spring of 1896 738 pound nets, worth $185,025, taking 1,638,593 shad, worth $156,950 at local prices. Of the above, 334 nets, taking 566,752 shad, were located in the mouths of the various rivers, leaving 404 nets, with a yield of 1,071,841 shad, as the number on the western shore of the bay proper.

In the limits of Princess Anne County two pound nets were set in Lynn Haven Roads, in 3 or 4 fathoms of water, one net being set off the head of the other. They were very large, the leaders being 327 fathoms in length, with 3¾-inch mesh, and the crib 50 by 60 feet with 2¼-inch mesh. Fishermen from Norfolk County set two small nets on Craney Island Flats, in Hampton Roads, a short distance west of Elizabeth River. Of the pound nets in Elizabeth City County, 11 were located between Newport News Point and Fort Monroe, and 62 between Fort Monroe and Black River, in from 10 to 18 feet of water. Although not strictly within the legal limits of those waters, it is advisable to list the pound nets between Poquosin Flats and York Spit as in York River, since shad taken in those nets have left the main body and are proceeding up the York. For the same reason those nets between York Spit and New Point are listed as in Mobjack Bay, and the 36 nets on the south side of Rappahannock Spit outside of a line drawn from Windmill Point to Stingray Point, the legal limit of Rappahannock River, are listed as within that stream.

On the shore of Mathews County, from New Point to Stingray Point, there were 93 nets set in from 10 to 24 feet of water. The remaining 234 pound nets on the west shore are located between Rappahannock Spit and Smith Point on the shores of Lancaster and Northumberland counties, in depths of water ranging from 12 to 40 feet. Pound nets are more numerous in this section than on any other portion of the Atlantic coast, there being 87 in 1896, in an area 6 miles long and 3 miles wide immediately below Smith Point. These nets were set mostly in strings of 6 or 7 each, but sometimes many more, one string having 16 nets. The mesh is generally 4¼-inch, but a few nets are constructed

with 2½-inch mesh for retaining alewives. The season extends from the first or second week of March to the end of May. The largest catch of shad in any one net was 12,130, obtained in the outer one of five set off Taskmaker Creek; while the smallest catch was 200 shad taken in a net set especially for alewives on the south side of Fleet Point.

On the eastern side of the Chesapeake 18 large pound nets situated on the shore of Northampton County and 32 on the shore of Accomack County, during the spring of 1896, caught a few shad. The catch by those nets in Northampton County is usually very small, and especially so in 1896, owing to the strong winds causing the fish to avoid that shore more than usual. The nets in Northampton County are set quite late, generally after the first week of April, when most of the shad have passed by. During some seasons shad are taken on this shore in considerable abundance. In 1885 2,600 were taken in one lift of a pound net, whereas in 1896 the same net yielded only 780 shad during the whole season. Of the 32 pound nets on the shore of Accomack County, 23 were set on Tangier Island and the remaining 9 on the east side of Pocomoke Sound. The season begins about March 20, and the last shad are taken about the end of June, the nets remaining in the waters until the end of September, catching quantities of bluefish, squeteague, Spanish mackerel, etc.

The following summary shows by counties the location and extent in 1896 of the pound-net fishery of that portion of the Chesapeake Bay located in Virginia, not including the nets operated in Mobjack Bay or at the mouths of York or Rappahannock rivers:

Counties.	Pound nets.		Boats.		Men.	Shad caught.	
	No.	Value.	No.	Value.	No.	No.	Value.
Western shore:							
Princess Anne	2	$2,500	1	$75	8	15,000	$2,300
Norfolk	2	500	2	75	2	7,500	800
Elizabeth City	73	20,975	101	2,525	105	163,722	17,541
Mathews	93	26,270	60	6,315	152	275,452	26,475
Lancaster	61	17,543	41	4,490	66	149,117	13,253
Northumberland	173	48,330	151	12,690	285	461,050	42,434
Eastern shore:							
Northampton	18	11,100	24	1,040	63	6,831	716
Accomack	32	3,800	33	2,355	46	29,577	3,369
Total	454	131,018	413	30,165	727	1,108,249	106,888

NOTE.—The Gloucester County pound nets located in York River and Mobjack Bay, and the Mathews County nets in Mobjack Bay, and the Lancaster County nets in Rappahannock River are not included in the foregoing.

MOBJACK BAY.

On the western side of the Virginia section of Chesapeake Bay there are 4 large coastal indentations which support important shad fisheries. Of these, 3 are estuaries of rivers, viz, James, York, and Potomac. The fourth, Mobjack Bay, receives the waters of a number of small streams, as Severn, Ware, North, and East rivers, yet it is a side elongation of Chesapeake Bay, 12 miles in length and 3 or 4 miles wide, with depth of water ranging from 18 to 25 feet.

Pound nets are the only apparatus used for taking shad, the number in 1896 being 76. Of these, 27 were located on the northeast side of the bay from New Point to the mouth of East River, and 49 on the southwest side between York Spit light and the mouth of Severn River, the nets on the north side of York Spit being listed as within this bay. These pound nets differed in no particular from those used in the Chesapeake, except that they were generally somewhat smaller, costing about $200 each. Shad were fairly abundant, but about the middle of March the fishing was injured by high winds, and the total catch for the year was less than usual, numbering 72,852 roe shad and 67,925 bucks. The fishermen of Mobjack Bay, as well as those of the Chesapeake, complain of the extremely low prices received, the local value of the 140,777 shad taken in this bay being only $13,874.

JAMES RIVER.

James River is formed by the junction of Jackson and Cowpasture rivers in Botetourt County and empties into Chesapeake Bay about 20 miles from the ocean, the entire river and all its tributaries lying wholly in Virginia. The total length, following its sinuosities, is about 335 miles, but in a straight line it is only 200 miles from the headwaters to the mouth. In the lower portion the width ranges from 2 to 6 miles, while from the entrance of the Chickahominy, 50 miles from the mouth, to the entrance of the Appomattox the average width of the river is less than 1 mile. At the entrance of the Appomattox the fluvial characteristics begin, and thence to Richmond the banks are quite steep and the course narrow and tortuous. The river is navigable for vessels drawing 16 feet to the head of tide water at Richmond, 111 miles distant from the mouth.

At Richmond there are numerous falls and rapids extending through a rocky bed a distance of 3 miles, in which the total descent is about 84 feet, and in these rapids there are several dams, supplying power to mills in Richmond and Manchester. These obstructions, however, do not entirely block the upward passage of shad, being low and extending only partly across the stream. Nine miles above Richmond is Bosher's dam, from 9 to 12 feet in height and 900 feet in length, entirely crossing the channel, forming a barrier to the further ascent of shad. If this dam were made passable, little benefit would be accomplished unless numerous other obstructions were similarly improved, there being 14 dams from 9 to 16 feet high within the 200 miles above Bosher's dam.

Prior to the erection of these obstructions large numbers of shad ascended as far as the junction of Jackson and Cowpasture rivers, and were taken in considerable quantities in those two tributaries over 335 miles from Chesapeake Bay. According to Marshall McDonald, the annual catch of shad between Richmond and Lynchburg was at one time far in excess of the present yield for the entire river, and even in the Valley of Virginia, west of the Blue Ridge, seine fisheries were

operated with profit. From April 1 to April 10, 1779, 2,200 shad were taken in one seine located at Wood Island, 100 miles above Richmond. At present few shad pass above the falls at Richmond, and practically none go higher than Bosher's dam.

The shad fisheries of James River are naturally divisible into three geographical sections, viz: (1) from the mouth of the river to the entrance of Chickahominy River, this portion being strictly an arm of the Chesapeake Bay; (2) from the Chickahominy to the entrance of Appomattox River at City Point, and (3) from the Appomattox to the foot of Bosher's dam, 9 miles above Richmond. Of the 324,555 shad taken in 1896, 100,379 were caught in the lower section, 190,791 between Chickahominy and the Appomattox, and 33,385 above the Appomattox.

The principal form of apparatus below the Chickahominy is the stake net, with an occasional pound net and seine. Between the Chickahominy and the Appomattox drift nets and seines are used, and thence to Richmond Falls the drift net is the only form of apparatus. In the falls there are a number of traps which take a few shad.

From Chesapeake Bay to Chickahominy River.—On the lower section of the James there were 84 strings of stake nets in 1896, each containing from 20 to 90 nets. The nets were each 30 feet long, from 40 to 70 meshes deep, with 5-inch mesh. The cost of the nets varies according to the depth of water in which set, but averages about $60 for a string of 50 nets, divided as follows:

Twine, 30 lbs. at 75 cents each	$22.50
Poles, 51 at 15 cents each	7.65
Skinning 51 poles at 7 cents each	3.57
Sticking 51 poles at 20 cents each	10.20
Hanging 50 nets at 11 cents each	5.50
Rings, 100 at 6 cents each	6.00
Rope, 50 lbs. at 10 cents each	5.00
Total	60.42

The strings of nets are set across the current on the sides of the channel in depths ranging from 8 to 18 feet. The season begins during the first week of March and ends about the last week of April. Fishing could be extended several weeks later, but on account of the low prices of shad and the deleterious effect of the warm water on the nets it is not generally profitable. Even with less than two months' fishing it is usually necessary to replace the nets at least once. In the 84 strings operated in 1896, containing 3,898 stations, there were used in all about 8,719 nets. The catch numbered 91,778 shad, of which 31,026, or 33.8 per cent, were bucks, the small proportion being due to the large mesh of the nets permitting them to pass through.

Just opposite Newport News, on either side of the channel, there were three small pound nets, worth about $100 each, which caught a few shad, the total yield being 3,119. These are the only pound nets used on the James, there being an interdiction against their use in this stream above Newport News.

Two seines were operated in 1896, one at Piney Grove in James City County, and the other at Swan Point in Surry County. These were

about 700 yards long, with 3-inch mesh in the bunt, and required the services of 9 men each. The season began May 12 and ended about the last of April, the catch of shad aggregating 5,482 in number, of which 4,355 were bucks.

From Chickahominy to Appomattox.—On the middle section of James River drift nets constitute the principal form of apparatus, yet a few seines are used, and in the extreme lower end there were 8 strings of stake nets in 1896. These strings, containing 235 nets, were operated by men living at Claremont and Sandy Point, taking 9,928 shad. The drift nets measure about 350 yards in length and 65 to 80 meshes deep, with 5-inch mesh. Where the channel is narrow, as from Coggins Point to City Point, this length is divided into two or three sections. On the shoal grounds between Coggins Point and City Point a number of shallow nets, 30 meshes deep, are used. These contain from 4 to 6 pounds of twine and are usually operated in two sections. Other than in depth they resemble in every particular the nets used in the channel. The total number of drift-net boats in the middle section of James River in 1896 was 182, using 69,727 yards of twine, and the catch of shad numbered 162,655, valued locally at $14,706.

Between the Chickahominy and the Appomattox there were formerly many seine beaches, most of which are now abandoned on account of the unprofitableness of the fishery and, in one or two cases, destruction of the beaches by engineering operations tending to improve the navigation of the river. In 1896 only four seine shores were operated, viz: Harrison Landing, Beechwood, Coggins Point, and Flowerdew Hundred. The seines were from 250 to 500 yards in length, with $2\frac{1}{2}$ and $2\frac{3}{4}$ inch mesh, and the yield of shad was 18,208, valued locally at $1,770. The large proportion of bucks in the catch of these seines is somewhat noticeable, numbering 13,385, or 73 per cent of the total yield, this being due doubtless to the large quantity of roes caught in gill nets in the lower part of the river.

From Appomattox to Bosher's Dam.—Above the entrance of Appomattox River drift nets are the only apparatus used in the James River shad fisheries. The principal fishing centers are Bermuda Hundred, Turkey Creek, and Deep Bottom, while a few nets are used above Dutch Gap, in Cox and Graveyard reaches. Formerly drift nets were used in Trent and Coal Yard reaches, situated in the loop of James River around Farrors Island, but since the opening of Dutch Gap that portion of the river has shoaled to such an extent that it is impracticable to drift in it. On account of the narrowness of the channel the nets above City Point are much shorter than those below, the length ranging from 40 to 100 yards. Usually two nets are operated by each boat, requiring the services of two men. The mesh is from $4\frac{7}{8}$ to $5\frac{1}{4}$ inches and the depth from 50 to 110 meshes. The season begins about the last week of March, three or four weeks later than at the mouth of the river, and closes about the end of May or first of June. In 1896 128 drift nets were used, the catch amounting to 33,385 shad, worth $2,709 at local valuation. Of this yield, 23,387, or 70 per cent, were bucks.

In the falls at Richmond there are numerous finger or fall traps, in which several hundred shad are taken annually while endeavoring to pass above the rapids. At one time the number of these fall traps exceeded 150, but the catch has been so small during recent years that the worn-out traps have not been replaced.

Chickahominy River.—The Chickahominy, one of the finest shad streams of the United States for its size, rises in Henrico County, 12 miles northwest of Richmond, and after flowing a distance of 60 miles empties into James River 50 miles from the Chesapeake Bay. Windsor Shades bar, 27 miles from its mouth, is the present head of navigation, a minimum depth of 8 feet existing to that point, the width of the channel ranging from 100 to 250 yards. Thence to Providence Forge, a distance of 5 miles, the channel is tortuous, 20 to 80 feet in width, flowing between low swampy banks, which open into lagoons or bays of wide water. From Providence Forge to Long Bridge, about 10 miles, the Chickahominy is a cypress swamp of from one-half to 1 mile in width, intersected by a channel 20 to 50 feet wide. Shad fisheries extend throughout the length of the Chickahominy, yet they are most extensive in the vicinity of Lanexa. The total catch of shad on this river in 1896 was 150,953, of which 131,643 were taken by means of drift nets, 17,510 by seines, and 1,800 by "hedgings." Of the total yield 103,748, or 68 per cent, were bucks.

In the lower portion of the Chickahominy and in the vicinity of Lanexa the drift nets contain each about 5½ pounds of No. 50 twine, 55 to 60 meshes deep, with 5-inch mesh. From Winns Landing to Providence Forge the nets contain from 1½ to 2 pounds of twine, 45 meshes deep, with 4⅞-inch mesh. The length of the 5½-pound net averages 200 yards, and of the 1¾-pound net 70 yards. The length of twine used by the 160 boats in 1896 measured 28,842 yards, one man being required for each boat. The season began about March 10 and closed some time near the middle of May. The yield was an average of recent years, aggregating 131,643 in number, of which 40,777 were roes and 90,866 were bucks. Eight seines were used in the Chickahominy during the same year, of which the largest, about 1,000 yards in length, was operated at Ferry Point, near the mouth of the river. This seine, however, is not used especially for taking shad, that species forming only a small proportion of the total catch. The lengths of the other seven seines range from 260 to 175 yards and the mesh from 1¾ to 2½ inches. The aggregate value of the 8 seines was $1,155, the number of men employed 43, while the total catch of shad numbered 17,510, worth $1,297 at the local valuation.

A short distance above Providence Forge, where the river is only a few feet in width, there are three or four hedges or pockets, each consisting of a crude dam, 2 or 3 feet high, permitting the passage of shad only through the current passing through an opening therein. A fisherman stands at this opening with a net in hand ready to lift out such fish as may attempt the passage. At the hedges operated in 1896 1,800 shad

were taken. The greater proportion of the fish caught by this method are either ripe or have already spawned.

Chickahominy River in the vicinity of Lanexa presents favorable conditions for the establishment of an auxiliary shad hatchery. Within a distance of 10 miles on either side of that station over 130,000 shad are taken annually, of which about 45,000 are roes. If 3 per cent of them are suitable for hatching purposes sufficient fertilized eggs would be secured to support an extensive hatchery. Large supplies could also be drawn from the James and the Pamunkey, each about 15 miles distant from Lanexa. The ripe fish could be obtained very cheaply and the shipping facilities are good, the main branch of the Chesapeake and Ohio Railroad passing along the river bank.

Appomattox River.—This river, the longest affluent of the James, rises in Appomattox County, Va., and after flowing about 140 miles empties into the James at City Point. Shad ascend only 13 miles to Petersburg, their progress above that city being barred by numerous rapids and dams. In a distance of 6½ miles above the city there are 5 dams, each from 2½ to 8 feet high, and numerous falls and rapids, giving a total descent of 110 feet. Shad are taken in the Appomattox by means of drift nets and seines. The former are operated at Broadway, in Prince George County, and at Covington Beach or Cat Hole, in Chesterfield County, the total number of nets in 1896 being 46. These nets are from 100 to 200 yards in length, 45 to 70 meshes deep, with 5-inch mesh, and two men and one boat are required for each. The men live mostly in Petersburg, camping on the shores during the season, paying the owners for the privilege at the rate of one shad per week for each fisherman. The season begins the second week in March and continues about two months. The catch during 1896 was 3,835 roe shad, 8,110 bucks, with a local valuation of $1,087.

The seines used in Appomattox River were located as follows: One at City Point, one at Gatlin Beach, two at Covington Beach, and one at the mouth of Swift Creek. They measure from 200 to 275 yards each in length, about 80 meshes deep, with 2½-inch mesh. The shore rental paid for the five seines aggregates $225 annually. The season is coincident with that of the drift nets in the same locality, and the aggregate catch of shad in 1896 was 8,309, valued locally at $794.

In the falls of the Appomattox just above Petersburg there are about 20 fall or finger traps, in which a few shad are taken with herring and other species. The catch of shad is at present very much less than it was twenty years ago, probably not exceeding 50 in 1896.

YORK RIVER.

York River is formed by the junction of Pamunkey and Mattaponi rivers at West Point, and, following a southeasterly course for a distance of 41 miles, it unites with Chesapeake Bay about 16 miles north of Fort Monroe. It is really an arm of Chesapeake Bay, with an average width of about 1½ miles, possessing no fluvial characteristics

whatever. The water of York River is brackish nearly to West Point, oysters being planted within 6 miles of that town. Pound nets and stake nets represent the principal forms of apparatus used in the shad fisheries, and a few shad are taken incidentally in fyke nets and seines. The catch of shad in 1896 was 182,375, of which the pound nets yielded 138,895, stake nets 42,640, fyke nets 590, and seines 250.

Of the pound nets 53 were set on the north side of the river, between York Spit Light and Gloucester Point; 34 on the south side, near Toos Point and Poquosin Flats, and 3 near Plum Point, at the head of the river, making a total of 90 nets. Excepting the 3 near Plum Point and 23 on the shore of York County, all of these nets are owned in the southeastern portion of Gloucester County, mostly in the settlement known as Guinea. They range in value from $50 to $500, averaging about $200 each, and with some repairs will last for several seasons. The depth of water ranges from 10 to 20 feet, the leaders being set across the current. Each fishing company has from 1 to 7 nets, and uses sailboats averaging $100 in value, the total number of sailboats being about one-half the number of pound nets used. The season begins the first week in March and closes about the end of May, the greater part of the catch being obtained during April. Of 5,243 shad taken in 4 pound nets in 1896 1,262 were obtained in March, 3,170 in April, and 811 in May. The catch in 1896 was unusually small, the total yield of shad in the 90 pound nets being only 138,895, an average of 1,543 per net. The largest yield for any one net was 4,380. In addition to this species, the pound nets take alewives, Spanish mackerel, squeteague or sea trout, bluefish, croakers, pompano, etc.

The stake nets in York River are located on both sides of the channel from Cappahosack to West Point, but most abundantly between Potopotank Creek and Plum Point, being set in rows of from 10 to 20 nets in from 11 to 14 feet of water. The nets are 6 to 9 yards long, 35 meshes deep, with 5-inch mesh. They last only about three weeks, two settings being required for each season. The season begins about March 1, although most of the nets are not out until the middle of that month, and closes the third or fourth week of April. Nearly all of the fishermen are also farmers, and agricultural operations shorten the fishing season. In 1896 58 boats engaged in this fishery, using 990 stake nets, 6,461 yards in length, and the catch aggregated 28,232 roe shad, worth $3,949, and 14,408 bucks, worth $1,183. Except sufficient for local use, all the catch was sent to Baltimore by the steamers running between that port and West Point.

During the past season two fishermen from Indiantown, on the Pamunkey River, attempted to take shad with drift nets in the narrow portion of York River between Gloucester Point and Yorktown, where the width is a trifle over a half mile. Their nets were 200 yards long, 65 meshes deep, with 5-inch mesh. After working about ten days without success they abandoned their attempt. It should be noted that the depth of water in this portion of York River is 80 feet or more, whereas the nets used were only about 15 feet deep.

Pamunkey River.—This river, which takes its name from a tribe of Indians, the remnant of which is yet engaged in shad fishing in its waters, is formed by the junction of the North Anna and South Anna rivers a short distance above Hanover Court-House, whence it flows a distance of 100 miles to its union with the Mattaponi at West Point. It is navigable, during eight or nine months of the year, for vessels drawing 5 or 6 feet of water, as far as Wormley Landing, 54 miles above West Point. Above Wormley Landing the river is tortuous, much obstructed by logs and brush, and from 40 to 120 feet wide. Shad ascend the Pamunkey in considerable numbers throughout its length, but are taken in greatest abundance in the lower 30 miles. Of the 184,257 shad caught in 1896 180,642 were taken by means of drift nets, 2,334 by seines, and 1,281 in stake nets.

The drift nets are operated throughout a distance of 43 miles from the mouth of the river, and principally for a distance of 10 miles below and the same distance above Lester Manor, 24 miles from York River. The drift nets below Williams Ferry average 150 yards in length, 55 to 70 meshes deep, with 4⅞ or 5 inch mesh. Above Williams Ferry the length ranges from 130 to 75 yards and the depth from 50 to 35 meshes. Below Williams Ferry two or three nets are carried by each boat, requiring the services of two men. Above that point, where the fishing is for local use exclusively, each boat has but one net, and in some instances but one man. When more than two nets are used the extra nets are old ones, which can be used only during weak tide or slack water. A total of 330 nets, 51,341 yards in length, were used by the 153 boats in 1896, the catch numbering 180,642 shad, for which the fishermen received $14,911. Below White House the season begins during the first week of March and closes some time in May, depending on the run of fish and the market price. At some landings the sturgeon fishery or agricultural operations shorten the season. Above Williams Ferry the season begins during the third and fourth week of March and closes about the 10th or 15th of May.

Several rows of stake nets are set in the extreme lower end of the Pamunkey during March and April. These are similar to the nets in the upper portion of York River, and their catch in 1896 was only 1,281 shad. There were two seines operating in this river during the past year, one at Smith Ferry and the other at Sweet Hall, distant 21 and 24½ miles respectively from the mouth of the river. The former was distinctively a shad seine, while the latter was used also for alewives, striped bass, etc. The yield of shad by the two seines was 2,334, of which 1,490 were bucks. Very few were taken in the upper one of these seines, it being shoal, and during the work of deepening it the shad passed by. In the narrows of the Pamunkey, near Hanover Court-House, there are several "hedgings," which take a few shad each year, probably not exceeding 500. It does not appear that shad pass above Hanover Court-House in any considerable numbers, and probably none are taken in South Anna and North Anna rivers.

There are few places south of Potomac River better adapted to shad-hatching operations than the Pamunkey between Hill's Landing and White House Station. Within a river length of 16 miles, the distance in a straight line approximating 6 miles, there were in 1896 109 drift-net boats, taking 154,072 shad, and two seines taking 2,334 shad, a total of 156,406. Of these 70,383, or 45 per cent, were roe shad, of which about 14,000 were taken after April 20. It is reported that 10 per cent of the roe shad taken after April 20 are suitable for fertilization, making a total of 1,400 that may be used for this purpose. This does not include the ripe fish that may be obtained prior to April 20, nor the number that may be drawn from the Mattaponi, 6 to 8 miles distant, or the Chickahominy, within 15 miles, each of which would yield nearly, if not quite, as many as the Pamunkey. This section of the stream is bordered by the West Point branch of the Southern Railway, giving convenient shipping facilities.

Mattaponi River.—The Mattaponi rises in Spottsylvania County, and after flowing a distance of over 120 miles unites with Pamunkey River at the head of York River. The lower 60 miles from the mouth to Aylett is navigable and has considerable traffic. From Aylett to Mundy's Bridge, a distance of 26 miles, the channel is obstructed by logs, drift, and overhanging trees, yet it is navigated by rafts and small boats. The Mattaponi is not quite so large or so deep as the Pamunkey, but is otherwise quite similar, and there is even less difference in the extent and characteristics of the shad fisheries of the two streams. As on the Pamunkey, drift nets and haul seines are the means of capture, the yield by the former apparatus being by far the greater.

The drift nets are similar in every particular to those used on Pamunkey River, except that they are somewhat longer, with a smaller number to each boat, the length of the 262 nets on this stream in 1896 aggregating 46,601 yards. The total catch by the 153 boats numbered 169,799, valued locally at $16,290. While a large portion of this catch is sold locally, most of it is sent by boat or hauled across land to the West Point branch of the Southern Railway, and thence shipped to Richmond and other distant markets.

The seven haul seines on the Mattaponi were used at the following points: Savage's, Walkerton (2 seines), Gathney's, Bugley's, and Jones Landing in King and Queen County, and at Pointer Landing in King William County. They range in length from 280 yards to 50 yards, the mesh being 2½ inches. The season begins generally during the first week of April and extends to about the end of May; but at Savage, 16 miles above West Point, the season is somewhat earlier than this. The total catch by the above seven seines was 10,117 shad, the smallest for a number of years. There were formerly several small seines above Pointer Landing, as well as at other places on the Mattaponi, but they have given way to the cheaper and more effective drift nets.

RAPPAHANNOCK RIVER.

This river rises on the eastern slope of Blue Ridge Mountains, in Fauquier and Rappahannock counties, and crosses the fall line at Fredericksburg, the head of navigation, 106 miles from its mouth, following the course of the river. The fluvial characteristics extend only about 40 miles below the fall line and the lower 50 miles is really an arm of Chesapeake Bay. About 2 miles above Fredericksburg there is a dam 900 feet long and 18 feet high, built in 1860 and used for developing water-power, which completely blocks the upward passage of fish.

In describing the shad fisheries of the Rappahannock, the river is naturally divisible into three sections: (1) from the mouth to Deep Creek, the boundary line between Lancaster and Richmond counties, 26 miles; (2) from Deep Creek to the boundary line between Westmoreland and King George counties, 45 miles; (3) thence to Fredericksburg, 36 miles.

From Chesapeake Bay to Deep Creek.—The lowest of these three sections is purely an arm of the Chesapeake, the width ranging from 4 to 2¼ miles. Pound nets, which constitute the only form of apparatus used for taking shad, were introduced in this locality in 1872, and their use has increased each year, the number employed in 1896 being an even 100, valued at $23,462. Fifty-seven of these were located at the extreme end of the north side of the river between Windmill Point Light and Windmill Point Creek, the depth of water ranging from 10 to 25 feet. The remaining 43 nets were located as follows: Twelve between Mosquito Point and the mouth of Corrotoman River, and 12 between the Corrotoman and Deep Creek on the north side; and on the south side, 8 near the mouth of the river and 11 between Urbanna Creek and Parrott Creek. The difference in the number of nets set on the north and south side of the river—81 and 19 respectively—is quite remarkable, due to the rough water and fewer fish on the south side.

The mesh in the heart of the pound nets is generally 4¼ inches, but a few of the nets have 2½-inch mesh, for retaining alewives also. The latter species are so cheap, however, that very few fishermen in this region bother with them. Each pound-net company has from 2 to 7 nets, requiring the services of an equal or greater number of men, and one or two sailboats, worth from $50 to $400 each, and one or two rowboats. The total number of men engaged in operating the 100 pound nets was 116, using 43 sailboats, valued at $6,321, and 31 rowboats, worth $690.

The season began during the last week of March and closed about the first of June, the greater portion of the catch being obtained from April 10 to May 10. The total catch was 194,067 shad, valued locally at $17,579. Of these, 46 per cent were roe shad and 54 per cent bucks. The pound nets also caught about 500,000 alewives and quantities of squeteague, bluefish, sturgeon, etc.

Except such as are sold locally the yield of shad in the pound nets,

as well as in other apparatus set in the Rappahannock, is sent to Baltimore by the daily steamers serving that river.

From Deep Creek to Layton.—In the second of the three sections of Rappahannock River, covering Essex, Richmond, and Westmoreland counties, the forms of apparatus used are stake nets, pound nets, drift nets, seines, and fyke nets. The total catch of shad in 1896 was 171,080, valued locally at $13,489, of which 104,118 were taken in stake nets, 51,575 in pound nets, 7,580 in drift nets, 6,792 in seines, and 1,015 in fyke nets.

The pound nets in this section are much smaller than those near the mouth of the river, averaging in value $125 each against $235 near the mouth. They are usually set singly, but occasionally two and even three are set in one string, especially between Sharp's wharf and Tappahannock. Along the northeast side of the river there were 63 pound nets, 52 on the shore of Richmond County and 11 on the Westmoreland shore. On the opposite side—the Essex County shore—there were 37 pound nets, making an even 100 nets for this section of the Rappahannock. The catch was smaller than for several years preceding. Three pound nets set near Sharp's wharf caught 4,442 shad in 1895 and 3,872 in 1896, 764 of the latter being obtained in one day. The total yield in 1896 was 51,575, valued at $3,923, 38 per cent of these being roes.

All the stake nets on Rappahannock River are located in this section, and they extend throughout the 38 miles from Deep Creek to Leedstown. They are 8 or 9 yards long, 10 to 20 feet deep, with 4½ to 5 inch mesh, of linen twine, and must be renewed each season, if not more frequently. They are set in strings of 10 to 30 nets on the sides of the channel at intervals of a few hundred feet. The total number in use in 1896 was 3,263, aggregating 27,164 yards in length, the yield of shad numbering 104,118, valued locally at $8,242. The stake-net season began about March 20 and ended the last of April, the greater portion of the yield being obtained during the first two weeks of April. Comparing the stake-net fishery of the Rappahannock with that of James River, it appears that the yield in the latter stream was 101,706 shad, or 2,412 less than in the former. But the value of the catch in the James was $18,524, over twice that of the Rappahannock, the difference being due principally to the season in the James being nearly three weeks earlier than in the latter stream.

The drift nets in the middle section of Rappahannock River are operated in the extreme upper end thereof above Leedstown. They average over 200 yards in length, 5-inch mesh, 60 meshes deep, and cost about $20 each, 2 nets being used by each boat, which requires the services of 2 men. The season extends from the last week in March to the first of May. The catch of the 9 drift-net boats in 1896 was 7,580 shad, worth locally $571, of which 40 per cent were roes, the percentage being greater than for several years preceding.

Two shad seines were used on the shore of Essex County, one at Mallory Point and the other at Port Tobacco, at distances of 46 and 71

miles, respectively, from the mouth of the river. These seines were 450 and 800 yards long, respectively, with 2 and 2½ inch mesh, and required the services of 6 or 7 men each. The season extended from the last week of March to the end of May, and at the lower beach 815 shad were taken, of which 585 were bucks, while at the upper one the yield of shad was 5,977, of which 3,791 were bucks. Both of these seines are also used throughout the year for taking other fish. Prior to 1885 a hatchery was operated on the opposite side of the river from the Port Tobacco seine, utilizing the eggs therefrom.

A few shad are taken during March and April in the fyke nets set near Tappahannock. Eight nets were used in 1896 worth $190, and the yield of shad numbered 1,015, of which 460 were roes and 555 bucks.

From Tobago Bay to Fredericksburg.—The upper end of the navigable portion of Rappahannock River consists of a tortuous stream, 36 miles in length, 50 to 250 yards wide in its upper 28 miles, broadening out at its lower end, and terminating in two small bays—Nanzatico and Tobago—a mile or more across. The counties bordering this section are King George, Caroline, Stafford, and Spottsylvania. Drift nets, pound nets, and seines are used for taking shad, and at the extreme upper limit, in Falmouth Falls above Fredericksburg, there are several fall or finger traps. The drift nets and pound nets are used from Tobago Bay to Hop Yard, the lower 17 miles, and the seines are used at the two extremities. Of the 52,642 shad obtained in 1896, 32,774 were caught by drift nets, 16,862 by pound nets, 2,948 by seines, and 58 by fall traps.

The drift nets measure from 75 to 100 yards in length, 30 to 52 meshes deep, with 5-inch mesh, and cost from $12 to $20 each. Near Port Royal the season begins about the second or third week of March and lasts about two months. In the short drifts, fishing is prosecuted only during slack water. When the water is clear fishing is restricted to the night time, but when it is muddy the fishermen operate mostly during the day. Of the 32,774 shad taken by these nets in 1896, 19,941, or 61 per cent, were bucks.

The pound nets in the upper section are very small, averaging about $65 in value each. Excepting two strings just below Oaken Brow, one containing 4 and the other 3 nets, all of the pound nets are set singly. An average of $10 is paid for shore rental for each net. The season extends throughout the months of April and May, and about 5 per cent of the catch is reported as being ripe roe shad. The total catch of shad by the 31 pound nets numbered 16,862, valued locally at $1,414, of which 6,285 were roes.

A 500-yard seine, with 2½-inch mesh and 8 feet deep, was operated on the upper side of Tobago Bay in 1896, taking 2,892 shad from March 20 to May 20. In addition to this seine there were two others, 150 yards in length each, with 2½-inch mesh and 6 feet deep, operated on the Stafford County shore, opposite Fredericksburg. Very few shad were taken in these two seines, the total number being 56, of which 49 were bucks.

In the falls of the Rappahannock above Fredericksburg and adjacent to Falmouth there are 19 fall or finger traps, which take many alewives and a few shad, the number of the latter in 1896 approximating 58, of which 38 were bucks. There are no shad whatever reported from this stream above Falmouth Falls.

POTOMAC RIVER.

Although the Potomac River forms the boundary line between Virginia and Maryland, it is located wholly within the limits of the latter State. By a compact made in 1785 a right of fishery in this river exists in common between citizens of the two States, citizens of Virginia enjoying equal privileges with those of Maryland. This makes it convenient to describe the shad fisheries of both sides of the river at the same time, and as the river is situated wholly in the limits of Maryland, this discussion is placed in the chapter on the shad fisheries of that State (page 199). It will suffice to note in this place that the yield of shad on the Potomac during 1896 numbered 684,063, of which 450,825, worth $43,084, were taken by residents of Virginia.

THE SHAD FISHERIES OF MARYLAND.

The extent, by water areas, of each branch of the shad fisheries of Maryland in 1896 is presented in the following series of three tables, showing (1) the number of persons employed, (2) the boats, apparatus, etc., used, and (3) the number and value of shad taken.

Statement, by water areas, of the number of men employed in each branch of the shad fisheries of Maryland in 1896.

Waters.	Number of fishermen.						Total, exclusive of duplication.	Shoresmen.	Transporters.	Total.
	Gill-net.		Seine.	Pound-net.	Fyke-net.	Bow or dip-net.				
	Drift.	Stake.								
Chesapeake Bay:										
Below Swan Point—										
Eastern Shore	.....	64	.....	27	.....	.....	91	.....	.....	91
Western Shore	.....	.....	.....	76	.....	.....	76	.....	.....	76
Above Swan Point—										
Eastern Shore	310	101	110	37	.....	.....	548	24	.....	572
Western Shore	206	.....	206	8	.....	.....	420	247	13	680
Potomac River	241	.....	87	116	.....	25	469	39	4	512
Patuxent River	19	.....	47	24	.....	.....	90	.....	.....	90
Pocomoke River	36	.....	24	.....	4	191	253	.....	.....	253
Wicomico River	180	19	20	6	9	.....	230	.....	.....	230
Nanticoke River	146	32	.....	20	26	.....	210	.....	.....	210
Marshyhope Creek	76	.....	40	9	.....	.....	125	.....	.....	125
Fishing Bay	.....	21	.....	5	.....	.....	23	.....	.....	23
Transquaking River	.....	.....	.....	24	.....	40	64	.....	.....	64
Blackwater River	36	.....	.....	27	.....	.....	62	.....	.....	62
Choptank River	236	68	71	135	6	.....	490	.....	.....	490
Tuckahoe Creek	75	.....	44	8	6	.....	127	.....	.....	127
St. Michael River	.....	60	.....	.....	.....	.....	60	.....	.....	60
Chester River	4	109	65	61	33	.....	266	.....	.....	266
Sassafras River	.....	.....	.....	21	.....	.....	21	.....	.....	21
Elk River	.....	.....	.....	85	.....	.....	85	.....	.....	85
Susquehanna River	98	.....	295	.....	a 9	8	406	71	.....	477
Total	1,663	474	1,009	689	93	264	4,116	381	17	4,514

a Fall-trap.

Statement, by water areas, of the boats, apparatus, etc., employed in the shad fisheries of Maryland in 1896.

Waters.	Boats.		Drift nets.			Stake nets.			Pound nets.	
	No.	Value.	No.	Length.	Value.	No.	Length.	Value.	No.	Value.
Chesapeake Bay:										
Below Swan Point—				*Yards.*			*Yards.*			
Eastern Shore	53	$1,530	.....	.....	.....	154	5,580	$616	22	$4,215
Western Shore	41	3,570	.....	.....	.....	.....	.....	.....	86	11,224
Above Swan Point—										
Eastern Shore	191	10,938	433	138,680	$11,154	1,322	32,900	3,745	63	3,885
Western Shore	186	38,410	654	110,350	9,925	.....	.....	.....	6	900
Potomac River	195	6,945	118	94,500	6,230	.....	.....	.....	131	8,175
Patuxent River	43	975	18	1,205	185	.....	.....	.....	33	4,116
Pocomoke River	126	729	40	2,180	322	.....	.....	.....	.....	.....
Wicomico River	194	1,470	307	20,040	2,884	70	1,400	290	5	470
Nanticoke River	109	2,459	151	22,429	3,376	282	3,788	084	26	2,635
Marshyhope Creek	51	485	75	7,160	912	.....	.....	.....	12	380
Fishing Bay	16	890	.....	.....	.....	388	6,930	459	4	260
Transquaking River	42	590	.....	.....	.....	.....	.....	.....	a 29	1,495
Blackwater River	53	490	46	1,840	184	.....	.....	.....	39	1,575
Choptank River	244	3,981	454	35,990	4,704	1,469	23,280	2,500	185	11,851
Tuckahoe Creek	57	659	117	8,802	1,140	.....	.....	.....	9	290
St. Michael River	31	555	.....	.....	.....	92	3,690	275	.....	.....
Chester River	141	2,718	2	290	45	178	7,020	963	b 81	5,515
Sassafras River	14	340	.....	.....	.....	.....	.....	.....	b 31	1,810
Elk River	41	2,268	.....	.....	.....	.....	.....	.....	b 139	8,020
Susquehanna River	148	24,490	223	28,672	3,403	.....	.....	.....	.....	.....
Total	1,976	104,492	2,638	472,138	44,464	3,955	84,588	9,532	901	66,816

Waters.	Seines.			Fyke nets.		Bow nets.		Shore property.	Total value.
	No.	Length.	Value.	No.	Value.	No.	Value.		
Chesapeake Bay:		*Yards.*							
Below Swan Point—									
Eastern Shore	.....	.....	.....	.....	.....	.....	.....	$860	$7,221
Western Shore	.....	.....	.....	.....	.....	.....	.....	925	15,719
Above Swan Point—									
Eastern Shore	2	4,700	$3,300	.....	.....	.....	.....	4,130	37,152
Western Shore	5	7,500	7,100	.....	.....	.....	.....	17,575	73,910
Potomac River	5	3,040	4,000	.....	.....	3	$6	5,100	30,456
Patuxent River	10	1,700	1,815	.....	.....	.....	.....	653	7,744
Pocomoke River	6	462	194	16	$204	97	505	871	2,825
Wicomico River	3	630	330	36	399	.....	.....	1,844	7,087
Nanticoke River	.....	.....	.....	143	2,495	.....	.....	1,105	12,754
Marshyhope Creek	8	545	410	.....	.....	.....	.....	2,970	5,157
Fishing Bay	.....	.....	.....	.....	.....	.....	.....	85	1,094
Transquaking River	.....	.....	.....	.....	.....	20	90	80	2,255
Blackwater River	.....	.....	.....	.....	.....	.....	.....	130	2,379
Choptank River	14	3,293	1,460	23	236	.....	.....	7,148	31,880
Tuckahoe Creek	8	1,244	900	34	314	.....	.....	3,940	7,243
St. Michael River	.....	.....	.....	.....	.....	.....	.....	80	910
Chester River	17	3,835	1,307	83	1,575	.....	.....	1,050	13,178
Sassafras River	.....	.....	.....	.....	.....	.....	.....	315	2,405
Elk River	.....	.....	.....	.....	.....	.....	.....	710	10,998
Susquehanna River	12	5,800	5,000	c 15	600	8	24	3,953	37,470
Total	90	33,349	25,816	c 15 335	600 5,223	128	625	53,524	311,092

a Includes 12 "stick weirs." b Not set specially for shad, and some catch very few of that species.
c Fall traps or pots.

Statement, by water areas, of the yield of shad in each form of apparatus employed in the fisheries of Maryland in 1896.

Waters.	Drift nets.		Stake nets.		Seines.		Pound nets.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Chesapeake Bay:								
Below Swan Point—								
Eastern Shore			4,620	$786			25,160	$3,570
Western Shore							134,119	18,347
Above Swan Point—								
Eastern Shore	133,480	$12,210	36,779	2,974	16,480	$1,895	7,595	825
Western Shore	109,423	11,761			17,142	2,169	2,244	274
Potomac River	136,880	11,459			44,060	3,382	51,698	5,533
Patuxent River	19,700	2,277			24,375	2,680	8,279	910
Pocomoke River	3,198	491			2,537	365		
Wicomico River	45,398	5,442	4,725	734	4,054	452	12,536	1,667
Nanticoke River	62,876	5,816	17,665	2,015			35,303	3,022
Marshyhope Creek	24,920	2,366			7,180	823	6,560	676
Fishing Bay			8,165	991			1,625	183
Transquaking River							12,004	1,133
Blackwater River	3,700	429					9,460	1,051
Choptank River	80,591	8,541	35,275	3,813	45,050	5,183	114,758	11,811
Tuckahoe Creek	39,670	4,084			22,195	2,295	283	27
St. Michael River			2,215	423				
Chester River	275	50	19,590	3,223	9,933	1,526	21,319	2,826
Sassafras River							1,290	166
Elk River							5,244	637
Susquehanna River	35,540	3,949			30,345	3,729		
Total	695,651	68,875	129,034	14,959	223,351	24,499	449,567	52,658

Waters.	Fyke nets.		Bow nets.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Chesapeake Bay:						
Below Swan Point—						
Eastern Shore					29,780	$4,356
Western Shore					134,119	18,347
Above Swan Point—						
Eastern Shore					194,334	17,904
Western Shore					128,809	14,204
Potomac River			600	$150	233,238	20,524
Patuxent River					52,354	5,867
Pocomoke River	205	$32	23,812	3,416	29,752	4,304
Wicomico River	1,302	185			68,015	8,480
Nanticoke River	9,337	795			125,181	11,648
Marshyhope Creek					38,660	3,865
Fishing Bay					9,790	1,174
Transquaking River			1,600	154	13,694	1,287
Blackwater River					13,160	1,480
Choptank River	402	38			276,070	29,386
Tuckahoe River	196	18			62,344	6,424
St. Michael River					2,215	423
Chester River	2,390	293			53,507	7,918
Sassafras River					1,290	166
Elk River					5,244	637
Susquehanna River	*a* 2,003	259	1,600	220	69,488	8,157
Total	15,835	1,620	27,612	3,940	1,541,050	166,551

a Fall traps or pots.

CHESAPEAKE BAY IN MARYLAND.

Chesapeake Bay extends northward into the State of Maryland a distance of 120 miles, running to within 12 miles of the northern boundary, dividing the State into two large portions, the Eastern Shore and Western Shore. It is from 4 to 20 miles wide and covers an area of 976 square miles, but, including its numerous tributaries up to the limit of tide water, it covers an area of 2,359 square miles within Maryland limits. The depth is from 3 to 18 fathoms, and the water is salty, except in the northern portion above Swan Point, where it becomes

somewhat brackish. A number of important rivers enter this bay from either side, and Susquehanna River enters at the northern end, continuing the separation of the two shores of Maryland and draining a large area of Pennsylvania.

At its entrance into Maryland, Chesapeake Bay receives each year 2,250,000 or more shad, of which about 750,000 pass up the Potomac, 330,000 proceed up the Pocomoke and Tangier Sound tributaries, 50,000 up the Patuxent, 350,000 up the Choptank and tributaries, 50,000 up the Chester, 650,000 in the meantime being taken on the shore of the Chesapeake and its smaller tributaries, leaving 70,000 or more to pass up into the Susquehanna. These figures include only the shad that are taken by the fishermen, and not those otherwise destroyed or that escape these fatalities and return to the sea, as to the number of which no estimate can be formed. The shad fisheries of each of the several tributaries of the Chesapeake will be separately described, leaving for the present chapter a notice of the fisheries of the bay proper. Many of the shad obtained in the bay are taken in the lower and middle portions, but the great bulk of the catch is taken in the extreme upper end.

Because of the differences in the physical characteristics, in the forms of apparatus used, and also in the seasons at which shad are taken therein, it is desirable in treating of the Chesapeake fisheries to separate them into two geographical sections, the first covering the lower three-fourths or more of the bay, from the Virginia line to Swan Point, and the second including that part above Swan Point, which is at the north side of the mouth of Chester River and opposite Patapsco River.

From the Virginia line to Swan Point.—This portion of Chesapeake Bay is 90 miles long and from 4 to 20 miles wide. From the western side it receives the waters of the Potomac and Patuxent rivers, while from the east it receives the Pocomoke, Wicomico, Nanticoke, Choptank, and Chester rivers, and some smaller streams.

The shad fisheries outside of the rivers are of comparatively small extent and confined to the use of pound nets and a few stake nets, yielding 159,279 and 4,620, respectively, in 1896, of which 29,780 were obtained by men living on the Eastern Shore and 134,119 by fishermen from the Western Shore.

The location of pound nets on the Eastern Shore was as follows: Pocomoke Sound, 8 nets, taking 7,149 shad; below Little Annemessex River, 5 nets, yielding 1,416 shad; Smith's Island, 1 net taking 4,875 shad; Tilghman Island and Wittman, 4 nets, with 2,640 shad; and Kent Island, 4 pound nets, yielding 9,080 shad. On the Western Shore 4 nets were located at Point No Point, 29 near the mouth of the Patuxent, 5 at Governor Run, and 48 between Holland Point and Gibson Island, making a total of 86 nets, worth $11,224, which yielded 53,167 roe and 80,952 buck shad, worth $18,347. Most of the pound nets are of the "single heart" variety, and the mesh in the bowl is generally 4 inches,

but some have 2½-inch mesh for retaining alewives. The season for shad begins the second or third week of March and continues for nearly two months. The yield at the various stations was much less in 1896 than in 1895 and several previous years. In the 5 nets set just below the mouth of Little Annemessex River only 1,416 shad were taken in 1896, whereas in 1893 2,100 shad were obtained in one lift of the same nets. The decrease was not confined to shad, but shared in by nearly all the species usually taken. In the spring of 1895 the 5 nets above referred to yielded $3,400 worth of fish, while the local value of the catch in the spring of 1896 did not exceed $600.

The stake nets are located along the shore from Tilghman Island to Kent Island. In 1896, 96 nets were set on the shore of Tilghman Island, 27 off Sherwood and Wittman, and 31 along the shore of Kent Island, making a total of 154 nets. The number of men employed was 64, and the catch numbered 3,300 roe and 1,320 buck shad, valued locally at $786. This fishery is almost entirely for local use, and comparatively few of the shad thus taken find their way into distant markets.

From Swan Point to head of Chesapeake Bay.—This section of the Chesapeake, comprising less than one-fourth of the area of the bay proper, is bordered on the east by Kent and Cecil counties and on the west by Baltimore and Harford counties. The depth of water in the channel ranges from 3 to 5 fathoms, yet there are numerous shoals and flats where the depth is from 2 fathoms to a few inches. The water is normally brackish, but during heavy freshets it becomes almost fresh above Spesutie Island. Susquehanna River enters the extreme northern end, and on the northeast three arms extend several miles inland, forming the estuaries of Northeast, Elk, and Sassafras rivers. The principal fishing centers are Havre de Grace on the Western Shore, and Charlestown, Northeast, Betterton, Tolchester, and Rock Hall on the Eastern Shore. This is the principal shad region of Chesapeake Bay, as determined by both the quantity and quality of the product. The yield in 1896, although smaller than usual, numbered 130,011 roes and 193,132 bucks, of which 87,875 roes and 155,028 bucks were taken by drift nets, 23,524 roes and 13,255 bucks by stake nets, 15,040 roes and 18,582 bucks by seines, and 3,572 roes and 6,267 bucks by pound nets, the total local value of the whole being $32,108.

This is the location of the most valuable drift-net fishery of the Atlantic coast south of Delaware Bay. The nets are operated from the mouth of the Susquehanna down to Poole Island, a distance of 25 miles, and at times even below that point. They are also operated in that arm of the Chesapeake known as North East River and in the extreme lower ends of Elk and Sassafras rivers. The depth of water in which they are drifted ranges all the way from 3 or 4 to 30 feet, but most of the nets are designed for use in 14 to 18 feet of water. From 400 to 2,000 yards of twine are carried by each boat, the total for the 191 boats operating in 1896 being 249,030 yards. This is usually cut

into lengths containing from 150 to 400 yards each. The size of the mesh is mostly 5¼ inches, but some fishermen use 5⅛, 5⅜, and 5½ inch. The cost of 1,000 yards medium-width twine is about $85. Two or three men are required for each boat, the value of the latter averaging nearly $100 each. The nets are used principally at night, a lantern mounted on a float being attached to each end. While the nets are drifting the fishermen "run" the net from end to end, discovering the presence of fish by the "feel" of the upper line. That portion of the net containing the fish is then raised and the shad removed, when the net is dropped to drift as before.

It is essential that the fish be removed very soon after they are enmeshed, otherwise they are likely to be mutilated by eels, which are very annoying during the shad season. Sometimes a large part of the catch is found to consist of heads and backbones of shad, from which the flesh has been stripped by eels.

The season begins about the 1st of April and extends to the last of May or 1st of June. The catch in 1896 was unusually small, the total yield for the 191 boats being only 242,903, an average of 1,272 per boat. Some boats have caught over 8,000 shad in one season. The catch by drift nets has been decreasing for several years, attributed by the fishermen to the increased number of pound nets in the Virginia section of Chesapeake Bay. The following summary shows the location and extent of the drift-net fishery in this part of the Chesapeake in 1896:

Residence of fishermen.	Men.	Boats.		Drift nets.		Shad caught.		
	No.	No.	Value.	Length.	Value.	No. of roes.	No. of bucks.	Value.
Kent County:				*Yards.*				
Rock Hall	44	17	$440	18,720	$1,720	9,860	10,310	$1,775
Harris Wharf	38	13	1,290	15,680	1,470	5,690	8,325	984
Betterton	44	16	1,545	21,760	1,924	8,340	12,535	1,597
Cecil County:								
Chesapeake City	15	5	305	6,420	565	3,250	5,670	842
Elkton	12	4	210	5,430	510	3,120	5,760	630
Northeast and Elk Neck	106	36	1,460	46,800	2,980	14,880	25,310	4,355
Charlestown	51	17	690	23,870	1,985	5,620	14,810	2,027
Harford County:								
Havre de Grace	175	70	10,170	94,950	8,400	32,523	65,049	10,328
Aberdeen and Perryman	10	4	600	4,800	480	1,374	2,139	446
Michaelsville	10	4	600	4,800	480	1,226	1,842	392
Abingdon and Edgewood	8	4	400	4,400	440	1,542	2,828	514
Baltimore County:								
Chase	3	1	140	1,400	125	450	450	81
Total	516	191	17,850	249,030	21,079	87,875	155,028	23,971

Twenty-five years ago stake nets were extensively operated in this portion of Chesapeake Bay, but they have gradually given way to the more effective and less costly drift nets. They are yet operated along the shore of Kent County between Swan Point and Worton Point, and especially on the flats off Tolchester Beach, the fishermen living on Kent County shore. The nets are about 25 yards in length and 45 meshes deep, with 5⅛ or 5½ inch mesh, and are set in rows in from 10 to 18 feet of water, 20 to 40 nets being used by each boat. In 1896 there were 101 men engaged in the stake-net fishery, using 1,322 nets, 32,900

yards long, worth $3,745. The nets were set about February 1 for striped bass, and the season for taking shad extended from March 20 to the beginning of May, the yield numbering 23,524 roes and 13,255 bucks, valued locally at $2,974. The price during that season was unusually small, the lowest certainly within the last ten years.

Six seines were used in the extreme northern end of Chesapeake Bay in 1896, their location being as follows: Carrot Cove (1 seine), Carpenter Point (1 seine), Fishing Battery Light (2 seines), and Spesutie Island (2 seines). The length ranges from 1,500 to 2,500 yards, the aggregate of the 6 seines being 11,600 yards, with 2 to 3 inch mesh. The value of the 6 seines was $10,200, and the number of fishermen employed 306, with 268 shoresmen. The season began the second week of April and lasted six or seven weeks, the catch numbering 14,560 roes and 18,052 bucks, worth $3,902. The yield of alewives numbered 6,516,000. In addition to the above, there was one seine on Miller Island used for taking striped bass and perch, in which some shad were caught. This seine was 600 yards in length, required 10 men to operate it, and the catch of shad numbered 480 roes and 530 bucks. Large quantities of alewives were obtained, but on account of the low prices ruling for these fish very few of them were marketed.

The two seines at the Fishing Battery Light are operated from large floats or batteries, containing stables, storehouses, salting sheds, quarters for the men, etc. An average float is simply a large raft, 60 by 80 feet, of sufficient buoyancy to be removed to any desirable point on the flats, where it is secured into position by piles passing through wells in the raft. Each of three sides of the float is provided with an apron 45 feet wide, held in position by stout chains, and which can be raised or lowered at will. This apron provides an inclined plane, on which the seine is hauled in the same manner as at shore seines. The selection of the side on which the hauling is made is determined by the direction of the current, the wind, etc. The fourth side is used as a wharf. When practicable three hauls are usually made each day, two on the ebb tides and one on a flood tide, the yield of shad on the former being five or six times as great as the latter.

Of the 69 pound nets operated in the upper portion of Chesapeake Bay in 1896, 46 were located between Turkey Point and Northeast, 7 between Charlestown and Carpenter Point, 6 off Betterton near the mouth of the Sassafras River, and 6 on the western shore from Miller Island to North Point. These nets cost from $50 to $150 each. They are usually set in strings containing from 2 to 4 nets each. They are not operated especially for shad, and that species represents only a small proportion of the total catch, the shad yield in 1896 numbering only 9,839, worth $1,099.

The use of pound nets or stake nets is prohibited "in Chesapeake Bay, north of a line 1 mile south of Pool Island, except the bay shore of Kent County up to Howell Point at the mouth of Sassafras River."

POTOMAC RIVER.

This river, the largest and most important tributary of Chesapeake Bay, is formed by the union of the north and south branches on the line between Maryland and West Virginia, whence, forming the boundary line between Maryland and the Virginias, it flows a distance of 290 miles to its entrance into Chesapeake Bay, 75 miles above Cape Henry. Below Washington it is broad and sluggish, forming one of the largest estuaries on the Atlantic coast, covering 370 square miles, not including its tributaries. This estuary is 100 miles in length and varies in width from 2 to 7 miles, with a navigable depth of 16 feet or more at low water, the depth in some places exceeding 100 feet. At Washington, the head of navigation, the fluvial characteristics appear, and from that point to Great Falls, 15 miles above, there are numerous shoals, with several small falls, the most important being Little Falls, at a distance of 5 miles above Georgetown, where the descent is several feet. At Great Falls, where the Potomac crosses the escarpment line, the water passes over a mass of rock, descending 35 or 40 feet, the total fall in a distance of 1½ miles being 80 or 90 feet. Great Falls have always presented a barrier to the upward movement of shad. If they could be passed no serious obstruction would be met with until where the river breaks through the Blue Ridge, just below Harpers Ferry, 60 miles above Georgetown. In 1882 an appropriation of $50,000 was made by Congress for the erection of suitable fishways at Great Falls, and in 1885 the work of construction was begun, the plans providing for a fishway in six sections in the Maryland channel. A high freshet during the night of October 29–30 considerably damaged the partly completed sections, and after examination it was decided that "the fishways were not planned sufficiently strong to withstand the effects of the violent floods of the locality in which they were placed," and the project was abandoned.

That portion of the river below the District of Columbia is entirely within the limits of the State of Maryland, the boundary line between Maryland and Virginia following the extreme low-water mark on the Virginia side of the main body of the river and from headland to headland at the mouths of creeks along the same shore. In 1785, while the boundary line was in dispute and before the adoption of the Constitution of the United States, Maryland and Virginia entered into articles of agreement for the regulation of commerce, navigation, and other industries of mutual interest, and one of the articles provided for a right of fishery in Potomac River in common to the citizens of the two States, and that in the regulation thereof neither State should enforce any law not approved by the other. The effect of this compact has been to prevent any regulation of shad fisheries by either of the two States, and the citizens of both States enjoy equal fishing privileges in the river.

Prior to 1830 shad fishing was prosecuted almost exclusively by means of seines, the fisheries being controlled by the well-to-do riparian proprietors. Nearly every large plantation on the river had its fishing

shore, the returns from which were large, some of them renting for several thousand dollars. Some time during the Thirties drift nets were introduced by fishermen from Delaware River, and by 1835 they had increased to such an extent as to embarrass the seining operations and to materially lessen the profits. A convention of fishermen was held at Alexandria, Va., to protest against the use of drift nets and to take measures to secure legal prohibition of them. This was the beginning of the contest which was waged for years between the riparian owners and the wandering fishermen who have successfully contested the right to equal fishing privileges with the former.

In 1871 it was reported that 24 seines were then used on the Maryland shore of the Potomac, requiring the services of 619 men, 74 boats, and 51 horses, and catching in the spring of that year 110,400 shad, worth $14,353. During the same year 243 drift nets were reported on the same side of the river, with 161,446 square fathoms of twine, requiring 456 fishermen and 213 shoresmen, catching 351,800 shad, valued at $38,698, making a total of 462,200 shad, worth $53,051, taken by residents of Maryland. No reliable estimates or records showing the extent of the fisheries of the Virginia shore during that year are available, but they have generally been more extensive than on the Maryland shore.

A fair idea of the comparative yield of shad in the Potomac during the past quarter of a century may be obtained from an examination of the following table showing the number of shad inspected in the District of Columbia from 1873 to 1896, inclusive, which represents from 50 to 75 per cent of the total yield in the river:

Year.	Jan.	Feb.	March.	April.	May.	June.	Total.
1873							852,900
1874							628,637
1875							464,215
1876							319,079
1877							131,199
1878							121,785
1879			3,570	116,938	168,515	22,218	311,241
1880	4	28	10,110	165,071	139,441	6,145	320,799
1881			16,074	233,716	200,723	7,855	458,368
1882		14	18,895	226,164	101,175	3,989	350,237
1883		4	11,254	171,641	76,127	2,452	261,478
1884			32,312	147,503	50,802	494	231,111
1885			6	55,155	68,450	1,847	125,458
1886			6,544	133,733	38,526	2,274	181,077
1887		4	7,141	151,694	106,475	3,796	269,110
1888			145	186,273	117,316	4,710	308,444
1889			6,902	277,956	160,891	2,828	448,577
1890	1	38	26,109	337,152	54,509	1,582	419,391
1891		14	5,012	246,791	63,653	2,319	317,789
1892		4	7,741	204,657	44,298	4,182	260,882
1893			16,809	229,250	60,460	1,450	307,978
1894	6	25	12,125	297,554	74,301	11,627	395,638
1895			27,256	459,165	131,321	5,568	623,310
1896		7	10,254	272,038	55,923	4,938	343,160

The average annual yield of shad in the Potomac during recent years has been about 750,000. The catch in 1896 was smaller than usual, numbering 684,063, of which 450,825 were obtained by the residents of Virginia and 233,238 by Maryland fishermen. An interdiction exists against shad fishing within the limits of the District of Columbia.

The following summary shows, by States, the number of people employed in each branch of the shad fisheries of the Potomac River in 1896:

Designation.	Virginia shore.	Maryland shore.	Total.
Fishermen:			
Stake-net	21		21
Drift-net	231	241	472
Seine	247	87	334
Pound-net	308	116	424
Bow-net		25	25
Shoresmen	31	39	70
Transporters	17	4	21
Total, exclusive of duplication	855	512	1,367

The following statement shows the boats, apparatus, etc., employed in the shad fisheries of the Potomac River in 1896:

Designation.	Virginia shore.			Maryland shore.			Total.		
	No.	Length (yds.).	Value.	No.	Length (yds.).	Value.	No.	Length (yds.).	Value.
Boats	325		$17,950	195		$6,945	520		$24,895
Stake nets	529	6,133	1,043				529	6,133	1,043
Drift nets	118	67,000	6,155	118	94,500	6,230	236	161,500	12,385
Seines	8	13,600	13,700	5	3,640	4,000	13	17,240	17,700
Pound nets	299		35,175	131		8,175	430		43,350
Bow nets				3		6	3		6
Shore property			16,425			5,100			21,525
Total value			90,448			30,456			120,904

The following statement shows the product of each branch of the shad fisheries of the Potomac River in 1896:

Fishery.	Virginia shore.			Maryland shore.			Total.		
	Roes.	Bucks.	Value.	Roes.	Bucks.	Value.	Roes.	Bucks.	Value.
Stake-net	6,746	4,764	$1,616				6,746	4,764	$1,616
Drift-net	85,440	56,960	11,729	82,128	54,752	$11,459	167,568	111,712	23,188
Seine	47,631	31,754	6,471	25,386	18,674	3,382	73,017	50,428	9,853
Pound-net	114,999	102,531	23,268	31,163	20,535	5,533	146,162	123,066	28,801
Bow-net				360	240	150	360	240	150
Total	254,816	196,009	43,084	139,037	94,201	20,524	393,853	290,210	63,608

The drift-net grounds extend from Mathias Point to Alexandria, a distance of 60 miles, but those nets are operated most extensively from Indian Head to River View. Below Mathias Point the water is salty and too clear and sluggish to permit the successful use of this form of apparatus, except when heavy rains have swollen the river. The nets range in length from 300 to 1,000 yards, averaging above 700 yards, and in depth from 30 to 90 meshes, depending respectively on the width and depth of the reach in which they are operated. They are usually so rigged as to float several feet below the surface of the water, being suspended by buoy lines at intervals of 15 or 18 feet. Those nets 60 to 90 meshes deep, when operated in the main channel, are buoyed with the upper line from 8 to 10 feet below the surface, permitting all boats, except the largest steamers, to pass over them without injury.

There are two general methods of hanging the drift nets, viz, the "single line" and the "double line." In the former the lower portion of the net is permitted to swing freely, having no bottom line and not being weighted. The mesh in these is generally $5\frac{1}{8}$ or $5\frac{1}{4}$ inch. The second form of nets, known as "double line," is operated mostly on the shoals, and consequently is usually longer and shallower. In these nets a line extends the entire length of the bottom, to which leaden weights are attached, serving to hold the net in a somewhat rigid position, and the mesh is usually 5-inch. The reason for the difference in the size of the mesh in the "single-line" and "double-line" nets is that the bottom of the former, swinging clear and free, readily yields to every motion of the fish enmeshed therein and the fish soon becomes wound up and entangled in the meshes, being unable to either withdraw or force its way through the net; while the latter, being in a somewhat unyielding position in the water, due to the weighted bottom line, is not easily entangled, and the mesh must be sufficiently small to hold the fish firmly. The "single-line" nets are usually from 50 to 90 meshes deep and the "double-line" nets from 30 to 60 meshes in depth. The former are drifted mostly during slack water, and consequently remain in the water usually only two or three hours at a time. The latter are operated on both tides, and may remain in the water a half day or longer. An ordinary gill net, full-rigged, costs $100 to $125; after being used one season its value is reduced one-half, and three seasons' work usually renders it unfit for further use. The season begins about the last week in March and ends about the middle of June. The yield in 1896 was unusually small, only 50 or 60 per cent of that obtained in 1895. The yield by the 118 boats from the Virginia shore numbered 85,440 roes and 56,960 bucks, a total of 142,400, while the Maryland fishermen obtained 136,880, of which 82,128 were roes and 54,752 buck shad. The price received by the fishermen was also low, averaging between $8 and $8.50 per hundred.

The stake-net fishery of Potomac River is of little importance, consisting of a few strings of nets operated in the lower half of the river by residents of Virginia. The total number used in 1896 was 529, set in 9 strings, requiring the services of 21 men who employed 12 boats, worth $935. The catch was quite small, numbering only 6,746 roe shad and 4,764 bucks, worth $1,616.

The pound-net fishery is confined almost entirely to the lower half of the river, the nets set for shad above Maryland Point being few in number and cheaply constructed. Pound nets were introduced about 1875, and since then they have constantly increased in favor. In 1889 there were 330 pound nets; in 1890, 376; in 1891, 411, and in 1896, 430. Of those used in 1896, 299 were operated by Virginians and 131 by residents of Maryland. The former, however, are much larger and catch many more shad than those on the Maryland side of the river, the Virginia nets being most numerous near the mouth, while most of the Maryland nets are between Nanjemoy Point and Blakistone Island.

The mesh in most of the shad pound nets has the following dimensions: Leader, 7 inches; first "pound," 6; second "pound," 4 or 5, and main "pound," 4 or 4¼ inches. Some of the nets have 2½-inch mesh, in order to retain the alewives; while a few of the regular shad nets have a backing of 2½-inch mesh, against which the fish are bunted when the net is lifted, the alewives not escaping readily through the large mesh except when the net is being lifted. There is a tendency to increase the size of the mesh, and during the last year it was 12 inches in some of the leaders, and this will probably be exceeded, as the tide runs strong and a small mesh trap is more likely to be swept away than one of larger mesh, and it also accumulates more seaweed and other floatage. The "pounds" are usually from 40 to 60 feet square and the leaders from 200 to 250 yards in length, the average cost of the nets approximating $100. The total catch of shad by the pound nets in 1896 numbered 269,228, of which 114,999 roes and 102,531 bucks were obtained by Virginia fishermen, and 31,163 roes and 20,535 bucks by residents of Maryland. This yield was not so large as usual, nor were the prices so high as in former years. Unusually warm weather in April resulted in glutting the market, and prices did not recover during the season. The lowest prices received were 6 cents for roes and 3 cents for bucks, but from two to three times that amount represented the average prices. The total value of the above yield was $28,801, of which $23,268 represented the Virginia and $5,533 the Maryland catch.

Seining was formerly the most extensive branch of the Potomac River shad fisheries, but its importance as compared with the drift-net and pound-net fisheries is becoming less each year.

The following shows the location and extent of this fishery in 1896:

Localities.	Distance above Smith Point.	Number of seines.	Length.	Number of men, including shoresmen.	Number of shad caught.		Value.
					Roes.	Bucks.	
Virginia:	*Miles.*		*Yards.*				
Stiff's Wharf	70	1	800	17	1,200	800	$172
Marlboro Point	74	1	1,800	37	4,200	2,800	560
Gumms Point	77	1	1,200	20	450	300	120
Wide Water	82	1	2,200	50	4,800	3,200	688
Freestone Point	91	1	2,400	47	14,181	9,454	1,891
Occoquan Creek	93	2	2,000	32	4,800	3,200	640
Stony Point	96	1	3,200	75	18,000	12,000	2,400
Maryland:							
Chapman Point	99	2	1,200	80	11,250	9,250	1,550
Bar Landing	102	1	1,000	18	4,536	3,024	552
Moxley Point	107	1	440	16	2,400	1,600	320
Tulip Hill	109	1	400	12	7,200	4,800	960
Total	.....	13	17,240	404	73,017	50,428	9,853

At Great Falls, 14 miles above Georgetown, there are a few bow nets used each spring from the last week in April to the first or second week of June. These nets are operated from a point known as "Shad Rock," which projects into the water on the Virginia shore just below the principal falls. Three bow nets were reported from that locality in 1896, the yield numbering 360 roe shad and 240 bucks.

PATUXENT RIVER.

The Patuxent, the most important shad stream between the Potomac and the Susquehanna, is situated wholly in Maryland, rising in Howard and Montgomery counties, and flows a distance of 110 miles to its entrance into the Chesapeake, 20 miles above the mouth of the Potomac. It is navigable for steamers of 7 or 8 feet draft to Bristol, 46 miles from the mouth. Aside from the numerous apparatus of capture, fish meet with no serious obstruction to their ascent of the river until near Laurel, 95 miles from the mouth, where the river is crossed by two dams for developing water-power. Because of the numerous fisheries in the lower half of the river and the narrowness of the stream very few shad ever reach Laurel and none ever pass above the dams at that town. Of the 52,354 shad taken in 1896, 24,375 were obtained by means of seines, 19,700 by drift nets, and 8,279 by pound nets. As the fish enter the river they encounter first the pound nets near the mouth; after proceeding about 35 miles they reach the lowest seine beach, and a short distance farther up, between Dunkirk and Leon, they reach the drift-net grounds.

The pound nets operated in the lower end of the river are mostly between Point Patience and Drum Point. They are small, averaging in value only $125 each, and have small mesh, depending more on taking alewives than shad. The catch of shad by the 33 nets in 1896 numbered 3,305 roes and 4,974 bucks, worth $910 at local values. The yield of alewives in the same nets numbered 795,830, valued locally at $2,152.

The seine beaches are located entirely in the upper reaches in Prince George and Anne Arundel counties, from Hill's Landing to Leon where the river is 500 or 600 feet wide. The seines range from 100 to 200 yards in length, with 2½ or 2¾ inch mesh, and are worth from $80 to $300 each. Ten shad seines were used in 1896, aggregating 1,700 yards in length and $1,815 in value. The catch numbered only 9,244 roe shad and 15,131 bucks, valued locally at $2,680.

Drift nets are operated only in a reach 5 or 6 miles in length, in the vicinity of Dunkirk and Leon. The nets are each about 200 feet in length, with from 5 to 5⅜ inch mesh, and cost $10 or $12. Of the 18 drift nets used in 1896, aggregating 1,205 yards in length, 10 hailed from Leon, Anne Arundel County; 7 from Dunkirk, Calvert County, and 1 from Nottingham, Prince George County. The catch numbered 19,700 shad, of which 8,520 were roes and 11,180 bucks, the aggregate value being $2,277.

SUSQUEHANNA RIVER.

While the Susquehanna is one of the longest rivers of the Atlantic coast, only 12 miles of its length is within the limits of Maryland. Since most of this river is situated in Pennsylvania, its general physical characteristics will be noted in the description of the shad fisheries of that State. The Maryland section ranges from a half to nearly 1 mile in width, but as the water is very shoal it is navigable only a few miles above the mouth. The fall in the 12 miles from the Pennsylvania

line to the entrance of the river into Chesapeake Bay is 69 feet, an average of 5.75 feet per mile, the greatest within a short distance of the mouth that exists on any large river of the Atlantic coast. The importance of the Susquehanna River shad fisheries suffers somewhat in comparison with those of the Susquehanna Flats. The latter fishing-grounds are usually more profitable, but as a rule, they also require larger and more costly apparatus of capture than the river fisheries. The apparatus used in the river consists of drift nets and seines near the mouth, and fall traps and bow nets in the rapids above Port Deposit.

The gill nets are drifted between the Baltimore and Ohio Railroad bridge and Port Deposit. They are similar to the nets used at the head of Chesapeake Bay, differing only in length, as the reach is not very wide. Of the 49 boats engaged in this fishery in 1896, 33 hailed from Port Deposit, 9 from Frenchtown, 5 from Perryville in Cecil County, and 2 from Lapidum in Harford County. They carried 28,672 yards of twine in lengths averaging from 125 to 130 yards each, the size of the mesh being mostly 5½ inches. The yield was much smaller than usual, the catch numbering only 14,060 roe shad and 21,480 bucks, the total local value being $3,949.

The seines are of two general sizes, the larger being from 600 to 800 yards in length, while the smaller ones are from 100 to 150 yards long. Of the former size there were 7 used in 1896, with an aggregate length of 5,200 yards and valuation of $4,700, requiring the services of 265 fishermen and 71 shoresmen. The catch was scarcely up to that of an average season, numbering 16,831 roe shad and 9,171 bucks, valued locally at $3,222. One of the seines caught 24,000 shad during the season of 1883. The small seines numbered 5, with 2¼-inch to 4½-inch mesh. Thirty men were required, and the catch numbered 1,759 roe shad and 2,584 bucks, worth $507, making a total of 30,345 shad, worth $3,729, taken in seines.

At various points in the rapids of the river below the Pennsylvania line there are several "fish pots" or fall traps, consisting of a small breakwater of rocks forming a triangle with the apex pointing downstream. At the apex is placed a slat-work wooden frame with the rear end raised a foot or two above the surface of the water and the front or up-river end resting on the bottom. In passing along the stream the fish meet these stone breakwaters, and following them reach the traps, upon and over which they are washed by the current, falling into a box placed under the raised or downstream end of the trap. These traps have engendered considerable bad feeling among the fishermen on the river. An interdiction exists against their use in Pennsylvania, but they are unrestricted in the Maryland section of Susquehanna River. The number reported in 1896 was 15, and the catch of mature shad numbered 778 roes and 1,225 bucks, worth $259.

On account of the increasing scarcity of fish, bow nets are not used so extensively as was formerly the case. They are operated from boats and also from rocks situated in favorable places in the channel, one

man being required for each net. The number of nets reported in 1896 was 8, with a yield of 1,600 shad, worth $220, making a total of 69,488 shad, worth $8,157, taken in the Maryland section of the Susquehanna.

Considerable complaint is made in this portion of the river regarding the refuse from a sulphide paper mill established in 1891 at Conowingo, about 10 miles from the mouth of the river. When the water is low this refuse moves back and forth with the tide, doing considerable injury to the fisheries, but during high water the refuse is carried out into the bay, where it does little damage.

The rivers entering Chesapeake Bay from the east are quite different from those on the western side of the bay. The eastern tributaries are more numerous, and, draining a low, flat region, their declivity is nearly uniform and without falls. Excepting two or three of the smaller ones, they rise in the somewhat elevated area forming the western portion of Delaware and flow in a general southwesterly direction, expanding at their mouths into broad estuaries. They are tidal nearly to the upper limits, and are navigable for vessels of 5 or 6 feet draft for three-fourths or more of their length. Beginning at the southern boundary, the most important are the Pocomoke, Wicomico, Nanticoke, Choptank, and Chester rivers, yet the tributaries of these and the smaller streams are so numerous that there is probably no point on the Eastern Shore of Maryland over 8 miles distant from tide water. The shad fisheries of each of these estuaries and their tributaries will be described in succession.

POCOMOKE RIVER.

Pocomoke River rises in Great Cypress Swamp, on the line of Maryland and Delaware, whence it flows between narrow banks a distance of 115 miles to its entrance in Pocomoke Sound. It is navigable for vessels of 9 feet draft to Snow Hill, about 50 miles from the mouth. The water is quite muddy, due to the suspension of the black alluvial soil from its source. Much of this earthy matter is deposited at the mouth of the river, where the accumulations of years extend for an average depth of 20 feet over 16 square miles, forming the "muds," over which at low tide there is a depth of 4 or 5 feet of water. The shad fisheries of the Pocomoke are of considerable local importance, and extend from the mouth of the river to several miles above Snow Hill, the principal fisheries existing at Pocomoke, Mattaponi Ferry, and Snow Hill. The yield in 1896 was less than usual, numbering 29,752, of which 23,713 were taken by men living in Worcester County and 6,039 by Somerset County fishermen. Of the total yield, 17,692 or 60 per cent were buck shad. The forms of apparatus are bow nets, drift nets, seines, and fyke nets.

The bow-net or dip-net fishery yields 80 per cent of the total number of shad taken on the Pocomoke. The bow nets are similar to those used in the Carolinas, except that they are of more costly material. The frame is of tough but light wood, bent in a long, oval shape, with the longest diameter from 14 to 16 feet. Within this frame is a loose net

of the best hemp twine, No. 35 or 40, with a "hang" of 5 or 6 feet, the twine measuring 200 meshes around the frame, the mesh being 4¼ inches. Usually two men are required for each net, one of whom operates the net while the other propels the boat; but in some instances the net is operated from a stationary point or the boat is permitted to drift with the current, requiring the services of only one man. The catch by the 97 bow nets used on this river in 1896 numbered 23,812, of which 14,052, or 60 per cent, were bucks. The season begins during the third week of March and lasts about two months, the fish being most numerous the second or third week of April. The season in 1896 was unusually short, and consequently the catch was small, averaging only 235 shad per net. Yet this average was far in excess of that for any other river in the United States, the nearest approach being an average of 95 shad per net on Santee River, in South Carolina. During certain years as many as 1,000 shad have been taken in a single bow net on the Pocomoke. The catch is practically all marketed in the towns and settlements adjacent to the river, the price received ranging from 10 to 30 cents each.

Drift nets are used in the lower end of the Pocomoke, from Shelltown to Rehobeth, and near Snow Hill, the head of navigation. They are from 40 to 60 yards long "in gear," and from 44 to 52 meshes deep, with 4¾ to 5¼ inch mesh, the cost ranging from $6 to $9 each. Two nets are usually carried by each boat, and generally two men are required, but in the headwaters one fisherman operates each boat. The boats in 1896 numbered 21, using 2,180 yards of twine and catching 1,293 roe shad and 1,905 bucks, valued locally at $491. The catch was the smallest for several years, the average being only 152 shad per boat.

There were 6 seines used on the Pocomoke River in 1896, 1 at Cedar Hall, 4 near the mouth of Nassawango Creek, and 1 at McKee Island, above Snow Hill. They were from 70 to 100 yards in length, 8 to 12 feet deep, with 2¼ to 2½ inch mesh. The shad season extended from the last week in March to the first week in June, and the catch numbered 2,537, of which 63 per cent were bucks. In addition to this species, quantities of alewives, perch, catfish, etc., were secured in the seines.

Fyke nets complete the enumeration of the apparatus in which shad are taken in the Pocomoke River, these nets being used by residents of Rehobeth and Shelltown, near the mouth of the river. They are not operated especially for shad, and secure also many eels, perch, alewives, catfish, pike, etc. They are set from the middle of September to near the last of April, and the catch of shad in the 16 nets in 1896 numbered 115 bucks and 90 roes, making a total of 29,752 shad secured in Pocomoke River.

Between Pocomoke and Wicomico rivers there are three small streams entering Tangier Sound, viz: Annemessex, Big Annemessex, and Manokin, in which a very few shad are to be found each year, especially in the last named; but there are no established fisheries, and the shad taken incidentally are used in the homes of the fishermen.

WICOMICO RIVER.

Wicomico River rises near the elevated rim which encircles Great Cypress Swamp, in which Pocomoke River has its origin, and after flowing a distance of 35 miles enters the head of Tangier Sound. Near its mouth it expands into a broad, shallow sheet of water, called Monie Bay, characteristic of nearly all tributaries of Chesapeake Bay. It is navigable for vessels of 7 feet draft from the bay to Salisbury, 23 miles above the mouth, where the lowest milldam crosses the stream. For many years the river was made a receptacle for refuse matter from the numerous sawmills on its banks, to the great injury of the spawning-grounds; but during recent years this refuse has been burned in the mill yards. Considering its small size, the yield of shad on the Wicomico is remarkable, with a navigable length of only 23 miles the product averaging about 75,000 shad annually. In actual yield it ranks third among Eastern Shore rivers, being surpassed by the Choptank and the Nanticoke. The apparatus employed consists of drift nets, stake nets, seines, pound nets, and fyke nets, the catch by the first named in 1896 being 67 per cent of the total yield on the river.

Drift nets are operated from White Haven to Williams Point, 1 mile below Salisbury, a distance of 12 miles. The length of the nets varies from 100 yards at White Haven to 40 yards at Williams Point, and the depth from 53 to 31 meshes, with from 4⅞ to 5⅛ inch mesh. The season begins about the middle of March and lasts six weeks, the catch ranging from 100 to 900 shad to each boat. The yield in 1896 was unusually small, averaging only 274 shad per boat, the catch by the 166 boats, using 307 nets, numbering 21,275 roes and 24,123 bucks, valued locally at $5,442.

There are usually several rows of stake nets operated each year near the mouth of the Wicomico River by men living at Victor and Mount Vernon, in Somerset County. The nets are 20 yards long, 40 meshes deep, with 5 to 5½ inch mesh, and are worth about $4 each. The season begins about the third week of March and lasts four or five weeks, the yield averaging about 250 shad per boat. In 1896 there were 19 boats, using 70 stake nets, taking 2,320 roe shad and 2,405 bucks. The number of stake nets in this portion of the river is increasing and the yield during recent years has been good, although somewhat less than usual last year.

During the season covered by this report there were 5 "double-heart" pound nets located on the north side of Wicomico River 4 miles below White Haven, being set across the current on the side of the channel, with one net on each string. They cost about $100 each, and the 5 nets required the services of 6 men and 3 skiffs. The season began March 14 and ended the first week in May, the catch numbering 7,064 roe and 5,472 buck shad, worth $1,667 at local valuation, and in addition thereto 57,860 alewives and also numerous striped bass, perch, catfish, spots, suckers, squeteague, etc., were taken.

Three small seines were operated in 1896 near the headwaters of the river within 4 miles of Salisbury, the length ranging from 145 to 340 yards each, with 2¼-inch mesh in the bunt. The season for shad began the second week in March and ended the latter part of May, the catch numbering 1,544 roes and 2,510 bucks, worth $452, the seines also taking alewives, striped bass, perch, catfish, etc.

The fyke nets are not set especially for shad. They are located in the lower portion of the river, 18 sets, or 36 nets, being used in the spring of 1896, requiring 9 men and 5 boats to fish them. The season for shad extended from the middle of March to the middle of May. The yield numbered 635 roes and 667 bucks, making a total catch in the Wicomico of 32,838 roe shad and 35,177 bucks, valued locally at $8,480. Except such as are sold in the immediate locality, most of the shad from this river are sent to Baltimore.

For several years the State of Maryland has maintained a small shad hatchery at Salisbury, on the Wicomico River, from which several million fry are annually distributed, not only in the Wicomico but in other streams of the peninsula.

NANTICOKE RIVER.

The headwaters of Nanticoke River are in Kent and Sussex counties, Del., uniting in a navigable stream at Seaford and 11 miles lower down crossing into Maryland. About 5 miles from the Delaware line it receives the waters of Marshyhope Creek, and from this junction flows 30 miles to its entrance into the head of Tangier Sound. In the lower 10 miles the river is a mile or more in width and the channel 12 to 30 feet deep; thence to Vienna, 25 miles from the mouth, the width is from 500 to 150 yards and the depth about the same as in the lower portion. From Vienna to the entrance of Marshyhope Creek the width is from 200 to 250 yards and the depth generally more than 20 feet. Above that creek the width and depth gradually diminish to 100 yards and 8 feet, respectively, at Seaford, where navigation ceases. Nanticoke River ranks third in the extent of its shad fisheries among the Maryland rivers, being surpassed only by the Choptank and Potomac. The fisheries extend from the mouth to several miles above Seaford, the total yield in 1896 being 216,308 shad, of which 52,467 were obtained in Delaware and 38,660 in Marshyhope Creek, leaving 125,181 as the number taken in the Maryland portion of the main river. The present chapter deals only with the latter section, notes on the portion located in Delaware being reserved for the description of the fisheries of that State. Drift nets, stake nets, pound nets, and fykes are the only forms of apparatus used in the shad fisheries of the Maryland section of the Nanticoke, and over 50 per cent of the yield is obtained by means of the first named.

Drift nets are operated from Quantico Creek to the Delaware line, and are most numerous from Vienna to Sharptown. They measure from 175 yards in length below Vienna to 115 yards at Galestown, and

from 65 to 51 meshes deep, with 4⅞ to 5¼ inch mesh. Each boat usually carries two nets and requires the services of two men. The season begins about the middle of March and lasts seven or eight weeks. The drifting begins usually at 1 o'clock on Monday morning of each week and on other secular days at 3 o'clock a. m., continuing until daylight. The largest catch in one day by any one boat in 1896 was 316 shad, taken on Monday, March 23, near Vienna. In one drift of a mile in length, with a net 165 yards long, 115 shad were taken. The total catch by the 73 drift-net boats numbered 62,876 shad, of which 36,566, or 58 per cent, were bucks. This catch was smaller than usual, the prices being so low that many of the men ceased fishing by the middle of April.

Stake nets are used in the extreme lower end of the Nanticoke from Roaring Point to Sandy Hill. The total catch in the 282 nets numbered 11,930 roes and 5,735 bucks, valued at $2,015. A very noticeable difference is observed in the proportion of roe and buck shad reported from Sandy Hill and those reported from fishing stations farther down the river. Of the total catch at Roaring Point, Jesterville, and Walterville over 80 per cent were roe shad, whereas at Sandy Hill the proportion that the roe bore to the total yield was less than 60 per cent. This is due to the fact that the mesh of most of the nets at Sandy Hill was 5 inches, whereas at the former places it was mostly 5⅛ inches. One boat at Jesterville using 25 nets, with 5⅛-inch mesh, caught 1,083 roes and 165 bucks in 1896.

While the pound nets in Nanticoke River are not set especially for shad, yet numbers of this species are taken therein. Of the 26 pound nets in 1896, 4 were set between Nanticoke Point and Roaring Point and the remaining 22 above Quantico Creek. The 4 at the mouth of the river were large nets, worth over $300 each, while the others cost from $50 to $80 each. The mesh in the bowl of the nets was from 2½ inches to 3 inches, small enough to retain alewives, of which large quantities were obtained.

The yield of shad was somewhat larger than usual, the 4 nets at the mouth of the river taking 8,596 bucks and 6,827 roes, the proportion of the roe shad being greater than for several years preceding. The remaining 22 nets took 8,680 roe shad and 11,200 buck shad, making a total of 35,303 shad taken in the pound nets, worth $3,022 at local values.

The fyke nets set in the lower part of the river, below Quantico Creek, catch a few shad with other fish. They are operated generally in sets of 2 nets each, in from 4 to 8 feet of water. In 1896, 143 fyke nets were used in the Nanticoke, of which 82 were owned at Wetipquin and 56 at Sandy Hill. The yield of shad was 5,897 bucks and 3,440 roes, with a valuation of $795, the price being unusually low. The Nanticoke River fyke nets produce over 50 per cent of the entire yield of shad in all the fyke nets operated in the Chesapeake Bay and tributaries, including both Maryland and Virginia.

Marshyhope Creek.—The northwest branch of Nanticoke River diverges from the main stream at Riverton, a small village in Wicomico County, and extends about 34 miles to the swamps of Kent County, Del. It has an average depth of 5 or 6 feet up to Federalsburg, 20 miles from the mouth, where it is crossed by a milldam. Considering its size, the shad fisheries of Marshyhope Creek are quite extensive. They are prosecuted from the mouth to Federalsburg, but are most extensive about Brookview, known until recently as Crotcher Ferry. The catch in 1896 numbered 38,660 shad, of which 24,920 were taken in drift nets, 7,180 in seines, and 6,560 in small pound nets.

The drift nets average nearly 100 yards in length, from 49 to 53 meshes deep, with 5 to 5¼ inch mesh. The season begins usually the last week in March and extends to about May 20. The total catch by the 38 drift-net boats in 1896 was 14,140 roes and 10,780 bucks, valued locally at $2,366. Between Brookview and Federalsburg, on the Marshyhope Creek, there were 8 seines operated. These ranged in length from 40 to 150 yards, aggregating 545 yards, with 2½-inch mesh. Forty men were employed in hauling them, the catch being 3,400 roes and 3,780 bucks, worth $823. The popular local opinion is adverse to the use of pound nets, yet 12 small nets were used above Brookview in 1896, with a total shad yield of 6,560, almost equally divided between roes and bucks. Several of the pound nets in Marshyhope Creek and a number in the Nanticoke are of an improved pattern, invented and patented by Capt. M. B. Marshall, of Vienna, Md.

FISHING BAY.

This bay is a broad estuary, 11 miles in length and 2 or 3 in width, connecting Transquaking and Blackwater rivers with the head of Tangier Sound. The depth of water in the channel approximates 20 feet, but in the extreme upper end and on the sides of the channel the depth of water averages about 5 feet. During some seasons the shad yield of Fishing Bay is of much local value, but in 1896 it was extremely small, the total catch in that year being about 9,790, whereas the average catch is three or four times that amount, stake nets and pound nets being the apparatus used.

The stake nets measure 16 or 18 yards in length, with from 5 to 5½ inch mesh. Being set on the flats at the sides of the channel, they are very shoal, averaging 16 meshes in depth. The last season was short, extending from March 16 to the middle of April, when crabs and eels became so numerous that fishing was abandoned. The catch in the 388 stake nets amounted to 4,300 roe shad and 3,865 bucks, valued locally at $991. Of the four small pound nets used, two were located near the entrance of Blackwater River at the head of the bay, and two off Fishing Point, about 6 miles above the mouth of the bay, the yield of shad numbering 660 roes and 965 bucks. The value of these nets and the men, boats, etc., employed are set forth in the tables showing the extent of the Maryland shad fisheries.

Transquaking River.—This is a small stream situated wholly in Dorchester County and entering Fishing Bay at the extreme northern part. Shad are taken by near-by residents, principally for local use. There are three forms of apparatus used, viz, pound nets, "stick weirs," and bow nets, the catch by the first named being over twice as great as by the other two combined. The pound nets are small, costing probably $70 each, and are operated from the 1st of March to the end of April, and also in the fall. The number used in 1896 was 17, catching 3,846 roe and 6,378 buck shad, valued locally at $920. The "stick weirs" are constructed by fixing sticks and brush in the bed of the river so as to form a weir. They are rude contrivances, costing possibly $15 each, and the catch is entirely for local use, the yield in the 12 weirs last season approximating 850 roe shad and 1,020 bucks. In addition to shad, many alewives and other species are taken in both pound nets and weirs.

A few bow nets are used on the Transquaking and its principal tributary, the number in 1896 being 20, yielding 1,600 shad, about equally divided between roes and bucks.

Blackwater River.—This stream is situated wholly in Dorchester County and empties into Fishing Bay, not far from the Transquaking. About 8 miles above its mouth it separates into two branches, known, respectively, as Little Blackwater and Big Blackwater. Shad ascend this river and its branches to the uppermost limits, and are taken at numerous points in drift nets and pound nets. The drift nets average 40 yards in length, 7 feet in depth, with 5-inch mesh. The 34 drift-net boats in 1896 required 36 men and used 46 nets, 1,840 yards in length, worth $184. The season began about the third week of March and lasted four or five weeks. The catch approximated 3,700, about evenly divided between roes and bucks. The pound nets and "stick weirs" used in the Blackwater and tributaries are similar to those in the Transquaking, except that they are somewhat smaller. Of the 39 used in these waters, 24 were in the main river, 9 in Little Blackwater, and 6 in Big Blackwater. The catch was 5,645 roe shad and 3,815 bucks, valued at $1,051, making the total yield of shad on the Blackwater River and tributaries 13,160, worth $1,480. Very few of these shad are shipped to distant markets.

CHOPTANK RIVER.

The Choptank is the largest and most important of the Eastern Shore rivers. From the Chesapeake to Hunting Creek, a distance of 30 miles, it is a tidal estuary, the width ranging from 5 miles to 500 yards and the depth in the channel from 70 to 20 feet, the water being nearly as salty as in Chesapeake Bay. About 18 miles above Hunting Creek it receives the waters of Tuckahoe Creek, a tributary nearly as long as the main stream above this point. The river is navigable for vessels of 9 feet draft to Denton, 7 miles above Tuckahoe Creek, and small-boat navigation extends to Greensboro, 8 miles further. The yield

of shad in 1896 was nearly one-half of the total product on all the Eastern Shore streams and nearly five times as many as were taken on Susquehanna River, numbering 276,076 on the main stream and 62,344 on Tuckahoe Creek, a total of 338,420, valued locally at $35,810. Of the total yield 183,730, or 54 per cent, were bucks. The forms of apparatus used are pound nets, drift nets, seines, and stake nets, with a few shad taken in fyke nets.

The location of pound nets extends from Nelson Point, near the mouth of the river, to 2 or 3 miles above the entrance of Tuckahoe Creek, but the nets are most numerous between Oxford and Windy Hill, a distance of 25 miles. In 1896 there were 24 strings with 2 pound nets each, 2 with 3 nets in a row, one string of 4 nets in a row, and 127 nets set individually, making a total of 185. Those near the mouth of the river average in value about $120, while the nets in the upper portion cost less than $40 each. The former are set more particularly for striped bass, bluefish, squeteague, perch, catfish, etc., and take comparatively few shad, while the catch by the latter consists largely of shad and alewives. The season begins in the lower part of the river during the second week of March, in the upper portion about ten days later, and lasts about two months, the bulk of the shad being taken from April 10 to May 10. Shad were somewhat scarce last year, and about the middle of April the weather became warm and prices fell so low that they did not even cover the expense of shipment, resulting in many of the nets being taken up. One net set near Oxford yielded 2,260 in one lift in 1895, whereas the yield during the entire season of 1896 did not equal that amount. The catch in the 185 nets numbered 52,226 roe and 62,532 buck shad, valued locally at $11,811.

The drift-net fishery is most extensive from the mouth of Tuckahoe Creek to Denton, but this branch of the shad fisheries is prosecuted from Windy Hill to the head of the river. The length of the nets ranges from 60 to 200 yards each and the depth from 40 to 60 meshes, according to the width and depth of the reach in which operated. From 2 to 5 nets are carried by each boat, the latter worth from $6 to $20 and having almost invariably a crew of two men. The season begins about the end of March and continues until nearly the middle of May. In 1896, on account of the low prices of shad, many fishermen ceased fishing earlier than usual, and the total catch by the 118 drift-net boats numbered only 33,281 roe and 47,310 buck shad, valued locally at $8,541.

The upper limit of the stake-net fishery on the Choptank is in the vicinity of Hunting Creek, near the lower limit of the drift-net fishery, and from this point to Castle Haven, a distance of 18 miles, these nets are quite numerous. They are set on the sides of the channel where the water is from 10 to 16 feet deep. The length of nets ranges from 12 to 25 yards each and the depth from 25 to 45 meshes, dependent respectively on the strength of current and the depth of water where they are located. The size of mesh is mostly 5 inches, a few nets of $5\frac{1}{2}$-inch mesh being employed also. From 10 to 100 nets are used by

each boat, the average number being about 40 or 45. The last season began about March 20 and lasted six or seven weeks, the yield by the 34 boats numbering 18,925 roe shad and 16,350 bucks, worth $3,813.

All the shad seines on Choptank River are operated within 8 miles of Denton, from Williston to Greensboro, in Caroline County. The length ranges from 120 to 325 yards each, and the depth from 10 to 30 feet. The seine shores are not so valuable as twenty or more years ago, but at present are worth from $50 to $500 each. In 1896 there were 14 seines operated on this river, with an aggregate length of 3,293 yards, and valuation of $1,460, requiring the services of 71 men, 14 boats worth $189, and $1,200 of shore property. The season began the third week of March and ended on May 15, as required by a State law. The large seines make about 12 hauls each day during the run of fish, the smaller ones being hauled somewhat more frequently. The most important of the seine fisheries is the Cedar Island fishery, owned by Mr. B. G. Stevens, which in some seasons takes 10,000 or 12,000 shad. The total shad yield in the 14 seines was 45,050, of which 24,110 were bucks, the local value being $5,183.

Between Dover Bridge and the entrance of Tuckahoe Creek there are usually a score or more fyke nets, in which a few shad are taken, the yield in 1896 numbering 402, of which over 70 per cent were bucks. Until recently there were several "pound weirs," or "stick weirs," in the headwaters of the Choptank, but legislation adverse to their use resulted in this branch of shad fishery being abandoned in 1895. Nearly all the shad taken in the Choptank River are shipped by steamer to Baltimore, and as most of them reach market after April 10, when large supplies are being received from Virginia waters and Delaware Bay, the price at which they are sold is necessarily quite low. This was especially true during the season herein reported, when the market was so glutted about the middle of April that many Choptank River shad were thrown away, and other shipments did not bring enough to pay expenses of marketing them.

Tuckahoe Creek.—This is the only tributary of Choptank River that has shad fisheries of any importance. Branching off about 8 miles below Denton, it is navigable for vessels of 8 feet draft for a distance of 10 miles. A small shad hatchery has been maintained for many years by the State of Maryland at Cowarts Point, a few miles above the mouth, from which five or ten million young shad are annually distributed. The shad fisheries of Tuckahoe Creek extend from the Choptank to Hillsboro, the yield in 1896 being 62,344, rendering it one of the most important shad streams on the Atlantic coast for its size. The forms of apparatus used are drift nets and seines, with a few pound nets and weirs.

The drift-net stations on Tuckahoe Creek are Cowarts Point (14 boats) and New Bridge (2 boats) in Caroline County, and Rees Landing and New Bridge (13 boats), Covey Landing (5 boats), Frank Landing (2 boats) and Todd Landing (2 boats) in Talbot County.

The nets are from 60 to 90 yards in length and are about 55 meshes deep, with 5 to 5¼ inch mesh. The 38 boats in 1896 used 117 drift nets, with an aggregate length of 8,802 yards and valuation of $1,140. The season began about the 1st of April and closed, according to law, on May 15. The catch per boat ranged from 200 to 2,000 shad, and averaged something over 1,000, the total catch of the 38 boats being 39,670, almost equally divided between roes and bucks, the number of the former being 20,040 and the latter 19,630.

The seine beaches on Tuckahoe Creek extend from Hillsboro to within 8 miles of the mouth of the river. Eight beaches were occupied last year, of which 2 were new ones. The seines range in length from 110 to 300 yards and from 9 to 37 feet in depth, with 2½-inch mesh generally. The catch of shad numbered 9,001 roes and 13,194 bucks, the proportion of the roes being smaller than usual.

Several pound nets and fyke nets are operated from the Talbot side of Tuckahoe Creek, taking a few shad, as well as alewives, perch, catfish, etc. Nine pound nets and 34 fykes were used in 1896, the former taking 283 and the latter 196 shad, as appears from the table showing the extent of the Maryland shad fisheries. Except sufficient for local consumption and for sale in the neighboring settlements and towns, all the shad taken on Tuckahoe Creek, as well as on Choptank River, are shipped to Baltimore by the daily steamers connecting that port with the river.

The local effect of close seasons is well illustrated by the condition on Choptank River and Tuckahoe Creek. In the lower half of the Choptank the shad season begins about the middle of March and ends about the 10th of May, whereas in Tuckahoe Creek and the upper portion of the Choptank the season begins about the 1st of April and closes by law on May 15, giving those sections nearly two weeks less of fishing than is enjoyed in the Lower Choptank. As a matter of fact, taking 1,000 shad after May 15 is generally less injurious to the future prosperity of the fishery than taking an equal number before that date, since the percentage of spawned shad in the former lot is greater than in the latter, thus yielding many more young shad when the fish are caught after May 15 than when taken before that date. Catching a shad immediately before it has spawned certainly prevents it from adding its quota to the supply of young fish; but this is also prevented if the shad be caught near the mouth of the river a month or more before its spawning period. It can not be denied, however, that many eggs are destroyed when seines are dragged over the spawning-beds.

ST. MICHAEL RIVER.

Eastern Bay is a side elongation of Chesapeake Bay, covering about 100 square miles and receiving the waters of the St. Michael, Wye, and smaller rivers. There are few fish in this bay, and the only one of its tributaries in which the shad fishery is of any consequence is St. Michael River. This small estuary, lying wholly in Talbot County,

is 16 miles long and varies in depth from 12 fathoms to 8 feet or less. Shad fishing is confined to the operation of several strings of stake nets, the yield finding a market in the near-by settlements. Sixty men engaged at intervals in this fishery in 1896, using 31 boats and 92 nets, 3,690 yards in length. The season began March 25 and closed the beginning of May, the catch numbering 1,212 roe shad and 1,003 bucks, valued locally at $423. That season was unusually backward and short and the fish remarkably scarce.

CHESTER RIVER.

Chester River is the second largest stream entering the Chesapeake Bay on the east, being surpassed in size only by the Choptank. It is navigable for vessels of 10 feet draft to Chestertown, 26 miles from its mouth, and for 3 or 4 feet draft about 10 miles farther. The width ranges from 2 or 3 miles near the mouth to 150 feet near Millington, at the head of navigation. The shad fisheries are prosecuted from the mouth of the river to the headwaters, but the catch is most numerous in the pound nets set near the mouth and in the stake nets from Chestertown to Millington. Of the total yield in 1896, 19,584 were taken by fishermen living in Kent County and 33,923 by fishermen from Queen Anne County.

The stake nets are set from Quaker Neck to Millington, the number of boats engaged in this fishery being 63, requiring 109 men to operate them. The nets measure from 20 to 50 yards in length and 30 to 45 meshes deep, with 5 to 5½ inch mesh, the aggregate length of the 178 nets used in 1896 being 7,020 yards. The season began April 6 and closed about May 25, the total yield being 13,440 roes and 6,150 buck shad, worth $3,223 at local valuation. A number of drift nets were formerly operated in Chester River, but they have gradually been superseded by stake nets, only 2 being reported for 1896, both operating at Chestertown.

Shad seines are used on the Chester River between Island Creek and Crumpton, 14 being employed in 1896, of which 5 were operated on the Queen Anne shore below Chestertown, the same number by men living at Chestertown, and 4 in the vicinity of Crumpton. There were also 3 seines at Queenstown, which took a very few shad. These seines measure from 400 to 150 yards in length, with 2 to 3 inch mesh, the aggregate length of the 17 being 3,835 yards. They were operated by 65 men, and in the season lasting from the middle of March to the end of May caught 3,874 roe and 6,059 buck shad, with a local valuation of $1,526.

The principal pound-net fishery of Chester River is located near the mouth of the river on both sides of the channel. On the southern shore, between Love Point and the Narrows, there were 11 pound nets in 1896, the value approximating $1,570. The mesh was 2½ inches, and the season for shad extended from the last week of March to the 1st

of June. The yield numbered 5,080 roes and 8,610 bucks, and was worth $1,943.

On the north shore of the river, between Eastern Neck Island and Swan Point, there were 51 nets set in 20 strings, the largest string containing 9 nets, but most of them with only 1 net each. These nets were much smaller than those on the Kent Island shore, the value of the 51 being only $3,240, and the catch of shad numbered 2,314 roes and 2,500 bucks, valued locally at $470. The yield of alewives during the same year was 768,000, worth $1,530. There were pound nets also at Chestertown, Quaker Neck, and Crumpton, the total numbering 19, worth $705. The catch of shad was 1,165 roes and 1,660 bucks, worth $413, making a total of 21,319 shad, valued at $2,826, taken in Chester River pound nets. In addition to shad, these nets take large quantities of alewives, perch, striped bass, catfish, etc.

The numerous fyke nets below Chestertown take many alewives and a few shad, the latter species being merely an incidental catch. The 83 fyke nets on the river in 1896 caught 2,390 shad, of which 1,440 were bucks and 950 were roes. This river ranks second among Maryland rivers in the number of shad taken in fyke nets, being surpassed only by the Nanticoke. The surplus of Chester River shad, after supplying the local demand, is sent to Baltimore and Philadelphia, good shipping facilities existing to those points by both steamer and rail.

SASSAFRAS AND ELK RIVERS.

Sassafras River.—In this tidal stream, 18 miles long, there are comparatively few shad, the great abundance of fresh water coming down from the Susquehanna attracting them past the mouth of this river. A few are obtained each year in pound nets set for alewives, perch, striped bass, etc. In 1896 there were 31 pound nets, worth $1,810, and the shad taken numbered 230 roes and 1,060 bucks, worth $166.

Elk River.—Elk River rises in Chester County, Pa., and enters Chesapeake Bay near the northern extremity, having a total length of 35 miles. From Chesapeake Bay to Elkton, the head of navigation, the river is a broad estuary three-fourths of a mile wide and 16 miles in length. There are no professional shad fisheries in Elk River, but a few shad are taken in the large number of pound nets set for alewives and other species. These nets are set on both sides of the channel from the mouth to Plum Point, near the head of the river. Those near the mouth take the largest quantity of shad, 100 or more being taken in each net, whereas few of the individual nets in the upper half take over 25 shad. The pound nets in 1896 numbered 139, worth $8,020, requiring 41 boats and 85 men to operate them. Shad were taken from March 20 to the end of May, the yield of this species being 1,629 roes and 3,615 bucks, valued locally at $637. The yield of alewives was 2,327,000 in number, but this represented only a portion of the quantity that could have been secured had there been a satisfactory market for them.

THE SHAD FISHERIES OF DELAWARE.

The shad fisheries of Delaware are prosecuted from Nanticoke River, Delaware River, Delaware Bay, and small tributaries entering them, as appears from the following series of tables:

Statement, by water areas, of the number of persons employed in each branch of the shad fisheries of Delaware in 1896.

Waters.	Fishermen.					Total, exclusive of duplication.
	Drift-net.	Stake-net.	Seine.	Pound-net.	Bow-net.	
Nanticoke River	72	.....	50	2	.....	120
Broad Creek	22	.....	10	.....	.....	32
Delaware Bay	46	14	.....	4	.....	64
Broadkiln Creek	15	.....	49	.....	.....	64
Mispillion Creek	60	.....	16	.....	.....	76
Murderkill Creek	20	.....	20	.....	16	56
St. Jones Creek	.....	.....	24	.....	.....	24
Leipsic Creek	10	.....	15	.....	.....	25
Duck Creek	.....	.....	22	.....	.....	22
Delaware River	164	.....	22	.....	.....	186
Appoquinimink Creek	.....	.....	6	.....	.....	6
Christiana Creek	6	.....	18	.....	.....	24
Total	415	14	252	6	16	699

Statement of the boats, apparatus, etc., employed in the shad fisheries of Delaware in 1896.

Waters.	Boats.		Drift nets.			Stake nets.		
	No.	Value.	No.	Length.	Value.	No.	Length.	Value.
				Yards.			*Yards.*	
Nanticoke River	47	$546	85	7,184	$1,195	.....	.....	.....
Broad Creek	13	154	22	1,540	325	.....	.....	.....
Delaware Bay	32	1,505	24	13,540	1,430	7	2,700	$240
Broadkiln Creek	32	335	13	600	43	.....	.....	.....
Mispillion Creek	58	1,280	50	2,500	400	.....	.....	.....
Murderkill Creek	34	340	20	500	60	.....	.....	.....
St. Jones Creek	6	100	.....	.....	.....	.....	.....	.....
Leipsic Creek	14	140	10	250	30	.....	.....	.....
Duck Creek	6	120	.....	.....	.....	.....	.....	.....
Delaware River	97	11,005	81	80,767	9,460	.....	.....	.....
Appoquinimink Creek	2	30	.....	.....	.....	.....	.....	.....
Christiana Creek	9	90	4	480	28	.....	.....	.....
Total	350	15,645	309	107,361	12,971	7	2,700	240

Waters.	Seines.			Pound nets.		Bow nets.		Shore property, value.	Total value.
	No.	Length.	Value.	No.	Value.	No.	Value.		
		Yards.							
Nanticoke River	10	1,674	$825	2	$60	.....	.....	$2,830	$5,456
Broad Creek	2	296	145	.....	.....	.....	.....	280	904
Delaware Bay	.....	.....	.....	2	325	.....	.....	2,200	5,700
Broadkiln Creek	18	1,580	370	.....	.....	.....	.....	1,630	2,378
Mispillion Creek	4	320	100	.....	.....	.....	.....	1,500	3,280
Murderkill Creek	6	480	150	.....	.....	10	$40	1,350	1,940
St. Jones Creek	6	500	150	.....	.....	.....	.....	400	650
Leipsic Creek	4	320	125	.....	.....	.....	.....	300	595
Duck Creek	6	427	150	.....	.....	.....	.....	225	495
Delaware River	4	2,250	1,050	.....	.....	.....	.....	857	22,372
Appoquinimink Creek	2	160	50	.....	.....	.....	.....	100	180
Christiana Creek	6	300	72	.....	.....	.....	.....	.....	190
Total	68	8,307	3,187	4	385	10	40	11,672	44,140

Statement showing the yield in each branch of the shad fisheries of Delaware in 1896.

Waters.	Drift nets.		Stake nets.		Seines.		Pound nets.		Bow nets.		Total.	
	No.	Value.	No.	Val.	No.	Val.	No.	Val.	No.	Val.	No.	Value.
Nanticoke River	22,760	$2,235	.....	.....	19,722	$1,803	280	$34	.....	.....	42,832	$4,072
Broad Creek	6,710	690	.....	.....	2,925	393	.....	.....	.....	.....	9,635	1,083
Delaware Bay	43,220	7,765	4,200	$672	.....	.....	100	19	.....	.....	47,520	8,456
Broadkiln Creek	2,695	387	.....	.....	13,805	2,139	.....	.....	.....	.....	16,500	2,526
Mispillion Creek	47,500	9,726	.....	.....	3,180	643	.....	.....	.....	.....	50,680	10,369
Murderkill Creek	3,500	693	.....	.....	2,900	569	.....	.....	2,300	$445	8,700	1,707
St. Jones Creek	.....	.....	.....	.....	4,060	507	.....	.....	.....	.....	4,060	507
Leipsic Creek	1,700	260	.....	.....	1,098	160	.....	.....	.....	.....	2,798	420
Duck Creek	.....	.....	.....	.....	1,500	240	.....	.....	.....	.....	1,500	240
Delaware River	278,857	39,080	.....	.....	2,012	261	.....	.....	.....	.....	280,869	39,341
Appoquinimink Creek	.....	.....	.....	.....	350	55	.....	.....	.....	.....	350	55
Christiana Creek	600	100	.....	.....	2,300	384	.....	.....	.....	.....	2,900	484
Total	407,542	60,936	4,200	672	53,922	7,154	380	53	2,300	445	468,344	69,260

NANTICOKE RIVER.

Most of the eastern tributaries of Chesapeake Bay have their sources in the State of Delaware, yet Nanticoke River is the only one which penetrates that State sufficiently far to maintain shad fisheries within the limits of Delaware. The general physical characteristics of this stream have already been described in the chapter on the shad fisheries of Maryland. The portion situated in Delaware is small, the distance from the State line to Seaford, the head of navigation, being only 8 miles. Above Seaford the river is very narrow and shallow and soon terminates in the swamps of Sussex County. The shad fisheries of the Delaware section of Nanticoke River are prosecuted by means of drift nets and seines. The former are used from the Maryland line to Seaford, the principal fishing centers being Seaford and Woodland, while seines are operated from 2 miles below Woodland to 2 miles above Seaford.

The catch of shad by these forms of apparatus in 1896 numbered 29,470 and 22,717, respectively, while 280 were taken incidentally in pound nets, making a total yield of 52,467 shad in this section of Nanticoke River.

The drift nets range from 70 to 90 yards in length, 49 to 55 meshes deep, with $5\frac{1}{8}$ to $5\frac{3}{4}$ inch mesh. The season now begins about March 20 and ends during the first or second week in May, being somewhat shorter during recent years than formerly. The laws of Delaware interdict the taking of shad in this river after May 31 of each year. In the vicinity of Seaford the water is so clear that all drifting must be done at night, whereas at Sharptown and below fishing is done principally during the day. In 1896 there were 36 boats engaged in drifting in this section of the Nanticoke, using 85 nets, aggregating 7,184 yards in length, and manned by 72 men. The largest catch by any one boat in one day was 148 shad, and the catch during the season ranged from

400 to 1,700 per boat, the total yield numbering 12,020 roe shad and 10,740 bucks, for which the fishermen received $2,235.

Haul seines are used only in the extreme upper limits of the river, above the Maryland border line. From that point to 2 miles above Seaford there are 10 seines, measuring from 125 to 200 yards in length, 20 to 30 feet in depth, with 2¼ to 2½ inch mesh. Five men are required at each fishery, and the beaches rent usually for about $15 annually. The season extends from the second week of March to the second or third week of May, and the catch by each seine usually ranges from 200 to 3,000 shad. The aggregate catch by the 10 seines in 1896 was 8,702 roe shad and 11,090 bucks, valued locally at $1,803.

Broad Creek.—This creek is a branch of Nanticoke River, joining that stream a short distance above the Maryland line. It penetrates the swamps of southern Delaware, and is navigable a distance of 8 miles, to Laurel. Its shad fisheries are of local importance only, the annual yield approximating 10,000, obtained by means of drift nets and seines which differ in no particular from those used on the upper portion of the Nanticoke. In 1896 there were 11 drift-net boats and two seining crews, and the catch aggregated 9,635 shad, of which 6,710 were obtained by drift nets and 2,925 by seines.

DELAWARE BAY AND RIVER.

The shad fisheries prosecuted in Delaware Bay by residents of the State of Delaware are very much less extensive than those carried on by citizens of New Jersey, and the same statement is applicable to Delaware River, although the difference in the latter is not so great. The residents of the two States fish generally on the same grounds, with similar forms of apparatus, depend on the same markets, and their interests are identical in nearly every particular. It is therefore most convenient to describe the fisheries of the two States in the same chapter, and as those prosecuted from the New Jersey shore are by far the most important the fisheries of both the bay and river will be described in the chapter relating to that State. It will suffice to state in this connection that in 1896 47,520 shad were taken in Delaware Bay and 280,869 in Delaware River by residents of Delaware, the value aggregating $47,797.

The principal fishing centers on the river are Newcastle, Delaware City, Wilmington, and Port Penn, while on the bay the principal centers are Bombay Hook and Bowers Beach.

There are a number of small streams tributary to Delaware Bay and situated entirely within this State which yield a number of shad each year, the most important being Broadkiln, Mispillion, Murderkill, St. Jones, Leipsic, Duck, Appoquinimink, and Christiana creeks. They all rise in the central and western part of Delaware and flow in a general easterly direction to their entrance into the bay. They are short, the longest barely exceeding 25 miles, and are tidal nearly to their source. The fisheries of each will be briefly noted.

Broadkiln Creek.—This creek is situated in Sussex County and empties into Delaware Bay a short distance above the breakwater at Lewes. It is nearly 20 miles long, navigable to Milton, a town of 1,200 inhabitants, about 14 miles from the mouth. According to Dr. Shortlidge, formerly fish commissioner of Delaware, shad were not caught in Broadkiln Creek previous to plantings of fry made there about eight years ago. They are now taken in some abundance by means of seines and drift nets. The run in 1896 was smaller than usual, in 1895 it was fair, while the catch in 1892 was the best on the creek. In 1896, 18 seines were used, with an aggregate length of 1,580 yards, and worth $370. The catch of shad numbered 6,185 roes and 7,620 bucks, with a local valuation of $2,139. A State regulation makes it "unlawful for any person or persons to make more than one haul on the ebb tide and one haul on the flood tide for the taking of shad in Broadkiln River, or to use the rattler, which is made to scare the shad, or to use anything that might be conceived of to drive the shad," and that the seine shall not remain across the river longer than one hour on each tide, but it does not appear that these regulations are enforced. The drift nets numbered 13, with an aggregate length of 600 yards, and a valuation of $43, and the catch numbered 1,033 roes and 1,662 bucks, worth $387 at local prices.

Mispillion Creek.—This is a narrow, tortuous, sand-hill creek, entering Delaware Bay about 17 miles northwest of Cape Henlopen. Near its mouth it averages 80 yards in width, and in the vicinity of Milford, the head of navigation, 18 miles from the mouth, the average width is about 30 yards. The apparatus used for taking shad are drift nets and a few seines. The former measure 50 yards in length, with 5⅛-inch mesh, and require the services of one boat and one or two men each. Most of the 60 drift-net fishermen live at Milford, and they fish between that point and 14 miles below. The number of nets employed in 1896 was 50, the catch by which is reported at 26,000 roe shad and 21,500 bucks. Four shad seines were used on the Mispillion in the vicinity of Milford, averaging 80 yards in length, with 2-inch mesh, and requiring the services of 4 men each. The catch of shad numbered 3,180, about equally divided between roes and bucks, with a local value of $643.

Murderkill Creek.—This creek is navigable from the mouth to Quillen Landing, 5 miles above Fredericka and about 12½ miles from Delaware Bay. Its shad fisheries are of small extent, confined to the use of a few drift nets, seines, and bow nets by men living at Fredericka. The seines used numbered 6, with an aggregate length of 480 yards, the yield of shad approximating 2,900, worth $569, of which 1,700 were roes. Twenty drift nets were used during the same year, catching 3,500 shad, worth $693, of which about three-fifths were roes. The Murderkill is the only river in Delaware from which the use of bow nets is reported. The catch by the 10 nets was reported at 1,300 roe shad and 1,000 bucks, worth $445, making an aggregate of 8,700 as the total yield in 1896.

St. Jones Creek.—St. Jones Creek is a tidal stream, 40 miles in length, which empties into Delaware Bay immediately above the entrance of Murderkill Creek and 75 miles below Philadelphia. It is navigable for vessels of 6-foot draft to Lebanon, 12 miles above the mouth; thence 5 feet can be carried a distance of 9 miles to Dover, the head of navigation and the capital of the State. The shad fisheries are limited to the use of haul seines at Lebanon, Cherrytree Landing, and Dover. These seines are each from 80 to 100 yards in length, with 2¼ to 2½-inch mesh, requiring 4 men each. They had a fairly good season in 1896, the catch in the six seines numbering 1,656 roe shad and 2,404 bucks, worth $507. There is a State interdiction against placing "any net, seine, or other device used in fishing in or across St. Jones River on or during any flood tide."

Leipsic Creek.—Leipsic Creek differs little from the other small creeks of this State, and its shad fisheries call for no special description. A few drift nets and seines are used between the mouth of the creek and Leipsic, 10 drift nets being employed in 1896, catching 900 roe shad and 800 bucks, and 4 seines caught 500 roes and 598 bucks—a total of 2,798 shad, worth $420.

Duck Creek.—This stream is narrow and winding, 15 miles in length, and empties into Delaware Bay 5½ miles above Bombay Hook Point. In 1896, 14 fishermen from Smyrna, in Kent County, used 4 seines, each 80 yards in length, with 2¼-inch mesh. From Walker, in Newcastle County, 8 men used 2 seines, each 53 yards in length. The catch by the former approximated 1,000 shad, of which two-thirds were roe; and the catch by the Walker fishermen was about one-half as large, with the same proportion of roes and bucks.

Appoquinimink Creek.—This is a tidal stream, 20 miles in length, lying altogether in Newcastle County, and emptying into Delaware River 5 miles below Port Penn and 46 miles below Philadelphia. It is navigable for vessels of 7-foot draft to Odessa, a town of 500 inhabitants, 9 miles from the mouth. Two seines, each 80 yards in length, with 2¼-inch mesh, were used in 1896 by 6 men from Odessa. The catch of shad was small, numbering only 350, of which nearly 60 per cent were roes.

Christiana Creek.—For purposes of navigation this creek is the most important one in Delaware, as it forms the harbor of Wilmington. It is navigable to Wilmington, a distance of 8 miles, and above that point it is crossed by several dams for generating water power. Six seines were used in 1896, averaging 50 yards in length, with 2½-inch mesh. Their catch is reported at 2,300 shad, of which two-thirds were roes. Four drift nets were also used, each 120 yards long, with 5¼-inch mesh. They caught 400 roe shad and 200 bucks, making a total of 2,900 shad, worth $484, taken during the year herein reported.

THE SHAD FISHERIES OF PENNSYLVANIA.

The shad fisheries of Pennsylvania are confined to the Susquehanna River and to the Delaware Bay and River and their tributaries. The following series of tables shows the extent of those fisheries in detail:

Statement, by water areas, of the number of persons employed in the shad fisheries of Pennsylvania in 1896.

Waters.	Number of fishermen.					Shoresmen.	Transporters.	Total.
	Drift-net.	Seine.	Bow-net.	Spear.	Total.			
Susquehanna River:								
Below Columbia dam	.....	286	51	.....	337	.....	.....	337
Above Columbia dam	.....	79	.....	.....	79	.....	.....	79
Juniata River	.....	12	.....	.....	12	.....	.....	12
Delaware Bay	11	.....	.....	.....	11	.....	.....	11
Delaware River:								
Below Scudder Falls	340	149	.....	.....	489	.....	.....	489
Above Scudder Falls	2	155	.....	30	187	16	2	205
Total	353	681	51	30	1,115	16	2	1,133

Statement, by water areas, of the boats, apparatus, etc., employed in the shad fisheries of Pennsylvania in 1896.

Waters.	Boats.		Drift nets.			Seines.		
	No.	Value.	No.	Length.	Value.	No.	Length.	Value.
				Yards.			*Yards.*	
Susquehanna River:								
Below Columbia dam	152	$3,714	.....	.....	.....	33	6,360	$2,345
Above Columbia dam	20	777	.....	.....	.....	16	2,260	1,190
Juniata River	2	30	.....	.....	.....	2	170	135
Delaware Bay	10	750	5	6,000	$725	.....	.....	.....
Delaware River:								
Below Scudder Falls	223	14,682	167	64,670	10,268	15	5,300	5,035
Above Scudder Falls	52	1,387	1	100	35	30	5,215	3,580
Total	468	21,340	173	70,770	11,028	96	19,305	12,285

Waters.	Bow nets.		Spears.		Shore property.	Total value.
	No.	Value.	No.	Value.		
Susquehanna River:						
Below Columbia dam	51	$185	.....	.....	$2,655	$8,899
Above Columbia dam	.....	.....	.....	.....	60	2,027
Juniata River	.....	.....	.....	.....	55	220
Delaware Bay	.....	.....	.....	.....	.....	1,475
Delaware River:						
Below Scudder Falls	.....	.....	.....	.....	20,596	50,581
Above Scudder Falls	.....	.....	30	$23	13,085	18,110
Total	51	185	30	23	36,451	81,312

Statement, by water areas, of the yield of shad in Pennsylvania in 1896.

Waters.	Drift nets.		Seines.		Bow nets.		Spears.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Susquehanna River:										
Below Columbia dam	.....	.....	53,706	$8,120	10,500	$1,893	.....	.....	64,206	$10,013
Above Columbia dam	.....	.....	5,693	1,696	.....	.....	.....	.....	5,693	1,696
Juniata River	.....	.....	700	287	.....	.....	.....	.....	700	287
Delaware Bay	18,600	$1,655	.....	.....	.....	.....	.....	.....	18,600	1,655
Delaware River:										
Below Scudder Falls	277,204	54,670	152,195	14,795	.....	.....	.....	.....	429,399	49,465
Above Scudder Falls	1,200	200	96,041	15,589	.....	.....	5,400	$540	102,641	16,329
Total	297,004	36,525	308,335	40,487	10,500	1,893	5,400	540	621,239	79,445

SUSQUEHANNA RIVER.

Susquehanna River is situated partly in Maryland and New York, but principally in Pennsylvania, traversing that State from its northern to its southern border. Its source is in Otsego Lake, New York, whence it flows a distance of 422 miles to its entrance into Chesapeake Bay. On account of the numerous rapids and the shoalness of the water, the river is not navigable except for skiffs in short reaches. It differs from most streams on the Atlantic coast north of Cape Lookout in that it maintains fluvial characteristics quite to its mouth and crosses the fall line very near its entrance into Chesapeake Bay, only the extreme southern end being tidal. From the mouth to Columbia, a distance of 43 miles, the width varies from a few hundred yards to something over a mile, and the channel is dotted with islands and rocks. The fall in this length is considerable, being 224 feet for the 43 miles, an average of over 5 feet per mile, resulting in numerous rapids but no abrupt falls of any moment. Aside from the large quantity of drift nets and seines near the mouth, the first serious obstruction to the ascent of shad is at Columbia, where the stream is crossed by a dam 6,800 feet long and 7 or 8 feet high, built about 1835 for the purpose of feeding the Susquehanna canal. This dam has been the principal cause of the destruction of the up-river fisheries, and its existence has naturally led to much contention between the fishermen and the owners of the dam, a brief account of which is given on pp. 225–226. Breaks frequently exist in this obstruction, permitting some shad to pass above it.

Forty miles above Columbia the Susquehanna receives its second largest tributary, the Juniata, a stream 100 miles in length, the shad fisheries of which were formerly of considerable local importance. The second dam on the Susquehanna is at Clark Ferry, just above the entrance of the Juniata, the structure being 7 feet high and nearly 2,000 feet long. At Sunbury, 38 miles above Clark Ferry, there is another canal dam 2,600 feet long and 7½ feet high. Immediately above Sunbury the Susquehanna receives its principal tributary, the West Branch, which flows a distance of 175 miles before its union with the Susquehanna, and which is obstructed by numerous dams. The Nanticoke dam, 7 miles below Wilkesbarre and 174 miles from Havre de Grace, is the fourth dam on the Susquehanna and has had very injurious effect on the shad fisheries. This structure, completed in 1830, is of cribwork, 900 feet long and 6 feet high above low water. There are a dozen or more old fish-dams between Nanticoke dam and the New York line. The fall in this length is slight, averaging scarcely more than 2 feet per mile. At Binghamton, N. Y., 318 miles from the mouth of the river, there is a cribwork dam 450 feet long and 5½ feet high at low water, extending entirely across the stream. Above Binghamton there are several primitive crib dams, producing falls of 3 to 10 feet.

In the early part of the present century, before the construction of the dams above enumerated, the shad fisheries of the Susquehanna were among the most important on the Atlantic coast, extending from the

mouth to some distance above the New York State line. But since 1835 they have been confined almost exclusively to that portion of the river lying below the Columbia Dam. The yield between Columbia and the Maryland line in 1896 numbered 25,672 roes and 38,534 bucks, of which 21,492 roes and 32,214 bucks were taken in seines and 4,180 roes and 6,320 bucks in bow nets. Thirty-three seines were used, of which 14 were at Washington Borough, 7 at East Prospect, and 8 at Columbia. The aggregate length of these seines was 6,360 yards and the value $2,345. The catch in 1896 was not up to the usual quantity. During the early part of the season the water was very high and in the latter part it was unusually low, thus shortening the season at each end. The bow nets used in the Susquehanna below Columbia are similar to those in the Maryland section of the river. They are worth from $3 to $5 and require one man to each net. They were used at the following places in 1896: McCall's Ferry, 16 nets; Fite's Eddy, 12; Creswell, 8; Long Level, 5, and Safe Harbor, 10, making a total of 51 nets.

The researches of the Wyoming Historical and Geological Society show that above the forks at Sunbury, in the early part of the present century, there were 40 fishing shores, some of which were worth $1,000 annually, the average value being about $300. There is an apparently trustworthy record of the capture of 9,997 shad at a single haul of a seine at Fish Island, near Wilkesbarre. It is reported that just below Nanticoke 3,800 shad were taken in one night, and at Monocacy Island 2,800 were taken at a single haul. At the Sterling Island fishery "over 2,000 were caught in one day in five hauls." These large catches were, of course, exceptional and possibly somewhat overrated, but they serve to show that the yield was very great. The same society estimates the annual value of the shad catch at the 40 fisheries above noted to have been at least $12,000. At an average of 8 cents each this would make 150,000 shad. The catch on the West Branch and the Juniata combined was probably equally large, and on the main river, between Sunbury and the Maryland line, the yield was doubtless much greater, making a total of at least 500,000 shad caught each year in that portion of the Susquehanna located in Pennsylvania. This abundance continued till the construction of dams on the Susquehanna during the Thirties, the most injurious being those at Columbia, Clark Ferry, Sunbury, and Nanticoke. The Columbia dam, being nearest the mouth of the river, naturally drew to it the obloquy of those interested in the destroyed up-river fisheries, that obstruction being regarded as the prime cause of all the difficulty.

The charter to the canal company required that a rafting channel should be left in the Columbia dam. Three years after its construction the State legislature directed that the company should build therein a sluice not less than 100 feet wide, with an ascent of 1 foot in 5, to promote the passage of fish. It does not appear that the company satisfactorily complied with this mandatory act, nor with a similar one

enacted in 1851, yet in 1863 the State formally acknowledged the dam as satisfactory. The hostile sentiment among the up-river residents increased, culminating in a mass convention at Harrisburg, composed of four or five hundred delegates, which resulted in the passage of an act by the legislature then in session requiring that the several companies owning or interested in dams on the Susquehanna should erect, within six months thereafter, such sluices or other devices as would permit the free passage of shad and other fish up that stream.

In compliance with this enactment the canal company owning the dam at Columbia, selecting a point about a quarter of a mile from the western bank, where shad were accustomed to gather in the greatest number during the season, removed a 40-foot section of the dam and in that space built a new subdam, the top of which was about level with the water below. The lower slope of the subdam was placed at an inclination of 1 in 15, and the sides of the aperture in the main dam were dentated, so as to promote the formation of eddies in the current passing over the subdam. This structure did not appear to answer its purposes, and in 1873 the State made an appropriation for another fishway at that point, the designs consisting of a single trough 120 feet long by 60 feet wide, running through the dam, and about 150 feet back into the part below, with its upper end sunk 2 feet below the crest of the dam, the sides of the trough or fishway being protected by strong abutments built up on both sides. This also proved ineffectual, and in 1880 a third fishway was placed in the dam, consisting simply of an opening 125 feet wide, this plan being chosen because it conformed to a break in the dam, experience having shown that shad passed through such an opening more readily than through any fishway that had been constructed. In 1886 a fourth fishway was constructed on the site of the one built by the canal company in 1866.

While shad do pass above the dam, yet during recent years few have been caught above Columbia, except when breaks exist in the obstruction. This was the case in 1873, 1877, 1895, 1896, and possibly during some intervening seasons. The break in 1895 occurred in the spring and many shad ascended as far as Clark Ferry. The men along the river were not prepared for their coming and few fish were caught. The break was not repaired, and in 1896 some few seines were used which did fairly well in those places where the bottom was sufficiently clean for hauling. The principal places above Columbia dam where shad were caught are Bainbridge, Marsh Run, Newmarket, McCormack Island, and Duncannon on Susquehanna River, and Newport on the Juniata. Seines were the only apparatus employed, and the number of these between Columbia dam and Clark Ferry dam was 14, with 2 on the Juniata near Newport. The length ranged from 250 yards down to 80, with 4¼ to 5½ inch mesh. The catch in the 14 seines on the Susquehanna numbered 2,417 roe shad and 3,276 bucks, valued locally at $1,696. The 2 seines at Newport, on the Juniata, caught 280 roe and 420 buck shad, worth $287, making a total of 6,393 shad taken

above the Columbia dam in 1896. The fishing season for shad on the Susquehanna and the Juniata rivers is limited "from Monday at sunrise till Saturday at sunset of each week from March 15 to June 25 of each year." In 1873, when there was a large break in Columbia dam, 9,000 shad were taken in one of the Newport seines; in 1876, when there were no breaks, 511 shad were caught, and in 1877, when there were two breaks, one 20 feet wide and one 35 feet wide, 826 shad were taken. If the break in the Columbia dam is not repaired, the catch above that point will doubtless continue to increase, as the fishermen will make preparation for them.

The shad fishermen on the upper Susquehanna have three principal complaints, the first and most general one being the existence of the Columbia dam. The second complaint is that in Juniata River below the Millertown dam, and to some extent in Susquehanna River, there are a number of rough V-shaped stone breakwaters, similar to those used in the Maryland section of the river, but having a small-meshed net stretched across at the apex instead of the usual finger or fall trap. This contrivance is intended for the capture of eels, but in the late summer and early fall large quantities of young shad are caught and destroyed. The seine fishermen near the Columbia dam are charged with a practice known locally as "shingling," which consists in attaching new shingles to weights by means of short lines and placing them in the current of water passing through the breaks in the dams. The current causes the anchored shingle to revolve rapidly, scaring the fish and thus preventing them from passing above the broken dam.

DELAWARE RIVER.

The shad fisheries prosecuted in Delaware River by residents of Pennsylvania are of importance, the catch averaging at least half a million, but the operations of the New Jersey fishermen are much greater. It is desirable to describe the fisheries of both sides of the river at the same time, and, those on the New Jersey side being the more numerous, an account for the entire river will be given in the chapter relating to that State. In 1896 there were 705 residents of Pennsylvania employed in the shad fisheries of Delaware River and Bay, using 173 drift nets, 45 seines, and 30 spears, and taking 550,640 shad, worth $67,449, as appears in the tables on page 223.

Schuylkill River.—The Schuylkill formerly yielded many shad. William Penn mentioned in one of his letters that "600 shad had been taken with one sweep of the seine" in that river. In 1818 the Schuylkill Navigation Company built two large dams across the stream, one at Shawmont and the other at Reading. In 1820 the city of Philadelphia built the large dam at Fairmount for water-supply purposes, thus completely destroying the shad fisheries above that point. But the fishing below the Fairmount dam was remunerative until the building of the gas works a few years later, the refuse from which causes shad to avoid this river.

THE SHAD FISHERIES OF NEW JERSEY.

The extent by water areas of the shad fisheries of New Jersey is presented in the following series of three tables, showing (1) the number of persons employed; (2) the boats, apparatus, etc., used, and (3) the quantity and value of the catch.

Statement showing, by water areas, the number of persons employed in the shad fisheries of New Jersey in 1896.

Waters.	Number of fishermen.				Total, exclusive of duplication.	Shoresmen.	Transporters.	Total.
	Gill-net.		Seine.	Fyke-net.				
	Drift.	Stake.						
Delaware Bay	565	.....	12	.....	577	.....	3	580
Delaware River below Scudder Falls	1,077	.....	312	.....	1,389	35	35	1,459
Delaware River above Scudder Falls	80	.....	176	.....	256	.....	.....	256
Cohansey Creek	32	.....	20	.....	52	.....	.....	52
Alloway Creek	.....	.....	2	.....	2	.....	.....	2
Salem Creek	30	.....	.....	.....	30	.....	.....	30
Raccoon Creek	.....	.....	5	.....	5	.....	.....	5
Mantua Creek	.....	.....	2	.....	2	.....	.....	2
Big Timber Creek	.....	.....	19	.....	19	.....	.....	19
Jenkins Sound	.....	.....	2	.....	2	.....	.....	2
Ludlam Bay	.....	.....	10	.....	10	.....	.....	10
Manasquan River	.....	8	14	10	28	.....	.....	28
Sandy Hook Bay	.....	54	.....	.....	54	.....	.....	54
Raritan Bay	.....	73	.....	.....	73	.....	.....	73
Raritan River	.....	.....	.....	1	1	.....	.....	1
New York Bay	.....	.....	.....	25	25	.....	.....	25
Hudson River	.....	176	.....	.....	176	.....	.....	176
Total	1,784	311	574	36	2,701	35	38	2,774

Statement showing, by water areas, the boats, apparatus, etc., employed in the shad fisheries of New Jersey in 1896.

Waters.	Boats.		Drift nets.			Stake nets.		
	No.	Value.	No.	Length.	Value.	No.	Length.	Value.
				Yards.			*Yards.*	
Delaware Bay	236	$29,080	230	271,200	$42,775	.....	.....	.....
Delaware River below Scudder Falls	606	60,950	538	262,547	49,455	.....	.....	.....
Delaware River above Scudder Falls	101	3,122	40	6,060	913	.....	.....	.....
Cohansey Creek	45	450	25	2,500	625	.....	.....	.....
Alloway Creek	1	20	.....	.....	.....	.....	.....	.....
Salem Creek	15	300	15	4,500	750	.....	.....	.....
Raccoon Creek	4	50	.....	.....	.....	.....	.....	.....
Mantua Creek	1	30	.....	.....	.....	.....	.....	.....
Big Timber Creek	4	135	.....	.....	.....	.....	.....	.....
Jenkins Sound	1	10	.....	.....	.....	.....	.....	.....
Ludlam Bay	5	50	.....	.....	.....	.....	.....	.....
Manasquan River	12	140	.....	.....	.....	8	400	$40
Sandy Hook Bay	26	930	.....	.....	.....	107	16,840	3,900
Raritan Bay	40	821	.....	.....	.....	982	24,304	4,256
Raritan River	1	60	.....	.....	.....	.....	.....	.....
New York Bay	13	855	.....	.....	.....	.....	.....	.....
Hudson River	69	4,905	.....	.....	.....	1,530	15,282	7,935
Total	1,180	101,908	848	546,807	94,518	2,627	56,826	16,131

Statement of boats, apparatus, etc., employed in New Jersey shad fisheries—Continued.

Waters.	Seines.			Fyke nets.		Value of shore property.	Total investment.
	No.	Length.	Value.	No.	Value.		
		Yards.					
Delaware Bay	2	850	$425			$24,040	$96,320
Delaware River below Scudder Falls	21	9,378	9,080			65,736	185,221
Delaware River above Scudder Falls	34	5,950	4,023			21,447	29,505
Cohansey Creek	10	600	300				1,375
Alloway Creek	1	100	45				65
Salem Creek							1,050
Raccoon Creek	2	210	110				160
Mantua Creek	1	100	50				80
Big Timber Creek	4	380	370				505
Jenkins Sound	1	50	15				25
Ludlam Bay	5	250	100				150
Manasquan River	6	1,322	145	20	$100	55	480
Sandy Hook Bay							4,830
Raritan Bay							5,077
Raritan River				11	550		610
New York Bay				214	1,314	275	2,444
Hudson River						1,175	14,015
Total	87	19,190	14,663	245	1,964	112,728	341,912

Statement by apparatus of the yield of shad in New Jersey in 1896.

Waters.	Drift nets.		Stake nets.		Seines.	
	No.	Value.	No.	Value.	No.	Value.
Delaware Bay	1,037,001	$94,576			700	$74
Delaware River below Scudder Falls	1,486,730	148,561			327,430	25,813
Delaware River above Scudder Falls	42,800	4,284			108,934	16,805
Cohansey Creek	11,850	1,542			10,000	1,050
Alloway Creek					300	35
Salem Creek	8,000	800				
Raccoon Creek					4,800	464
Mantua Creek					2,000	220
Big Timber Creek					10,400	728
Jenkins Sound					40	16
Ludlam Bay					50	12
Metedeconk River and Barnegat Bay					*a* 150	38
Manasquan River			200	$50	625	312
Sandy Hook Bay			6,600	1,320		
Raritan Bay			15,675	3,409	*a* 1,010	223
Hudson River			168,800	24,316		
Total	2,586,381	249,763	191,275	29,095	466,439	45,790

Waters.	Pound nets.		Fyke nets.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Delaware Bay					1,037,701	$94,650
Delaware River below Scudder Falls					1,814,160	174,374
Delaware River above Scudder Falls					151,734	21,089
Cohansey Creek					21,850	2,502
Alloway Creek					300	35
Salem Creek					8,000	800
Raccoon Creek					4,800	464
Mantua Creek					2,000	220
Big Timber Creek					10,400	728
Jenkins Sound					40	16
Ludlam Bay					50	12
Metedeconk River and Barnegat Bay					150	38
Manasquan River			1,500	$375	2,325	737
Ocean Shore	*a* 13,675	$2,715			13,075	2,715
Sandy Hook Bay					6,600	1,320
Raritan Bay	*a* 26,702	4,005	*a* 250	38	43,037	7,675
Raritan River			2,500	938	2,500	938
New York Bay			49,758	7,337	49,758	7,337
Hudson River					168,800	24,316
Total	40,377	6,720	54,008	8,688	3,338,480	340,056

a Caught incidentally in apparatus set for other species.

DELAWARE BAY AND RIVER.

The sources of the Delaware are in the high plateau of central New York, in Delaware and Schoharie counties, at an elevation of over 1,800 feet above sea level. Eighty miles below the headwaters it becomes the eastern boundary of Pennsylvania, and by a breach, known as the "Delaware Water Gap," it passes through the Kittatinny Mountains at a distance of 200 miles below its source. It crosses the escarpment line near Trenton, the head of navigation, 280 miles from its headwaters and 133 miles from the Atlantic Ocean. From Trenton to Fort Delaware, a distance of about 75 miles, it is a broad, navigable stream from ½ to 2 miles in width, supporting considerable commerce below Philadelphia. Near Fort Delaware it increases in width, and at some indefinite and much-disputed point it merges into Delaware Bay, which is merely a continuation of the estuary of the river. This body of water separates the States of Pennsylvania and Delaware from New Jersey, and the fisheries are prosecuted by the residents of those three States.

The present chapter covers all the shad fisheries of Delaware River and Bay, including those which are prosecuted by residents of Pennsylvania and Delaware, as well as those of New Jersey. These fisheries are the most extensive in America, the annual yield ranging between 3,000,000 and 4,000,000, being several times greater than on any other river on the coast. In 1896 the catch numbered 3,882,624, of which 3,003,595 were taken by residents of New Jersey, 550,640 by residents of Pennsylvania, and 328,389 by Delawareans. In describing the shad fisheries of this body of water, it is most convenient to divide it into three sections, the first covering Delaware Bay; the second, the tidewater portion of the river from the head of the bay to the fall line at Scudder Falls; and the third from the escarpment line to the head of the river. Of the total yield in these waters in 1896, 1,103,821 were caught in the bay, 2,602,628 in the tidal portion of the river from the head of the bay to Scudder Falls, and 176,175 from the section above Scudder Falls.

The following table shows the number of persons employed in each branch of the shad fisheries of Delaware Bay and River during 1896:

Branch of fishery.	Delaware Bay.	Delaware River below Scudder Falls.	Delaware River above Scudder Falls.	Total for Delaware Bay and River.
Stake-net	14			14
Drift-net	622	1,661	2	2,285
Seine	12	526	288	826
Spear			30	30
Pound-net	4			4
Shoresmen		51		51
Transporters		37		37
Total	652	2,275	320	3,247

The following table shows the boats, apparatus, etc., employed in the fisheries of Delaware Bay and River in 1896:

Designation.	Delaware Bay.			Delaware River below Scudder Falls.		
	Number.	Length.	Value.	Number.	Length.	Value.
		Yards.			*Yards.*	
Boats	278		$31,335	988		$88,762
Stake nets	7	2,700	240			
Drift nets	259	290,740	44,930	826	414,044	70,096
Seines	2	850	425	45	17,903	15,720
Pound nets	2		325			
Spears						
Shore property			26,240			93,109
Total			103,495			267,687

Designation.	Delaware River above Scudder Falls.			Total for Delaware Bay and River.		
	Number.	Length.	Value.	Number.	Length.	Value.
		Yards.			*Yards.*	
Boats	91		$2,384	1,357		$122,481
Stake nets				7	2,700	240
Drift nets	1	100	35	1,086	704,884	115,061
Seines	59	10,190	7,048	106	28,943	23,193
Pound nets				2		325
Spears	30		23	30		23
Shore property			38,612			157,961
Total			48,102			419,284

The following table shows the yield of shad in Delaware Bay and River, by each form of apparatus, in 1896:

Apparatus.	Delaware Bay.			Delaware River below Scudder Falls.		
	Number of roe.	Number of buck.	Value.	Number of roe.	Number of buck.	Value.
Stake nets	2,520	1,080	$672			
Drift nets	724,677	374,144	103,996	1,375,561	710,030	$226,595
Seines	350	350	74	285,517	231,520	44,422
Pound nets	55	45	19			
Total	727,602	376,219	104,761	1,661,078	941,550	271,017

Apparatus.	Delaware River above Scudder Falls.			Total for Delaware Bay and River.		
	Number of roe.	Number of buck.	Value.	Number of roe.	Number of buck.	Value.
Stake nets				2,520	1,080	$672
Drift nets	800	400	$200	2,101,038	1,084,574	330,791
Seines	104,610	64,965	28,841	390,477	296,835	73,337
Pound nets				55	45	19
Spears	2,160	3,240	540	2,160	3,240	540
Total	107,570	68,605	29,581	2,496,250	1,386,374	405,359

Delaware Bay.—Delaware Bay is the broadest portion of the estuary of Delaware River, forming an arm of the sea varying in width from 4 to 30 miles and is 45 miles in length, covering 600 square miles. Its northern limit is somewhat indefinite and has been the subject of considerable contention. For sake of convenience, in this report the head of the bay has been assumed to be at a line drawn from Bombay Hook on the Delaware shore to the mouth of Stow Creek on the New Jersey shore. The channel, which traverses the axis of the bay, is from 30 to 50 feet deep and from 1 to 3 miles in width, and on either side there are broad shoals or flats covered by from 5 to 20 feet of water. The water in the bay has about the same density as that in the ocean. The forms of apparatus used are drift nets, stake nets, seines, and pound nets, the first named being by far the most important and obtaining over 99 per cent of the total catch.

The following series of tables shows by States the extent of each branch of the shad fisheries of Delaware Bay during the year covered by this report:

Table showing, by States, the number of persons employed in each branch of the shad fisheries of Delaware Bay in 1896.

Branch of fishery.	Delaware.	New Jersey.	Pennsylvania.	Total.
Stake-net	14			14
Drift-net	46	565	11	622
Seine		12		12
Pound-net	4			4
Total	64	577	11	652

Table showing, by States, the boats, apparatus, etc., employed in each branch of the shad fisheries of Delaware Bay in 1896.

Designation.	Delaware.			New Jersey.		
	Number.	Length.	Value.	Number.	Length.	Value.
		Yards.			*Yards.*	
Boats	32		$1,505	236		$29,080
Stake nets	7	2,700	240			
Drift nets	24	13,540	1,430	230	271,200	42,775
Seines				2	850	425
Pound nets	2		325			
Shore property			2,200			24,040
Total			5,700			96,320

Designation.	Pennsylvania.			Total.		
	Number.	Length.	Value.	Number.	Length.	Value.
		Yards.			*Yards.*	
Boats	10		$750	278		$31,335
Stake nets				7	2,700	240
Drift nets	5	6,000	725	259	290,740	44,930
Seines				2	850	425
Pound nets				2		325
Shore property						26,240
Total			1,475			103,495

Table showing by States the yield of the shad fisheries of Delaware Bay in 1896.

Apparatus.	Delaware.			New Jersey.		
	Number of roe.	Number of buck.	Value.	Number of roe.	Number of buck.	Value.
Stake nets	2,520	1,680	$672			
Drift nets	27,586	15,634	7,765	684,692	352,309	$94,576
Seines				350	350	74
Pound nets	55	45	19			
Total	30,161	17,359	8,456	685,042	352,659	94,650

Apparatus.	Pennsylvania.			Total.		
	Number of roe.	Number of buck.	Value.	Number of roe.	Number of buck.	Value.
Stake nets				2,520	1,680	$672
Drift nets	12,399	6,201	$1,655	724,677	374,144	103,996
Seines				350	350	74
Pound nets				55	45	19
Total	12,399	6,201	1,655	727,002	376,219	104,761

The drift nets in Delaware Bay are used principally in the channel and on the edge thereof. They average over 1,100 yards each, the aggregate length of the 259 nets used in 1896 being 290,740 yards, or 165 miles, the usual size of mesh being 5¼ inches. Many fishermen operating these nets live up the river, locating temporarily near the mouth of Stow and Cohansey creeks, and shipping their fish from Bay Side.

The fishing season begins about the second week of March and continues until the 1st of May, when the sturgeon fishery proves more remunerative, and many of the fishermen are attracted to that industry. Those who do not engage in the sturgeon fishery usually shorten their nets and fish for shad in the upper reaches of the river in the vicinity of Philadelphia. In the early part of the season, when the water is usually turbid, the nets may be operated during the day, but as the water becomes clearer night fishing is more profitable. Of the drift-net catch, 1,037,001 were obtained by New Jersey fishermen, 43,220 by Delawareans, and 18,600 by residents of Pennsylvania; a total of 1,098,821, valued at $103,996. The great excess of roes over bucks is noticeable, the former being 94 per cent greater than the latter, due mainly to the large mesh used in the drift nets.

The stake-net fishery in Delaware Bay is confined to the use of 7 rows on the flats on the Delaware side of the bay immediately above the mouth of Mispillion Creek, in from 6 to 10 feet of water. These strings or rows are nearly 400 yards in length, and are worth about $35 each. The catch in the 7 rows in 1896 numbered 2,520 roe shad and 1,680 bucks, valued locally at $672. Two seines, each 425 yards in length, were used on the New Jersey side of the Delaware Bay in 1896 for taking striped bass, perch, etc. These caught a few shad, the total numbering 700, about equally divided between roes and bucks.

Delaware River below Scudder Falls.—The estuary of Delaware River, from the head of Delaware Bay to the fall line just above Trenton, is, from a commercial and fishery point of view, one of the most important streams on the Atlantic coast. It varies in width from 4 miles at the lower end to a few hundred feet near Trenton, up to which point it is navigable. On the east it borders Salem, Gloucester, Camden, Burlington, and Mercer counties, N. J., and on the west it passes the shores of Newcastle County, Del., and Delaware, Philadelphia, and Bucks counties in Pennsylvania. By the compact of 1783 between the States of New Jersey and Pennsylvania, the whole surface of Delaware River from shore to shore is the dividing line between the two States as far as relates to the arrest and prosecution of offenders against the laws of either State. All fishing is interdicted after June 10 of each year, and also from sunset Saturday night until 12 o'clock p. m. Sunday of each week. The principal fishing centers are Penn Grove, Pennsville, Salem, Pedrickton, Gloucester, and Camden in New Jersey; Delaware City and Newcastle in Delaware, and Philadelphia in Pennsylvania. Drift nets and seines are the only apparatus used. Of 2,602,628 shad caught in 1896, 2,085,591 were taken by drift nets and 517,037 by seines.

The following series of tables shows the extent of each branch of the shad fisheries of this water area:

Table showing, by States, the number of persons employed in each branch of the shad fisheries of Delaware River below Scudder Falls in 1896.

Branch of fishery.	Delaware.	Pennsylvania.	New Jersey.	Total.
Drift net	164	340	1,157	1,661
Seine	22	149	355	526
Shoresmen	.....	16	35	51
Transporters	.....	2	35	37
Total	186	507	1,582	2,275

Table showing, by States, the boats, apparatus, etc., employed in the shad fisheries of Delaware River below Scudder Falls in 1896.

Designation.	Delaware.			Pennsylvania.		
	Number.	Length.	Value.	Number.	Length.	Value.
		Yards.			*Yards.*	
Boats	97	.....	$11,005	223	.....	$14,682
Drift nets	81	80,767	9,460	167	64,670	10,268
Seines	4	2,250	1,050	15	5,300	5,035
Shore property	.....	.....	857	.....	.....	20,596
Total	.....	.....	22,372	.....	.....	50,581

Designation.	New Jersey.			Total.		
	Number.	Length.	Value.	Number.	Length.	Value.
		Yards.			*Yards.*	
Boats	668	.....	$63,075	988	.....	$88,762
Drift nets	578	268,607	50,308	826	414,044	70,096
Seines	26	10,353	9,035	45	17,903	15,720
Shore property	.....	.....	71,656	.....	.....	93,109
Total	.....	.....	194,734	.....	.....	267,687

Table showing, by States and apparatus, the yield of shad in the Delaware River below Scudder Falls in 1896.

Apparatus.	Delaware.			Pennsylvania.		
	No. of roe.	No. of buck.	Value.	No. of roe.	No. of buck.	Value.
Drift nets	179,666	99,191	$39,080	180,823	96,381	$34,070
Seines	1,210	802	261	88,529	63,666	14,795
Total	180,876	99,993	39,341	269,352	160,047	49,465

Apparatus.	New Jersey.			Total.		
	No. of roe.	No. of buck.	Value.	No. of roe.	No. of buck	Value.
Drift nets	1,015,072	514,458	$152,845	1,375,561	710,030	$226,595
Seines	195,778	167,052	29,366	285,517	231,520	44,422
Total	1,210,850	681,510	182,211	1,661,078	941,550	271,017

The drift nets are similar to those operated in the bay, but are smaller. Indeed, it is somewhat difficult to separate the drift-net fishery of the bay from that in this portion of the river. In the early part of the season many of the fishermen operate in the upper portion of the bay and the extreme lower end of the river, and as the season advances they proceed up the river, shortening their nets when necessary. Hence the separation of the drift-net fishery of the river from that prosecuted in the bay is only approximately correct. Of the 414,044 yards of drift nets used in this section of the river in 1896, 80,767 yards, or 46 miles, were operated by 164 Delaware fishermen; 64,670 yards, or 37 miles, by 340 fishermen from Pennsylvania, and the remaining 268,607 yards, or 157 miles, by residents of New Jersey. The nets used in the lower portion of the river are much longer than those above Philadelphia, the average length of the former being about 800 yards, and of the latter 200 or 300 yards. The drift-net catch in 1896 numbered 1,375,561 roe shad and 710,030 bucks, for which the fishermen received $226,595. This gives an average catch per boat for the Delaware fishermen of 3,443 shad; for the New Jersey fishermen, 3,289, and 1,660 shad per boat for the Pennsylvania fishermen. This is reported to have been the best yield since 1893, it being 20 per cent larger than in 1895 and 30 per cent larger than in 1894.

From the head of Delaware Bay to the falls above Trenton there were 45 shad seines operated in 1896, of which 4 were in Delaware, 15 in Pennsylvania, and 26 in New Jersey. The seine fisheries in the lower part of the river below Fort Delaware take very few shad, their catch consisting principally of perch, striped bass, catfish, carp, etc., the average yield of shad in the 8 seines operated there in 1896 being less than 500 each. Above Fort Delaware the river narrows and maintains an average width of from 1 to 2 miles up to the mouth of the Schuylkill River. This stretch of the river contains 5 seine fisheries, all of which are valuable, the catch of shad in 1896 approximating 76,300, of which 25,000 were taken at the Clenmell Cove fishery, located immediately above Thompson Point, at the mouth of Clenmell Creek.

Between Eagle Point and Fisher Point, on the New Jersey side of the river and directly opposite the city of Philadelphia, there are three very valuable fisheries, which catch more shad than any other three seine fisheries in the United States. The first of these is the Howell Cove, or Fancy Hill, which yielded 65,000 shad in 1896. The seine used was 1,000 yards in length with 4⅞-inch mesh, the season extending from April 27 to June 5, and 55 men being employed. The following summary shows, for a series of years, the yield of shad at the Fancy Hill fishery:

Year.	No. of shad.	Year.	No. of shad.	Year.	No. of shad.
1818*a*	11,492	1847*b*	59,949	1869*c*	37,274
1819*a*	159,864	1848*b*	17,304	1870*c*	52,759
1820*a*	170,505	1849*b*	38,998	1871*c*	45,000
1821*a*	107,091	1865*b*	64,925	1872*c*	55,000
1822*a*	107,194	1866*c*	59,550	1873*c*	22,900
1845*b*	90,540	1867*c*	98,000	1896*c*	65,000
1846*b*	125,659	1868*c*	43,900		

a Gill nets not used during this period. *b* A few gill nets used.
c Gill-net fishery fully established.

The second is the well-known Gloucester fishery, the yield of which in 1896 is reported at 70,000 shad. A 1,000-yard seine was used; the season extended from April 20 to May 28, and the men employed numbered 53. The following summary shows the catch of shad at this fishery in seven years:

Year.	No. of shad.	Year.	No. of shad.
1884	26,428	1892	30,500
1885	30,969	1894	50,000
1890	38,600	1896	70,000
1891	36,500		

The third of this series of valuable fisheries, known as the Pea Shore fishery, is located immediately above Camden, the seine being operated in the channel between Pettys Island and the New Jersey shore. This seine is only one-half the length of the two preceding and required only 29 men to operate it, but the reported catch of shad for 1896 is not far short of the other two, approximating 55,000, valued locally at $4,125.

Between the Pea Shore fishery and Burlington there were 5 seine fisheries in 1896, 3 of which were on the New Jersey shore and 2 on the Pennsylvania side of the river. These are of less value than the 3 fisheries opposite Philadelphia, but their yield of shad is considerable, varying from 35,000 at the Riverton fishery to 3,000 at the Dunks Ferry fishery. From Burlington to Trenton there were 11 fisheries in 1896, 7 on the Pennsylvania and 4 on the New Jersey shore, the catch ranging from 5,000 to 20,000 shad. In 1833 the Badger Island fishery, one of the 7 on the Pennsylvania side, caught 2,100 shad on April 1,

and 54,000 shad during the entire season. This fishery then rented for $1,400 per annum. In 1896 3,000 shad were caught at the Badger Island fishery.

In the rapids between Trenton and Scudder Falls dam there are 6 seine fisheries, located in the most favorable spots. Two of these are situated directly below the dam, 2 on the New Jersey shore opposite Yardley, and the remaining 2 on separate islands between that point and Trenton. The catch of shad in these seines in 1896 ranged between 1,000 and 16,000 in number.

From Scudder Falls to the headwaters.—Near Trenton the Delaware crosses the escarpment line, 133 miles from the ocean. The fall here is very slight, the descent within 7 miles being only 10 to 20 feet, according to the tide and prevalence of freshets. Six miles above Trenton, at the head of the rift known as Scudder Falls, there is a timber and stone dam 4 or 5 feet high and 800 feet or more in length, extending in a broken line across the stream, with a chute 115 feet in width for the passage of fish and rafts. This dam was constructed originally in 1835 and improved about 1869. In 1870 the fishermen brought suit in the county court at Doylestown, Pa., against the company, claiming that the change in the dam was injurious to the passage of shad. The court imposed a nominal penalty on the company, and restrained them from repairing or improving the dam. As a result, it has so deteriorated that it offers little obstruction to the passage of fish.

At Lambertville, 15 miles above Trenton, there is a stone and cribwork dam, from 3 to 10 feet high and 1,700 feet long, a chute being left for the passage of rafts. At Lackawaxen there is a canal-feeder dam just below the entrance of Lackawaxen River. This is a cribwork structure about 400 feet long and 2 feet high, with a chute 160 feet wide for rafts. During freshets the water stands several feet above the crest of this obstruction and shad ascend in some numbers to Burrows dam, in New York, about 50 miles above Lackawaxen. There are numerous minor dams at various points between Trenton and the New York line, but they do not seriously impede the upward passage of fish or downward navigation of rafts or small boats.

The shad fisheries above tide water are more extensive on the Delaware than on any other river of the United States, the catch in 1896 numbering 176,175, worth $29,581. They extend from Scudder Falls to Lackawaxen, a distance of 140 miles, but are most extensive in the stretch 40 miles above Scudder Falls dam. With the exception of one drift net operated a short distance above the falls, seines and spears are the only apparatus used in taking shad in the upper section of the Delaware. Of the 176,175 shad caught in 1896, 169,575 were taken by means of seines, 5,400 by spears, and 1,200 by the one drift net.

The legal season closes on June 15 of each year and all fishing is interdicted from sunset on Saturday to 12 o'clock on Sunday night of each week.

The following series of tables shows, by States, the extent of each branch of the shad fisheries of the Delaware River above Scudder Falls dam in 1896:

Number of persons employed.

Persons employed.	Pennsylvania.	New Jersey.	Total.
Drift-net	2		2
Seine	155	133	288
Spear	30		30
Total	187	133	320

Boats, apparatus, etc., used.

Designation.	Pennsylvania.			New Jersey.			Total.		
	No.	Length (yards).	Value.	No.	Length (yards).	Value.	No.	Length (yards).	Value.
Boats	52		$1,387	30		$997	91		$2,384
Drift nets	1	100	35				1	100	35
Seines	30	5,215	3,580	29	4,975	3,468	59	10,190	7,048
Spears	30		23				30		23
Shore property			13,085			25,527			38,612
Total			18,110			29,992			48,102

Number and value of shad caught.

Apparatus.	Pennsylvania.			New Jersey.			Total.		
	No. of roe.	No. of buck.	Value.	No. of roe.	No. of buck.	Value.	No. of roe.	No. of buck.	Value.
Drift nets	800	400	$200				800	400	$200
Seines	59,119	36,922	15,589	45,491	28,043	$13,252	104,610	64,965	28,841
Spears	2,160	3,240	540				2,160	3,240	540
Total	62,079	40,562	16,329	45,491	28,043	13,252	107,570	68,605	29,581

Most of the available locations on the Upper Delaware are occupied by seine fisheries, and as the last two or three seasons have yielded large returns several abandoned fisheries are being cleaned out and operated. Some of these fisheries are very old, having been operated continuously since the beginning of the present century. Lovett's fishery, in Bucks County, was established in 1790; Lower Dutch Neck fishery, in 1810; and Badger Island fishery, in the same county, in 1812. The yield by the 59 seines in 1896 numbered 104,610 roes and 64,965 bucks, a total of 169,575, valued locally at $28,841. This yield was unusually large, more being obtained at times than could readily be disposed of, and the price received was the lowest known on the river for several years. The large run may be due somewhat to the fact that for four or five years preceding there were heavy freshets, which restricted the fishing in the early part of the season, thus permitting the shad to reach the upper waters to spawn.

The following statement shows the annual catch since 1883 at the Taylorsville fishery, a short distance below Titusville:

Year.	No. of shad.	Year.	No. of shad.
1884	1,628	1891	955
1885	1,093	1892	960
1886	709	1893	840
1887	835	1894	1,177
1888	1,752	1895	2,300
1889	1,661	1896	2,491
1890	1,967		

Although an interdiction exists against the use of spears in taking shad on Delaware River, yet that form of apparatus was used quite extensively in 1896 at the Lackawaxen dam, 146 miles above Trenton. Some of the spear fishermen operated from rowboats, while others worked from the apron of the dam. Thirty men are reported as taking 2,160 roe shad and 3,240 bucks, worth locally about $10 per hundred.

There are several streams in New Jersey tributary to the Delaware, in most of which some shad are taken each season. Among these are Cohansey, Salem, Raccoon, Mantua, and Timber creeks, each of which will be described in succession. In other streams along this shore, such as Maurice River, Woodbury, Old Mans, Rancocas, Cooper, etc., there are a few shad taken for local use, but the fisheries are so intimately associated with the fisheries of the Delaware, or they are so small and so irregularly prosecuted, that it is not practicable to show the actual quantity taken.

Cohansey Creek.—Cohansey Creek, which enters Delaware Bay 37 miles above Cape May, is tidal as far as Bridgeton, the head of navigation, 20 miles from the mouth. At that point there is an earthen dam, 11 or 12 feet high, across the stream for developing water-power. While the fisheries of this creek are not of great extent, yet it ranks third in importance among the shad-producing streams of New Jersey, being surpassed in this particular only by the Delaware and Hudson rivers. The yield in 1896 numbered 21,850 shad, worth $2,592, of which 11,850 were taken by drift nets and 10,000 by seines.

The drift-net fishermen live at Bridgeton and Fairton. The nets used by them average 100 yards in length, with 5⅛-inch mesh, costing about $25 each. In 1876 the drift nets numbered 18 and the catch of shad by them was 4,000. In 1896 25 drift nets were used by 32 fishermen, the catch numbering 7,900 roe shad and 3,950 bucks, worth $1,542. The Bridgeton fishermen operated 10 seines in 1896 at various points on Cohansey Creek, averaging 60 yards in length and requiring 2 men each. The size of mesh is from 2¼ to 4 inches, and they are hauled for carp, striped bass, alewives, etc., as well as shad. The catch of shad during the year above noted approximated 10,000, about equally divided between roes and bucks.

Salem River.—Salem River rises in the northeastern part of Salem County and discharges into Delaware River at a point about 4 miles below Fort Delaware. Fishermen from the town of Salem use drift

nets in this stream, the nets averaging 300 yards in length, with 5⅛-inch mesh, 2 men being required for each. Fifteen nets were used in 1896, catching about 8,000 shad, of which two-thirds were roes.

Raccoon River.—The shad fisheries of Raccoon River, which enters Delaware River opposite Marcus Hook, were limited to the use of 2 small seines, each 70 yards in length, the yield in which numbered only 4,800, of which two-thirds were bucks. The small catch was due to the shad being driven away by the dumping of mud in Delaware River just below the entrance of Raccoon River.

Mantua Creek.—This creek discharges into Delaware River about 10 miles below Philadelphia, at a point abreast of Mifflin Bar. Only 1 seine was used in 1896, 100 yards in length, with 3-inch mesh. The yield was about an average for recent years, numbering 2,000 shad, about equally divided between roes and bucks.

Big Timber Creek.—This creek, forming the dividing line between Gloucester and Camden counties, is 30 miles in length and navigable only a short distance above the mouth, yet its shad fisheries have been successfully operated for many years. Four seines are employed, each about 100 yards in length, with 3½-inch mesh; they are hauled for other species as well as shad. The catch in 1896 numbered 4,160 roe shad and 6,240 bucks, the local value being $728.

OCEAN SHORE OF NEW JERSEY.

In several of the small sounds and bays on the ocean shore of New Jersey a few shad are taken each year in the seines, stake nets, and fyke nets set for other species of fish, the total yield in 1896 numbering 2,565, valued at $803. Shad were reported from Jenkins Sound, Ludlam Bay, Barnegat Bay, Metedeconk River, and Manasquan River, the yield from each of which is shown on page 229. On the coast from Barnegat Bay to Sandy Hook numerous pound nets are operated from May 1 to October 31, in which shad are taken incidentally during May. The nets set in 1896 numbered 49, valued at $116,600, yielding 6,940 roe shad and 6,735 bucks, valued locally at $2,715, an average of 279 shad per net. This is the southernmost point on the Atlantic coast at which shad are taken in considerable numbers outside the general coast line.

SANDY HOOK BAY.

This bay, forming a part of the waterway tributary to the harbor of New York City, is separated from the ocean on the east by a narrow sand beach known as Sandy Hook. The shad fisheries are confined to the use of stake nets, which average between 150 and 160 yards in length, with from 5¼ to 6 inch mesh, and cost about $40 each. The season begins about the first week in April and usually lasts four weeks. The nets used in 1896 numbered 107, with an aggregate length of 16,840 yards and valuation of $3,900, 26 boats worth $930, and 54 men being employed. The catch was much less than usual, numbering only 3,540 roe shad and 3,060 bucks, valued locally at $1,320.

RARITAN BAY.

Raritan Bay occupies the triangular space between Staten Island, New York, and the coast of Middlesex and Monmouth counties, N. J., and its waters commingle with those of the ocean through Lower Bay. Its shad fisheries are valuable, the annual yield approximating 50,000, the forms of apparatus used being pound nets, stake nets, seines, and fyke nets. Of the 43,637 shad taken in 1896, 26,702 were obtained in pound nets, 15,675 in stake nets, 1,010 in seines, and 250 in fyke nets. The stake nets are set specially for shad, but the pound nets, seines, and fyke nets depend principally on the catch of other species.

The stake nets range from 20 to 40 yards in length, averaging about 25 yards, and the season extends from the first week of April to the 15th or 20th of May. The number of nets used in 1896 was 982, with an aggregate length of 24,304 yards and valuation of $4,256, requiring 73 men and 40 boats. Their catch of shad amounted to 8,515 roes and 7,160 bucks, valued locally at $3,409. The pound nets are set usually the first week of April, and shad are taken in them from that time until about the middle of May. They are owned by men living at Port Monmouth, Belford, and Keansburg, and the number of nets operated in 1896 was 35, valued at $26,750. Twenty-seven boats, worth $5,740, and 56 men were employed, and the catch of shad, which was very much less than usual, numbered 14,552 roes and 12,150 bucks, valued locally at $4,005. The 5 seines aggregated 3,733 yards in length and $2,450 in value, with 2½-inch mesh, and their catch of shad numbered 485 roes and 525 bucks, valued locally at $223. These seines are hauled principally for squeteague, striped bass, and alewives. The Port Monmouth fyke-net fishermen usually catch a small number of shad, the catch in the 25 fykes in 1896 numbering 140 roes and 110 bucks.

Raritan River.—The Raritan is the longest river situated wholly within New Jersey. Its sources are in the northwestern part of the State, the main stream being formed by the junction of the north and south branches, 4 or 5 miles west of Somerville, whence it flows a distance of 45 miles to its entrance into Raritan Bay at South Amboy. It is a tidal and navigable stream from the bay to the city of New Brunswick, a distance of 14 miles. The shad fisheries of Raritan River in 1896 consisted in the use of 11 fyke nets, worth $550, which were set near the mouth of the river from March 1 to June 10. They were operated by 1 man using 1 boat, worth $60, and the catch of shad approximated 2,500, which were sold locally at $938. These fykes are also set from September to December for striped bass.

In that section of the New Jersey shore bordering New York Bay and Hudson River many shad are caught each year, the yield in 1896 being 217,858, of which 49,758 were caught in fyke nets in New York Bay and 168,800 in stake nets in Hudson River. A description of the entire fisheries of these water areas is given in the chapter on the shad fisheries of New York State.

THE SHAD FISHERIES OF NEW YORK.

The shad fisheries of New York State are located principally in Hudson River and the sections of New York Bay leading thereto, over 98 per cent of the yield in 1896 being obtained in those waters. A few shad are also obtained in the Nissequague River, Little Neck Bay, Gardiner Bay, Long Island Sound, and Great South Bay, but the catch in the last three bodies of water is merely incidental to the taking of other species of fish.

The following series of tables shows the extent of the shad fisheries of each water area of this State:

Statement, by water areas, of the number of persons employed in each branch of the shad fisheries of New York in 1896.

Waters.	Number of fishermen.								Shoresmen.	Total
	Gill-net.			Seine.	Pound-net.	Fyke-net.	Spear.	Total, exclusive of duplication.		
	Drift.	Stake.	Pole.							
New York Bay:										
Lower Bay	.....	.....	.....	.....	18	.....	.....	18	.....	18
Gravesend Bay	.....	.....	.....	.....	8	8	.....	8	.....	8
The Narrows	120	.....	.....	.....	.....	.....	.....	120	.....	120
Upper Bay	.....	21	.....	.....	.....	.....	.....	21	1	22
Hudson River	583	64	2	250	.....	6	.....	901	9	910
Little Neck Bay	2	.....	.....	.....	8	.....	.....	10	.....	10
Nissequague River	24	.....	.....	.....	.....	.....	20	28	.....	28
Total	729	85	2	250	34	14	20	1,106	10	1,116

Statement, by water areas, of the number of boats, apparatus, etc., employed in the shad fisheries of New York in 1896.

Waters.	Boats.		Drift nets.			Stake nets.			Pole nets.		
	No.	Value.	No.	Length.	Value.	No.	Length.	Value.	No.	Length.	Value.
New York Bay:				*Yards.*			*Yards.*			*Yards.*	
Lower Bay	6	$530	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gravesend Bay	6	600	.....	.....	.....	.....	.....	.....	.....	.....	.....
The Narrows	59	3,020	106	46,900	$6,560	.....	.....	.....	.....	.....	.....
Upper Bay	10	2,000	.....	.....	.....	302	2,416	$1,510	.....	.....	.....
Hudson River	447	18,774	337	164,020	23,425	1,099	8,438	2,268	2	445	$100
Long Island Sound:											
Nissequague River	12	240	12	408	124	.....	.....	.....	.....	.....	.....
Little Neck Bay	7	401	1	760	80	.....	.....	.....	.....	.....	.....
Total	547	26,165	456	212,088	30,189	1,401	10,854	3,778	2	445	100

Waters.	Seines.			Pound nets.		Fyke nets.		Spears.		Shore property.	Total value.
	No.	Length.	Value.	No.	Value.	No.	Value.	No.	Value.		
New York Bay:		*Yards.*									
Lower Bay	.....	.....	.....	4	$1,000	.....	.....	.....	.....	.....	$1,530
Gravesend Bay	.....	.....	.....	2	1,200	34	$850	.....	.....	$300	2,950
The Narrows	.....	.....	.....	.....	.....	.....	.....	.....	.....	350	10,530
Upper Bay	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,500	5,010
Hudson River	41	9,607	$5,840	.....	.....	20	105	.....	.....	4,880	55,392
Long Island Sound:											
Nissequague River	.....	.....	.....	.....	.....	.....	.....	20	$20	.....	384
Little Neck Bay	.....	.....	.....	6	1,430	.....	.....	.....	.....	100	2,011
Total	41	9,607	5,840	12	3,630	54	955	20	20	7,130	77,807

Statement, by water areas, of the yield of shad in each form of apparatus employed in the fisheries of New York in 1896.

Waters.	Drift nets.		Stake nets.		Pole nets.		Seines.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
New York Bay:								
The Narrows	63,500	$7,620	.....	.....	.....	.....	.....	.....
Upper Bay	.....	.....	30,000	$3,600	.....	.....	.....	.....
Hudson River	297,178	42,958	38,975	6,233	14,800	$616	68,345	$8,991
Long Island Sound:								
Nissequague River	1,256	314	.....	.....	.....	.....	.....	.....
Little Neck Bay	128	46	.....	.....	.....	.....	.....	.....
Total	362,062	50,938	68,975	9,833	14,800	616	68,345	8,991

Waters.	Pound nets.		Fyke nets.		Spears.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
New York Bay:								
Lower Bay	14,000	$1,680	.....	.....	.....	.....	14,000	$1,680
Gravesend Bay	1,630	195	4,800	$576	.....	.....	6,430	771
The Narrows	.....	.....	.....	.....	.....	.....	63,500	7,620
Upper Bay	.....	.....	.....	.....	.....	.....	30,000	3,600
Hudson River	.....	.....	800	123	.....	.....	420,098	58,921
Great South Bay	*a* 364	61	.....	.....	.....	.....	364	61
Gardiner Bay	*a* 4,391	1,031	.....	.....	.....	.....	4,391	1,031
Long Island Sound	*a* 516	145	.....	.....	.....	.....	516	145
Nissequague River	.....	.....	.....	.....	482	$115	1,738	429
Little Neck Bay	1,649	529	.....	.....	.....	.....	1,777	575
Total	22,550	3,041	5,600	699	482	115	542,814	74,833

a Incidental catch.

NEW YORK BAY.

The numerous bodies of water leading from the ocean to the mouth of Hudson River have several designations, but the name New York Bay applies to the whole area from Sandy Hook to the Battery. The near approach of Staten Island to the western end of Long Island divides the bay into two unequal portions, known as Upper Bay and Lower Bay. The general form of Lower Bay is that of an equilateral triangle, each side of which approximates 15 miles in length. Upper Bay is about 5 miles long and 3 or 4 miles in width. Connecting the two, occupying the space between Long Island and Staten Island, are the Narrows, the least width of which approximates 1 mile. At the extreme upper end of Lower Bay, occupying the cove between Coney Island light and Fort Hamilton, is Gravesend Bay, a small body of water covering about 2 square miles. The fisheries of each of these water areas are described in succession.

Lower Bay.—The shad fisheries of Lower Bay are confined to the use of several pound nets on the shore of Staten Island between Elm Tree beacon and Fort Tompkins light. These nets are set separately in 12 to 15 feet of water, and are worth about $250 each. Four were used in 1896, requiring 18 men and 6 boats, the value of the latter being $930. The season began April 1 and ended about the middle of June, and the catch approximated 8,400 roes and 5,600 bucks, valued locally at $1,680.

Gravesend Bay.—The shad fisheries of Gravesend Bay in 1896 were represented by 2 large pound nets and 2 rows of fyke nets, set in from 10 to 25 feet, the pound nets being set individually and the fyke nets with 30 in one row and 4 in another. The pound nets are larger than those on the shore of Staten Island, and are valued at $600 each. It is necessary to have two sets of twine, since the large quantity of drift and refuse becoming fixed to them prevents their being operated more than a week at a time. Each of the fyke nets has five 14-foot hoops with two funnels to the net. The catch of shad by the 2 pound nets numbered 978 roes and 652 bucks, worth $195, while the fyke nets caught 2,880 roes and 1,920 bucks, valued at $576.

The Narrows.—Each season a large number of shad drift nets are operated in the Narrows, the season beginning usually about April 1, two or three weeks before the Hudson River season opens, and closes about May 15. The nets average 400 yards in length with 5⅛ to 5½ inch mesh, and cost about $75 each. On account of the extensive navigation through this channel it is necessary to operate the nets 25 or 30 feet below the surface, this being effected by long buoy lines, the most usual length being 26 feet. Even at this depth the suction of large steamers frequently entangles the nets in a mass and sometimes even lifts them up into the screws. In 1896 there were 59 boats drifting nets in the Narrows, using 46,900 yards of twine and operated by 120 men. The catch was much less than usual, the total number of shad taken being 38,100 roes and 25,400 bucks, valued locally at $7,620. Most of the fishermen live on Staten Island and at Bay Ridge, Fort Hamilton, and Gravesend on Long Island. The others live "up the river" and elsewhere and rendezvous at Fort Hamilton during the fishing season. The latter operate also to some extent on the Hudson, but the Narrows is their principal fishing-ground.

Upper Bay.—In the Upper Bay shad were taken by means of stake nets and fyke nets set along the western side of the bay on the Jersey Flats, between the northern end of Staten Island and Bedloe Island. The stake nets were owned by fishermen from Bay Ridge, and were set in 4 rows containing 151 "stations." The abundance of drift matter and other refuse in the water necessitated the use of two sets of nets, each remaining in the water about a week, thus requiring 302 nets for the 151 "stations." The nets were each 24 feet long by 28 feet deep, with 5¼-inch mesh, and were set with the top from 10 to 12 feet below the surface of the water. The poles were from 60 to 70 feet in length, and 26 feet apart in the rows. To operate these 4 strings of nets required the services of 21 fishermen, using 10 boats, valued at $2,000. The season began about the 1st of April and lasted six weeks, the total yield of shad approximating 30,000 in number, of which about three-fifths were roes. The fyke nets are owned by fishermen from Hudson County, N. J. The yield in the 214 used in 1896 numbered 27,267 roe shad and 22,491 bucks, for which the fishermen received $7,337.

HUDSON RIVER.

In point of commerce the Hudson is the most important river of the United States, and formerly its shad fisheries were the most valuable on the Atlantic seaboard, but in this particular it is now surpassed by several other rivers. Its sources are in the Adirondack Mountains in Essex County, whence it flows in a general southeasterly direction about 110 miles to Sandy Hill, and thence almost due south nearly 200 miles, to its entrance into New York Bay. From New York Bay to Piermont the width is from 1 to 2 miles; between Piermont and Haverstraw it expands into Tappan Bay, with a length of 12 miles and a width of 4 or 5 miles; while from Haverstraw, 34 miles distant from New York, to Albany the width of the river varies from 900 to 300 yards. At Troy, 6 miles above Albany, it receives its principal tributary, the Mohawk, whose volume of water is greater than that of the Hudson above that point. Above Troy the river partakes of the characteristics of a large mountain stream, with numerous falls and rapids.

At Troy there is a State dam, built in 1826, of log cribwork filled in with stone, 1,100 feet long and 10 feet high, which forms an impassable barrier to the further progress of shad except when the water rises above the crest of the dam during high freshets. There was formerly a fishway in this obstruction, but it was destroyed by a freshet several years ago and has not been replaced. At Mechanicsville, 9 miles above Troy, there is a dam of cut-stone masonry 16 feet high, built in 1882. Three-quarters of a mile above is a dilapidated log dam with an original height of 8 feet. At Stillwater, 3 miles above Mechanicsville, there is another log dam, forming an irregular line 6 feet high across the stream. Above Stillwater the river is comparatively level for a distance of 12 or 13 miles, almost to the Saratoga dam, which is of stone, 8 feet in height, built in 1873. Above Saratoga there are several other dams from 2 to 16 feet in height, among which are those at Fort Miller, Fort Edward, Sandy Hill, Glens Falls, Palmer Falls, etc. Prior to the construction of the Troy dam, in 1826, shad ascended the Hudson to the falls at Sandy Hill, 50 miles above Troy, and up to fifteen years ago they were taken in some abundance within a short distance below Troy. But during recent years there has been little fishing above Castleton, a short distance below Albany.

Shad enter the Hudson usually during the first week in April and remain until the last of June. The legal season extends from March 14 to June 15 of each year, with a close time operative from sunset on Saturday until sunrise on Monday of each week. The fisheries extend from the mouth of the river nearly to Albany, the river being well filled with twine up to Hudson, in Columbia County, while above that town few fish are taken. The yield fluctuates considerably from year to year. In 1880 there were 711 men employed and the catch of shad numbered 639,000. In 1885 the yield was reported at 1,174,835,

in 1886 at 1,300,949, and in 1887 at 1,568,634. In 1895 the yield was 1,155,610, but in 1896 only 588,898 shad were taken in this river, the local value of which was $83,237. Of this yield, 297,178 were caught in drift nets, 180,775 in stake nets, 68,345 in seines, 41,800 in pole nets, and 800 in fykes. The catch by the New Jersey fishermen numbered 168,800, while 420,098 were taken therein by residents of New York State.

The following table shows by States the number of persons employed in each branch of the shad fisheries of the Hudson River in 1896:

Fishery.	New Jersey.	New York.	Total.
Drift-net		583	583
Stake-net	176	64	240
Pole-net	8	2	10
Seine		250	250
Fyke-net		6	6
Shoresmen		9	9
Total exclusive of duplication	176	910	1,086

The following table shows by States the apparatus employed in each branch of the shad fisheries of the Hudson River in 1896:

Apparatus, etc.	New Jersey.		New York.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
Boats	69	$4,005	447	$18,774	516	$23,679
Drift nets			337	23,425	337	23,425
Stake nets	1,518	7,425	1,099	2,268	2,617	9,693
Pole nets	12	510	2	100	14	610
Seines			41	5,840	41	5,840
Fyke nets			20	105	20	105
Shore property		1,175		4,880		6,055
Total		14,015		55,392		69,407

The following table shows by States the number of shad caught in each form of apparatus in the Hudson River in 1896:

Apparatus.	New Jersey.		New York.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
Drift nets			297,178	$42,958	297,178	$42,958
Stake nets	141,800	$20,590	38,975	6,233	180,775	26,823
Pole nets	27,000	3,726	14,800	616	41,800	4,342
Seines			68,345	8,991	68,345	8,991
Fyke nets			800	123	800	123
Total	168,800	24,316	420,098	58,921	588,898	83,237

Drift nets are used on the Hudson from the New Jersey line to within a short distance of the Troy dam. In the lower half of the river, below Saugerties in Ulster County, the nets range from 450 to 1,000 yards in length, with an average of about 500 yards, but the length, as well as the depth, depends on the size of the channel in which they are operated, the nets being as large as the width of the channel admits. The largest nets are used at Hyde Park, Highland, West Point, and Verplanck Point, the last named being the center of the

most extensive fishery on the river. To avoid injury from vessels, the buoy lines are so arranged as to permit the net to drift 6 to 30 feet below the surface. The drift nets reported from this river in 1896 numbered 337, with an aggregate length of 206,590 yards and value of $23,425, while the catch aggregated 162,385 roe shad and 134,793 bucks, valued locally at $42,958.

The upper limit of the stake-net fishery is Croton Point, on the east side of the river, just above Sing Sing, while on the west side the uppermost limit is Nyack, Rockland County. The stake nets north of the Jersey line are small and inexpensive, costing about $1.50 each, being set on the flats in shallow water, not over 15 feet deep. The catch by the shoal-water nets in 1896 was unusually small, as the shad kept well out in the channel. In 1895 the fish ran more inshore, so that those nets made good catches. The stake nets between Alpine, N. J., and the mouth of the river are much larger and are set on the edge of the channel, in water 20 to 50 feet deep. The usual dimensions of these nets are 90 meshes long and 100 meshes deep, with 5 inch mesh; many, however, are 100 meshes square. The depth necessitates poles of great length and strength, hickory and white oak being used generally. The nets are set in rows of 25 or 30 each, running from the shore to the middle of the channel. On the New York side there were no stake nets below Fort Washington Point, and between there and Yonkers there were but 3 rows, containing 120 nets; but on the New Jersey side, between the mouth of the river and Alpine, opposite Yonkers, N. Y., there were 1,518 stake nets in 1896, which caught 141,800 shad—more than one-fourth the yield of the entire river.

The stake nets in the extreme lower end of the river are subject to considerable damage from the vessels continually passing, the greatest amount of injury being done at night, when it is not always possible to avoid the twine. Not infrequently a fisherman will have one-third of his nets destroyed in a single night, and a large percentage of loss in this manner is always expected. However, the fishermen claim that much of the damage is the result of pure indifference on the part of vessel captains, who make no effort to avoid the twine. The total number of stake nets on the river in 1896 was 2,617, aggregating 21,170 yards in length, and valued at $9,693, and their catch numbered 106,065 roe shad and 74,710 bucks, worth $26,823. Of this yield 85,080 roes and 56,720 bucks were taken in the 1,518 nets set on the New Jersey shore, and 20,985 roes and 17,990 bucks in the 1,099 nets set in the New York portion of the river.

A third form of gill net used on the Hudson River, known as the "pole net," is similar in construction to the drift net, but its mode of operation is somewhat like that of a stake net. The net is a continuous section, 200 to 250 yards in length, costing from $40 to $60. Poles are set on the edge of the channel about 35 feet apart, and to the lower side of which the net is fastened at the commencement of every flood tide by means of "arms" or ropes 6 feet long. At the end of the flood tide the

net is lifted, the fish removed, and the net is again set at the beginning of the succeeding flood tide. There were but 14 of these nets on the river in 1896, but they were quite successful, the average catch being about 3,000 shad, and another season will doubtless witness an extended use of this form of apparatus.

Compared with those of the Delaware River, the seine fisheries of the Hudson are of little importance, a single seine on the former stream taking more shad each year than the 40 or more on the Hudson. The seines range in length from 120 to 500 yards, with from 2 to 2½ inch mesh in the bunt and 4-inch to 5-inch mesh in the wings. The seven operated in the lower 80 miles of the river take few shad, their catch consisting principally of alewives and other species. The most extensive seine fishery on the river is near Kinston Point, where two seines are operated by steam launches from a scow anchored in the middle of the river, the catch by which in 1896 numbered 7,200 roe shad and 4,800 bucks—nearly one-fifth of the entire seine catch on the river. The total shad yield of the 41 seines operated in 1896 was 41,757 roes and 26,588 bucks, valued locally at $8,991.

GREAT SOUTH BAY AND GARDINER BAY.

A few shad are caught incidentally in the pound nets set in Great South Bay, the yield in 31 pound nets set in the spring of 1896 being reported at 196 roes and 168 bucks. This small catch was due to the lateness of the period when the nets were set.

In the pound nets at the eastern end of Long Island Sound, between Montauk Point and Orient Point, some shad are taken each year. The nets are most numerous in Fort Pond Bay and Napeague Bay and along the shores of Gardiner Island. Shad are caught during April and May and are obtained in greatest number on the eastern side of Gardiner Island. The total number of nets in 1896 was 105, and their catch of shad numbered 1,600 roes and 2,791 bucks, for which the fishermen received $1,031.

LONG ISLAND SOUND.

Most of the shad entering Long Island Sound pass along the northern shore of that body of water and enter the large tributaries flowing into it through the State of Connecticut, very few being taken on the New York shore. Of the 74,319 shad caught in this sound and tributaries in 1896, 70,288 were taken along the northern shore and in the rivers flowing therein, while only 4,031 were taken along the southern shore. Of the latter, 516 were taken in pound nets near Orient Point, 1,738 in Nissequague River, and 1,777 in Little Neck Bay. Shad doubtless run into the other small bays and tributaries along this shore, but in numbers too small to warrant the establishment of fisheries. The shad fisheries of the three sections above noted will be described separately, while those of the waters tributary to the northern side of Long

Island Sound will be described in the chapter on the shad fisheries of Connecticut.

In the pound nets at the eastern end of the sound on the Suffolk County shore, between Orient Point and Horton Point, a few shad are taken incidentally with other species. These nets run out from the shore into 20 or 30 feet of water, one net being the usual number to the string. In 1896 there were 14 pound nets in this locality, and the catch of shad numbered 210 roes and 306 bucks, valued at $145.

Nissequague River.—Westward of Horton Point no shad are taken on the southern shore of Long Island Sound until Nissequague River is reached. This is a small sand-hill stream extending from Smithtown Bay for several miles into the interior. While shad have been caught in this stream for a number of years, yet fisheries have been prosecuted only during the past two or three years. The fisheries were most extensive in 1896, when drift nets were operated at various times, catching 1,256 shad from May 1 to May 13. On the night of May 13 fishing was stopped by the local authorities, the twine being destroyed and arrests made of a number of the fishermen. After that date many of the fishermen engaged in taking shad by the means of spears, it being easier to elude arrest when so engaged than when using a drift net.

The number caught by spears from May 13 to the end of the season, about June 12, approximated 482, over half of which were roes. This made a total of 1,738 shad taken in the Nissequague in 1896. If the operations of the fishermen had not been interfered with the yield for the season might possibly have approached 5,000.

Little Neck Bay.—This bay is quite shallow and covers only 2 or 3 square miles. Strictly speaking, it is not a tributary of Long Island Sound, but rather of East River, and it is claimed that the shad enter this body of water by way of East River and the Narrows and not through Long Island Sound. Seasons of scarcity in Little Neck Bay are usually coincident with those in New York Bay and Hudson River, and not with those in the Connecticut. Shad have been taken in Little Neck Bay each season for many years, the principal apparatus employed being pound nets, which are set from April 15 to about June 10. In 1896 there were 6 nets used, worth $1,430, but the yield of shad was unusually small, numbering only 776 roes and 873 bucks, for which the fishermen received $529. One pound net, which in 1896 caught only 29 shad, yielded 1,154 in 1895, and prior to 1890 the average annual catch was about 2,000 for each net. A single gill net was used in this bay in 1896. This net was 760 yards in length, and the catch numbered 92 roe shad and 36 bucks, valued at $46, making a total of 1,777 shad, worth $575, taken in this body of water.

THE SHAD FISHERIES OF CONNECTICUT.

The extent, by water areas, of each branch of the shad fisheries of Connecticut is presented in the following series of tables:

Statement, by water areas, of the number of persons employed in each branch of the shad fisheries of Connecticut in 1896.

Waters.	Drift-net.	Seine.	Total, exclusive of duplication.
Long Island Sound: *a*			
Connecticut River	94	36	130
Housatonic River	34	17	45
Bridgeport Harbor	6	.....	6
Pine Creek	4	.....	4
Total	138	53	185

a In Long Island Sound a number of men operate pound nets, in which shad are taken incidentally, but there are no regular shad fisheries on the Connecticut shore of that sound.

Statement, by water areas, of the boats, apparatus, etc., employed in the shad fisheries of Connecticut in 1896.

Waters.	Boats.		Drift nets.			Seines.			Shore property.	Total investment.
	No.	Value.	No.	Length.	Value.	No.	Length.	Value.		
Long Island Sound:				*Yards.*			*Yards.*			
Connecticut River	59	$1,200	48	13,858	$3,321	12	1,883	$863	$465	$5,849
Housatonic River	34	966	29	5,640	820	5	1,165	380	370	2,536
Bridgeport Harbor	5	80	5	540	78	.....	.....	.....	100	258
Pine Creek	4	60	4	155	46	.....	.....	.....	20	126
Total	102	2,306	86	20,193	4,265	17	3,048	1,243	955	8,769

Statement, by water areas, of the yield of shad in each form of apparatus employed in the fisheries of Connecticut in 1896.

Waters.	Drift nets.		Seines.		Pound nets.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Long Island Sound	.....	.....	*a* 41	$10	*a* 7,093	$1,669	7,134	$1,679
Connecticut River	45,851	$8,244	*b* 5,839	1,264	.....	.....	51,690	9,508
Housatonic River	8,286	2,072	1,592	399	.....	.....	9,878	2,471
Bridgeport Harbor	1,017	285	.....	.....	.....	.....	1,017	285
Pine Creek	569	139	.....	.....	.....	.....	569	139
Total	55,723	10,740	7,472	1,673	7,093	1,669	70,288	14,082

a Caught incidentally in apparatus set especially for other fish than shad.
b Of these, 146 shad, worth $30, were taken in seines operated especially for alewives.

LONG ISLAND SOUND.

This sound, occupying the coastal depression between Long Island and the shore of Connecticut, approximates 115 miles in length and 15 to 25 miles in width. It is comparatively shallow, the depth in the eastern portion being usually less than 200 feet, while in the part west of Connecticut River it averages from 75 to 100 feet. At its eastern end there is a chain of islands extending in a northeasterly direction from Long Island to Rhode Island, and through the passages between these islands the waters of the sound mingle with those of the ocean,

the principal channel being the Race, between Little Gull Island and Fisher Island. At its western end the sound connects with the waters of New York Bay through a long narrow passage known as East River, which separates the western end of Long Island from New York City. Throughout its length, except near the mouth of the large rivers, the density of the water is very little less than that of the ocean. The principal river tributaries are the Thames, Connecticut, and Housatonic, which bring down large quantities of fresh water.

While some shad doubtless enter Long Island Sound through East River, the great bulk passes through the Race at the eastern end. They appear usually about the second week of April and are taken first in the pound nets set immediately west of the mouth of Connecticut River. Most of them pass up the Connecticut, but a large number proceed westward, a few being caught in the pound nets set along the shore, while others enter the Housatonic and some of the smaller streams of Connecticut and Long Island. The run into these waters during recent years appears to be much smaller than formerly. The catch in 1896 in the sound and its tributaries numbered only 74,321, of which 51,690 were taken in the Connecticut, 9,878 in the Housatonic, and the remaining 12,753 along the shore of the sound and in smaller tributaries, whereas the catch in the Connecticut alone was formerly half a million or more.

While a few shad are caught in Long Island Sound proper, there are no fisheries dependent exclusively on that species. At the southeastern end, on the shore of Long Island between Orient Point and Horton Point, there are a few pound nets each year which take some shad, the number of nets in 1896 being 14, and the yield of shad numbering 516. Very few shad run along the northern shore of Long Island Sound east of Connecticut River, and in the 77 pound nets there in 1896 only 244 shad were caught. In 28 of those nets not a single shad was taken, and 20 was the highest number caught in any net. In 1895 the 182 pound nets on that shore yielded 290 shad.

Between Connecticut River and New Haven Harbor shad are somewhat more numerous, and a number are taken in the pound nets. Immediately at the mouth of the Connecticut, between the jetties and Cornfield Point, there were 3 pound nets in 1896, which yielded more shad than all the rest of the nets in the sound. They were set about the 10th of April, and from that time to the middle of June the three caught 4,592 shad, worth $1,083, of which 2,327 were roes and 2,265 were bucks. Seven or eight miles west of the above three nets, between Duck Island and Kelsey Point, there were three other pound nets, which yielded 197 roe shad and 295 bucks. A 100-yard seine, operated at the mouth of the Hammonasset River in 1896, caught 16 roe and 25 buck shad among other species. The area occupied by the 6 pound nets above mentioned was formerly the location of one of the most profitable shad fisheries on the coast. As late as 1885 there were 49 pound nets in that section, which yielded 123,100 shad. In 1886 there

were 48 nets and the catch numbered 69,900, while in 1887 the number of nets was 46 and the yield of shad 61,950. Pound nets were set in this section for the first time in 1849. The largest catches were made from 1863 to 1871 and from 1875 to 1880. During 1872, 1873, and 1874 adverse legislation restricted the use of these nets to three days in the week.

The following summary shows the number of shad taken annually during a series of years in a single pound net located at Money Point, about 6 miles west of the mouth of the Connecticut River, the location being the same each year:

Year.	No. of shad.	Year.	No. of shad.	Year.	No. of shad.	Year.	No. of shad.
1856	3,643	1864	12,265	1872	a 8,271	1880	13,275
1857	5,183	1865	9,410	1873	a 7,343	1881	10,500
1858	6,111	1866	10,594	1874	a 9,200	1882	9,637
1859	3,000	1867	12,500	1875	20,037	1883	6,200
1860	6,000	1868	13,000	1876	11,041	1884	7,200
1861	6,100	1869	11,000	1877	10,465	1885	7,858
1862	6,853	1870	16,558	1878	b 4,550		
1863	10,730	1871	13,508	1879	19,175		

a Law restricted fishing to three days in each week. b Not very much injured by jelly-fish.

Between Hammonasset Point and New Haven Harbor there were 15 pound nets set in the spring of 1896 for menhaden and other species, which yielded 724 roe shad and 864 bucks. Of these, 206 roes and 285 bucks were taken in one net near the mouth of Farm River, whereas in 1895 943 shad were taken in 3 nets set in the same locality. In 1886 there were 27 nets between Hammonasset Point and New Haven harbor, which yielded 10,300 shad, while in 1885 30 nets in the same locality caught 18,200. In 1887 there were 38 nets in the locality named, and the yield of shad was 9,300. The only apparatus which was operated on the Connecticut shore west of New Haven Harbor in which shad are reported to have been caught, was 1 pound net at Welch Point, near the town of Milford, which yielded 177 shad in 1896 and 189 in 1895.

THAMES RIVER.

This river is really an estuary of Long Island Sound, extending 15 miles northward to Norwich, where it receives the waters of the Shetucket and Yantic rivers. Its width varies from a quarter to half a mile, except that near the mouth it is a mile or more wide, forming the excellent harbor of New London. On both the Shetucket and Yantic rivers there are numerous dams extending to within a short distance of their entrance into the Thames, forming complete barriers to the ascent of fish. Previous to 1880 a considerable number of shad were caught in Thames River, the yield during the height of the season being several hundred daily, but during the past ten or fifteen years very few have been taken. In 1885, 300 were reported; in 1886, 45; in 1887, 27; and in 1888 only 4 were caught, while in 1889 and 1890 there were none reported; in 1891, 2 were taken, and in 1893 there was 1, and since that year no shad have been reported from this river.

CONNECTICUT RIVER.

With the exception of Kennebec River, the Connecticut is the principal shad stream of New England. This river rises in the extreme northern part of New Hampshire, within half a mile of the Canadian border, flows in a general southerly direction a distance of 375 miles, forming the boundary line between New Hampshire and Vermont, and, traversing Massachusetts and Connecticut, empties into Long Island Sound near the eastern end. It is navigable for steamers from the mouth to Hartford, a distance of 50 miles. Above Hartford there are numerous falls, the most important being Enfield, Holyoke, Turner, Bellows, Olcott, and McInloe, all of which are provided with dams for developing water-power.

At Enfield, 66 miles from the sound, the river descends over a rocky bed, with a fall of 32 feet in a distance of 5 miles. A dam 1,500 feet long and 4 feet high, built of logs filled in with stone, extends in a broken line across the river. Originally this dam consisted of two wings running out from either side of the river, leaving an opening of 150 feet for navigation purposes. This opening was closed about fifteen years ago by a new section of dam 5 feet high, in the middle of which there is a fishway 40 feet long. Windsor Locks Canal permits the passage of small boats around the obstruction. The Enfield dam has caused much irritation among the fishermen above that point, especially among those in Massachusetts. In 1886 the general assembly of that State adopted a resolution suggesting mutual measures on the part of the States of Connecticut and Massachusetts toward overcoming this obstruction, but no satisfactory result was accomplished.

The Holyoke dam, 18 miles above Enfield, extends entirely across the river, with a length of over 1,000 feet and a height of 35 feet. It was completed in 1849 and is one of the most substantial constructions of its kind in the country, developing about 15,000 horse-power, used mainly in the manufacture of paper. During freshets the water on the crest of the dam is sometimes several feet deep, but ordinarily there is little overflow. A condition was imposed in the charter that the Holyoke Water Power Company should pay for the fisheries destroyed above the dam, and this requirement was complied with. Under a provision of the common law enjoining owners of dams high enough to stop the passage of fish to provide a suitable fishway, the Holyoke company was directed to build a fishway. The company contended that it was exempt from this common-law injunction because it already had paid for the fisheries destroyed above the dam, as required by the charter.

In a very interesting case, involving the rights of river fisheries, of the water-power corporations, and of the eminent domain of the State over both, the United States Supreme Court, affirming the decisions of the supreme court of Massachusetts, decided that as the dam had injured the fisheries below as well as destroying those above that

obstruction, it was subject to the common-law provision and must build a fishway. The fishway was completed in 1873, it being after the Brackett plan, a modification of the Foster fishway. It is one of the largest and most expensive ever constructed, being 440 feet in length, with a general inclination of 1 foot in 15, divided into compartments or bays by means of ⊥-shaped partitions that extend at right angles from the sides, causing the water to wind through such a long, circuitous course that it actually runs about 1,500 feet before it emerges at the lower end. As the height of the dam is 30 feet, the fall of the water averages about 1 foot in 50 with little momentum, but it does not appear that shad have ever passed above this fishway in quantities.

During the colonial period shad were abundant in the lower half of Connecticut River, ascending as far as Bellows Falls, 170 miles from Long Island Sound, where the abrupt descent of the river prevented further progress. They easily passed Turner Falls, 50 miles below, several thousand being taken there in a single day with dip nets. The first artificial obstruction to their progress was the dam at Turner Falls, erected in 1798. This obstruction prevented shad from passing that point, and it also seriously affected the spawning of salmon in the river, but, as there were areas below Turner Falls suitable for shad spawning, the run of this species below that point was not apparently injured.

In 1849 the dam at Holyoke was completed, cutting off 36 miles more from the upper limit of the shad run, including many spawning-grounds. The effect of this is shown distinctly in the reliable accounts of the catch made at the Parsonage seine fishery, near the mouth of the river. The average annual yield of shad from 1827 to 1836 was 10,376; during the succeeding ten years it was 9,332, the slight decline being perhaps attributable to increased fishing at near-by points. The erection of the Holyoke dam in 1849 prevented the fish from ascending to the upper waters, and as they retreated down the river they were taken more abundantly than formerly. The average yearly catch by the Parsonage seine in the five years following the erection of the dam was 19,490 shad; during the next ten years (1854–1863) the average was but 8,364, and for the following six years (1864–1869) it further decreased to 4,482 annually, less than one-half of the former yield.

For many years preceding 1881 the regulations of Massachusetts and Connecticut in reference to the Connecticut River shad fisheries were similar, a close season beginning June 21, and an interdiction prevailing against the use of nets with less than 5-inch mesh. An increased use of pound nets at the mouth of the river aroused much antagonism among the up-river fishermen, especially those in Massachusetts, and resulted in the spring of 1881 in an enactment by the legislature of that State extending the open season to July 1 and permitting the use of nets with 2-inch mesh. The effect of this enactment is well shown in the table on page 256. In 1880, by the use of 5-inch mesh, only 7,727 shad were taken in that portion of the Connecticut situated in Massa-

chusetts, while the small mesh in the following season caught 38,382 shad, nearly five times as many as during the previous year, the small mesh permitting the capture of shad of all sizes. This resulted in a greatly diminished catch during succeeding years. In 1882 the number of shad taken in that portion of the river was but 2,770, or less than 8 per cent of the yield in the year previous, and the largest product in any one season since has been but 3,591, or less than 10 per cent of the yield in 1881. Since 1883 the product decreased annually, and it does not appear that any shad have been taken in that portion of the Connecticut since 1890. The average yield for the six years ending in 1881 was 16,100 annually, and during the fifteen years following 1881 it has been only 852 shad annually.

At present the Connecticut River shad fisheries extend from Long Island Sound to Wethersfield, a distance of 40 miles, but they are most extensive in the reaches between Essex and Haddam. The yield in 1896 aggregated 45,851 taken in drift nets and 5,839 in seines. The fishery by drift nets is most extensive from Essex to Higganum, the principal centers being Hamburg, Chester, Hadlyme, Higganum, and Haddam.

The number of nets used in the river in 1896 was 48, of which 31 were operated by men living in Middlesex County, 15 by men from New London County, and 2 by Hartford County fishermen. These measure in length from 140 to 350 yards, averaging about 290 yards, with 5½-inch mesh, and cost about $70 each, each net requiring one boat, worth $20, and 2 men.

The season is dependent on the movements of ice in the river, but it generally begins the first or second week in April and extends to the third week of June. The legal season extends from March 1 to June 20 of each year, and fishing is interdicted from sunset on Saturday night to sunset on the following Sunday night of each week.

Of the total yield in 1896, 22,197 were roes and 23,654 bucks, the price received for the former being $5,200 and for the latter $3,044. Seines were formerly the only apparatus used for taking shad in the Connecticut, but these have been gradually superseded by drift nets. In 1896 there were only 12 seines used, most of which were operated between Haddam and Wethersfield. These approximated 150 yards in length, and several were used mainly for catching alewives. Their yield of shad was the largest since 1880, numbering 5,839, valued at $1,264. A seine at Wethersfield caught 2,799 shad in 1896, against 730 in 1895. Another seine at the same place caught 1,894 shad in 1896 and but 709 in 1895.

The following compilation shows the number of shad taken in Connecticut River during a number of years. Returns for years previous to 1879 for that portion of the river situated in Connecticut are not available. The South Hadley seine fishery, a short distance below the Holyoke dam, was formerly the most valuable seine fishery above the Enfield dam. The yield at that fishery is also noted in the table.

Table showing the number of shad taken in Connecticut River during a number of years, also the yield at the South Hadley seine fishery.

Year.	Connecticut.	Massachusetts.	Total.	Yield at South Hadley fishery.	Year.	Connecticut.	Massachusetts.	Total.	Yield at South Hadley fishery.
1853	.....	.....	.....	45,000	1883	177,308	3,591	180,899	3,099
1865	.....	.....	.....	35,000	1884	150,045	1,593	151,638	1,593
1868	.....	.....	.....	7,341	1885	190,300	1,718	192,018	1,718
1869	.....	.....	.....	8,807	1886	117,950	577	118,527	577
1870	.....	.....	.....	779	1887	80,350	850	81,200	850
1872	.....	.....	.....	4,822	1888	68,450	824	69,274	824
1873	.....	.....	.....	3,598	1889	42,325	796	43,121	796
1874	.....	.....	.....	3,016	1890	34,318	58	34,376	58
1876	.....	12,792	.....	10,741	1891	20,503	.....	20,503	.....
1877	.....	6,503	.....	3,412	1892	18,376	.....	18,376	.....
1878	.....	17,790	.....	8,169	1893	21,778	.....	21,778	.....
1879	436,981	13,409	450,390	6,296	1894	38,776	.....	38,776	.....
1880	269,918	7,727	277,645	4,698	1895	34,323	.....	34,323	.....
1881	351,678	38,382	390,060	18,196	1896	51,690	.....	51,690	.....
1882	272,903	2,770	275,673	2,114					

From the preceding statement it appears that during the six years following 1878 the shad yield aggregated 1,726,305; during the succeeding six years it was 538,516, and during the six years ending in 1896 only 185,447 shad were taken in the Connecticut. The alleged reasons for the continued decrease are summed up as follows: (1) The erection of jetties at the mouth of the river, resulting in a change of the current flowing therefrom through Long Island Sound; (2) pollution of water by sewage and refuse from manufactories along the shore; (3) overfishing, and (4) the erection of dams across the stream, thereby preventing the fish from ascending to the spawning-beds. It is questionable whether the first-named factor has had any effect on the abundance of shad. The jetties deflect the current only slightly from its natural course, and should the shad not run up the Connecticut they would doubtless appear in increased numbers at other points in Long Island Sound, which does not seem to have been the case.

The second factor has undoubtedly had a very deleterious effect on the fisheries. That the sanitary conditions of the Connecticut are unfavorable to the existence of shad admits of no doubt, the sewage from the cities and the acid refuse from the numerous factories on the shores of the stream so polluting the water as to make it unfavorable to the existence of animal life therein. Especially is this the case during the summer months, when the young fish are in the river, the water becoming so tainted with acids and refuse that the surface is frequently spotted with dead fish. While the extensive fisheries have doubtless materially assisted in bringing about the present depleted condition of the Connecticut, yet they have merely hastened the work that would eventually be accomplished by the dams and the unsanitary state of the water, even if no fisheries existed. The most objectionable development of recent years is the concentration of the fisheries near the mouth of the river, nearly all the fish being caught before they have reached the spawning grounds, thus reducing natural reproduction to almost an insignificant factor in keeping up the supply. It is apparent that the future of the Connecticut River shad fisheries is far more dependent on artificial propagation than has been the case in the past. But there is

little to be said favorable to further work of this nature unless improvement be made in the conditions of the river. Were this accomplished, artificial propagation could doubtless greatly increase the run of fish; and if suitable restrictions were applied to the fisheries the shad reaching the spawning-beds between Haddam and Windsor Locks might also tend to keep up the supply.

Farmington River.—The Farmington is the only one of the several tributaries of the Connecticut that has yielded shad during recent years. It rises in Berkshire County, Massachusetts, and, flowing a distance of 75 miles, enters the Connecticut about 5 miles above Hartford. At Poquonock, 5 miles above the mouth, there is a log dam 4 or 5 feet high and 264 feet long, entirely crossing the river. Above this point there are numerous other dams at short distances, forming a complete barrier to the ascent of fish. Formerly the shad fisheries of Farmington River were of some local importance, but during the past ten or twelve years the catch has been small. In 1881 the yield numbered 11,505, in 1882 it was 3,800, and in 1883 but 1,155 shad were caught. Since then the yield has been very small, except in 1885, when 3,400 shad were caught by seines. In 1896 one seine was used to obtain spawn for the State hatchery, catching about 500 shad, which represents the full extent of the fisheries during that year.

HOUSATONIC RIVER.

This river rises near Pittsfield in the western portion of Massachusetts, and, after flowing a distance of 123 miles, enters Long Island Sound 4 miles east of Bridgeport. It is navigable for 13 miles to Derby, where it receives its principal tributary, Naugatuck River, a small rapid stream. A mile or so above Derby the Housatonic is crossed by a stone dam 22 feet high and 636 feet in length, completed in 1870 at a cost of $430,000, and developing 1,500 horsepower, used for various manufacturing purposes. The usual spring-freshet depth over the crest is 4 or 5 feet. A fishway was built in this obstruction, the designs being furnished by the late Mr. Foster, of Maine. Very soon thereafter it appeared that shad would not pass above this dam, not even attempting to enter the fishway, although many were seen in immediate proximity to the lower end. The fishway was destroyed by freshets in 1873 and has not been rebuilt. Above Birmingham the fall of the Housatonic is very great, averaging 8 feet per mile. There are a few dams, the most important one of which is at Lanesville, where the fall obtained is 12 feet. Very few shad pass above the Birmingham dam, and none appear to go beyond Lanesville, 40 miles above the mouth. In the early part of the present century, previous to the erection of obstructions on the river, shad ascended to Falls Village, 73 miles from Long Island Sound. At that point the river falls abruptly over limestone ledges a total distance of 100 feet, forming a complete barrier to the further ascent of fish.

It was reported in 1883 that 11 seines on the Housatonic caught

11,550 shad and 27 gill nets caught 4,500, a total of 16,050, and in 1884 that the yield in 12 seines was 39,000 and in 47 gill nets 13,000, making a total of 52,000 shad taken on the Housatonic during that year. In 1885 the yield was 50,600; in 1886 it was reduced to 24,800, and in 1887 the catch of shad was still further reduced to 12,400. The present fisheries are confined to the use of a few drift nets and seines between the mouth of the river and Birmingham, the annual yield ranging from 8,000 to 15,000 in number. The drift nets in 1896 numbered 29, with a total length of 5,640 yards, requiring 29 boats, worth $536, and 34 men. Of these nets, 22 were used by men living on the east side of the river and 7 on the west side. The season began about the middle of April and extended to the third week of June. The catch was not up to the usual quantity, 8,286 shad being taken, of which 4,335 were roes and 3,951 bucks. In 1896 there were 5 seines operated below Birmingham by men living on the Fairfield County side of the river. These range in length from 150 to 250 yards, with from 3 to 5 inch mesh, and require three or four men and one boat for each. The seining season began about a week earlier and closed three weeks earlier than the drift-net season. The catch of shad was 812 roes and 780 bucks, making a total of 9,878 shad, worth $2,471, taken on the Housatonic River.

Bridgeport Harbor, Pine Creek, etc.—In the harbor of Bridgeport, 3 miles west of Housatonic River, a few shad are taken each year, most of them being secured in a channel known locally as "The Gut." In 1896 6 men operated 5 drift nets in that locality, and took 652 roe shad and 365 bucks, valued locally at $285. In Pine Creek, Black Rock Harbor, Ash Creek, and several other small streams between Bridgeport and Stamford, there are a few shad taken every season by means of short drift nets. Four shad fishermen, with an equal number of boats, are reported from those waters in 1896, using 4 drift nets, the catch in the season extending from April 20 to June 10, numbering 342 roe shad and 227 bucks, worth $139.

THE SHAD FISHERIES OF RHODE ISLAND.

The shad caught in Rhode Island are taken incidentally in apparatus set especially for other species, except that in Warren River 6 men used 3 pound nets, worth $920, 3 boats, worth $90, and shore property valued at $120, catching 9,258 shad. The following table shows by water areas the yield of shad in this State in 1896:

Statement showing, by water areas, the yield of shad in Rhode Island in 1896.

Waters.	Pound nets.		Miscellaneous.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Atlantic Ocean	1,051	$287	.....	.....	1,051	$287
Narragansett Bay	2,163	589	.....	.....	2,163	589
Warren River	9,258	2,408	.....	.....	9,258	2,408
Pawcatuck River	.....	.....	400	$115	400	115
Providence-Blackstone River	.....	.....	500	142	500	142
Greenwich River	.....	.....	160	49	160	49
Total	12,472	3,284	1,060	306	13,532	3,590

OCEAN SHORE OF RHODE ISLAND.

Along the ocean shore of Rhode Island, from Watch Hill to Point Judith, there are several pound nets each spring in which a few shad are taken incidentally. These nets are set about April 20 and remain until the fall, catching shad during the first two or three weeks in which they are set, viz, from April 20 to May 10. There were 14 pound nets in this locality in 1896, the total value of which was $16,800, and their catch of shad is reported at 946, of which about 40 per cent were roes. The average weight of the roe shad approximated 5 pounds, while the bucks averaged in weight about 3 pounds each. The roes sold at an average price of 38 cents and the bucks at about 20 cents each. On the shore of Block Island there were 4 pound nets in 1896, valued at $4,900, in which 105 shad, worth $32, were taken. In 1895 the same 4 pound nets caught about 200 shad.

NARRAGANSETT BAY.

There are numerous pound nets set each spring at various points in Narragansett Bay, the principal species taken being scup, squeteague, and sea bass. The nets are most numerous off the southern shore of Newport Island, in Western Channel and between Sakonnet and Tiverton. In these pound nets a few shad are taken each year, but this species is rarely sufficiently numerous to receive special attention from the fishermen. In the 98 nets in Narragansett Bay in 1896, the catch of shad was 1,090 roes and 1,073 bucks. Over half of these were taken in 39 nets set in the Eastern Channel, between Sakonnet Point and Mount Hope Bay, the catch being 685 roes and 563 bucks. The largest yield in any single pound net was 70 roe shad and 78 bucks, obtained in a net off Rumstick Neck, at the northern end of Narragansett Bay near the mouth of Providence River.

Warren River.—While a few shad run up most of the tributaries of Narragansett Bay, yet they are not in sufficient numbers to support important fisheries, and the only well-known shad stream in the State is Warren River. This small stream is a tidal arm of Narragansett Bay near its northern limit. It is only a few hundred feet in width, about 10 miles in length, and contains no obstructions to the free passage of fish. It has been an important shad stream during the last thirty years at least. In 1880 it was reported that about 5,000 shad, with an average weight of 3½ pounds each, were taken in 5 pound nets set in this river. In 1896 there were 3 pound nets set at the head of the river, near the Massachusetts State line. The shad season began April 20 and ended May 29, and the catch numbered 5,480 roes and 3,778 bucks, valued locally at $2,408. This was an average for recent years, the yield ranging from 6,000 to 12,000 annually.

Pawcatuck River.—The Pawcatuck formerly yielded a large number of shad, but at present it is obstructed by numerous dams, which completely block the passage of fish. Yet a few shad are taken in the

lower portion of this river each year, as well as in Old Warwick Cove and Patowomut River, the aggregate yield in these waters averaging about 400 annually, taken by means of seines, dip nets, etc.

Providence-Blackstone River.—The numerous dams and the sewage from the city of Providence have served to almost exterminate shad from Providence-Blackstone River. But each year a few hundred are taken by seines, dip nets, and other contrivances, the yield in 1896 being estimated at 500 in number.

Greenwich Bay.—Two seines hauled in Greenwich Bay in 1896 caught 108 roe shad and 52 bucks, which sold for $49.

THE SHAD FISHERIES OF MASSACHUSETTS.

There are no regular shad fisheries in Massachusetts, this species being caught only incidentally in connection with the taking of other fishes. The following table shows, by water areas, the yield of shad in each form of apparatus operated in this State in 1896:

Waters.	Drift nets.		Seines.		Pound nets.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Taunton River	.....	.....	3,355	$934	.....	.....	3,355	$934
Buzzards Bay	.....	.....	.....	.....	721	$252	721	252
Vineyard Sound	.....	.....	.....	.....	2,664	582	2,664	582
Cape Cod Bay	22,080	$691	9,080	454	1,745	304	32,905	1,449
Massachusetts Bay	.....	.....	.....	.....	170	17	170	17
Merrimac River	.....	.....	7	2	.....	.....	7	2
Total	22,080	691	12,442	1,390	5,300	1,155	39,822	3,236

TAUNTON RIVER.

This river is formed by the union of Satucket and Matfield rivers in Bridgewater, Mass., whence it flows to its entrance into Narragansett Bay. It is navigable for 18 miles to East Taunton, where it is crossed by a dam, developing a fall of 9 feet of water. Shad enter Taunton River about the latter part of March and remain until some time in June, although few are taken after the end of May. It does not appear that there have ever been important fisheries in this river dependent exclusively upon shad, and during recent years that species has been taken only incidentally in connection with the alewife fisheries. The following summary shows for recent years the total yield of shad in this stream:

Year.	Number of seine fisheries.	Number of shad caught.	Year.	Number of seine fisheries.	Number of shad caught.
1878	13	7,308	1888	10	6,353
1879	9	3,009	1889	13	7,329
1880	11	6,615	1890	10	4,836
1881	10	5,739	1891	9	2,451
1882	11	11,173	1892	12	2,056
1883	11	5,012	1893	6	2,104
1884	10	4,037	1894	9	2,814
1885	10	4,964	1895	8	3,804
1886	8	2,620	1896	8	3,355
1887	8	4,550			

In 1880 there were 15 seines used in Taunton River, requiring the services of 108 men, and their catch of shad was reported at 6,615, weighing 21,498 pounds. The yield of alewives during the same season numbered 1,718,000. In 1896 there were 8 fisheries for alewives, at which 13 seines were used, with an aggregate length of 1,903 yards and valuation of $1,478. These required the services of 87 fishermen and 22 shoresmen, and their catch of shad numbered 3,355, worth $934, and of alewives 1,898,478, valued at $9,478.

BUZZARDS BAY.

In this coastal indentation, covering 225 square miles on the southern shore of Massachusetts, there are a few shad taken each year incidentally in the pound nets set primarily for alewives, scup, butterfish, etc. These nets are set along the shore west of Apponagansett Bay, at the mouth of Pamansett River, between that river and Goose Neck, and on Elizabeth Islands. The number used in 1896 was 35, valued at $11,550, and the season extended from early in April to some time in November, shad being taken during April and May. The yield of shad was 721, valued at $252, while the alewives taken in the same nets numbered 258,875, worth $1,380. A State law interdicts the use of pound nets in Buzzards Bay after the expiration of the permits granted prior to the enactment of that regulation. These privileges expire at the end of the season of 1897, and after that date there will probably be no fishing in this locality except that with hand lines and the clam and scallop fisheries.

Vineyard Sound.—In the Vineyard Sound pound-net fishery there are a few shad taken each year, the yield in the 42 nets operated in the spring of 1896 being 2,664, valued at $582. The same nets caught also 320,165 alewives, which sold for $1,525. Shad are first taken in these nets about April 20, and few are caught after May 15.

CAPE COD AND MASSACHUSETTS BAY.

The principal shad yield in Massachusetts is obtained by the mackerel fishermen from Provincetown, each of the small vessels engaged in drifting mackerel nets from that port taking a few shad incidentally during the month of June, the yield usually ranging from 600 to 1,200 shad annually to each vessel. The vessels engaged in this fishery measure from 5 to 15 tons, are manned by two or three men each, and carry from 25 to 45 nets, averaging 60 yards in length, with from 3 to 3½ inch mesh. In 1896 there were 27 small vessels engaged in this fishery, with an aggregate measurement of 341 tons and valuation of $21,950. These vessels were operated by 58 men and carried 791 nets, 47,453 yards in length, valued at $7,910, and the total catch of shad was 19,040, for which the fishermen received $596. These shad were unusually small, averaging only about 2 pounds each, due to the small mesh of the nets. Seven Provincetown sailboats, worth $1,300, manned by 14 men, and carrying 150 mackerel drift nets similar to those used

on the small vessels, caught a few shad in 1896, their entire yield being 3,040, which sold for $95.

Occasionally Provincetown boats catch some shad while seining for mackerel. In 1896 the steamer *Cormorant*, 4.81 net tonnage, made three hauls of shad, one each on June 6, 7, and 9, catching 9,080, which were sold fresh at 5 cents each.

The pound nets and weirs set in Cape Cod Bay catch a few shad, the number taken ranging upward to 50 or more to each net. In 1896 85 nets set in this bay took 1,745 shad, valued at about $300.

Comparatively few of the trap nets set in Massachusetts Bay catch shad; in 1896 only 5 are reported as having taken this species, the total yield being 170, worth $17.

MERRIMAC RIVER.

The sources of the Merrimac are in eastern-central New Hampshire, the main stream being formed by the junction of the Pemigewasset and Winnipesaukee rivers, on the line of Belknap and Merrimac counties, whence it flows 110 miles to its entrance into the sea near Newburyport. The head of navigation for coasting vessels is a few miles above Haverhill, but small river boats ascend as far as Lawrence. At Lawrence the stream is crossed obliquely by a substantial dam 32 feet high and 900 feet long, at the south end of which is a wooden fishway, the whole being completed in 1848 at a cost of about $250,000. At Lowell, 12 miles above Lawrence, there is a second dam about 30 feet high, built in 1830 and enlarged in 1876. A third dam exists at Manchester, N. H., constructed in 1871, its length being 420 feet and its height about 12 feet. There are three other dams on the river above Manchester, viz, at Hooksett, Garvin Falls, and Sewell Falls.

Previous to the erection of these obstructions there were large runs of shad and other anadromous fish into and up the Merrimac. It is claimed that at the junction of the two head tributaries, the Pemigewasset and the Winnipesaukee, the shad and salmon separated, the former following the eastern branch into Lake Winnipesaukee, while the latter ascended the colder waters of the Pemigewasset, penetrating its source in the White Mountains.

In a report[1] of special commissioners of Massachusetts, appointed in 1865, "concerning the obstructions to the passage of fish in the Connecticut and Merrimac rivers," the following approximation of the yield of shad in the Merrimac is given:

Year.	Estimate for river below Pawtucket Falls.	Estimate for Pawtucket Falls.	Total.	Value, at prices prevailing in 1865.
1789	700,000	130,000	830,000	$138,300
1805	450,000	90,000	540,000	90,000
1835	306,000	59,000	365,000	60,000
1865	50,000	.....	50,000	8,500

[1] Report of the Commissioners, Senate, No. 8, 1866, p. 39.

Since the erection of the Lawrence and Lowell dams the run of shad in the Merrimac has been constantly decreasing, as appears from the following summary, covering a period of nineteen years:

Year.	Number of seines.	Number of shad reported.	Number taken in Amesbury seine.	Year.	Number of seines.	Number of shad reported.	Number taken in Amesbury seine.
1878	7	5,033	2,836	1888	1	.....	.....
1879	8	2,781	1,757	1889	5	18	.....
1880	7	2,139	1,478	1890	0	.....	.....
1881	6	1,192	704	1891	3	.....	.....
1882	4	387	282	1892	2	.....	.....
1883	2	146	57	1893	4	2,020	.....
1884	2	111	.....	1894	3	2,750	.....
1885	2	130	86	1895	0	94	.....
1886	1	73	.....	1896	7	7	.....
1887	1	28	.....				

THE SHAD FISHERIES OF MAINE.

The extent by water areas of each branch of the shad fisheries of Maine is presented in the following series of three tables, showing for 1896 (1) the number of persons employed; (2) the boats, apparatus, etc., used, and (3) the quantity and value of the catch.

Statement of the number of persons employed in each branch of the shad fisheries of Maine in 1896.

Waters.	Drift-net.	Seine.	Weir.	Total, exclusive of duplication.
Casco Bay	20	*a* 11	.....	31
Kennebec River	72	.....	118	178
Androscoggin River	5	4	4	11
Eastern River	6	.....	24	30
Harrington River	6	.....	.....	6
Pleasant River	15	.....	.....	15
Total	124	15	146	271

a Purse-seine fishermen.

Statement of the boats, apparatus, etc., employed in the shad fisheries of Maine in 1896.

Waters.	Boats.		Drift nets.			Seines.			Weirs.		Value of shore property.	Total value.
	No.	Value.	No.	Length.	Value.	No.	Length.	Value.	No.	Value.		
				Yards.			*Yards.*					
Casco Bay	19	$4,224	64	4,228	$885	*a* 1	320	$350	.....	.....	.....	$5,459
Kennebec River	209	6,483	107	10,838	1,568	.....	.....	.....	114	$20,400	$5,971	34,422
Androscoggin River	6	65	5	400	75	1	90	20	2	125	50	335
Eastern River	27	662	12	900	102	.....	.....	.....	17	2,815	817	4,396
Harrington River	6	30	9	540	54	.....	.....	.....	.....	.....	.....	84
Pleasant River	14	178	31	1,860	186	.....	.....	.....	.....	.....	.....	364
Total	281	11,642	228	18,766	2,870	2	410	370	133	23,340	6,838	45,060

a Purse seine.

Statement of the yield of shad in Maine in 1896.

Waters.	Drift nets.		Seines.		Traps and weirs.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Casco Bay	6,110	$355	40,325	$2,017	18,055	$1,208	64,490	$3,580
Kennebec River	45,787	5,026	.....	.....	205,542	17,780	251,329	22,806
Androscoggin River	1,530	138	5,500	495	6,380	574	13,410	1,207
Eastern River	3,000	270	.....	.....	22,383	1,974	25,383	2,244
Penobscot River	.....	.....	.....	.....	114	27	114	27
Harrington River	3,000	192	.....	.....	.....	.....	3,000	192
Pleasant River	9,000	720	.....	.....	.....	.....	9,000	720
St. Croix River	.....	.....	.....	.....	12	2	12	2
Total	68,427	6,701	45,825	2,512	252,486	21,565	366,738	30,778

SACO RIVER.

This river has its sources among the White Mountains, nearly 100 miles from its entrance into the ocean near Biddeford Pool. At Biddeford, 6 miles from the sea, there are two falls, each about 16 feet high. From that point to Hiram Falls, 45 miles from the sea, there are no less than 8 dams, each from 6 to 14 feet high, and at Hiram Falls the river descends 80 feet in five successive plunges. Formerly shad abounded in the lower end of the river, but it does not appear that they passed above Biddeford Falls, though salmon ascended as far as Hiram Falls. During recent years no shad have been reported from Saco River.

CASCO BAY.

Shad have been caught in Casco Bay more or less extensively for the last forty or fifty years, but the yield has fallen off considerably during recent years. They appear in these waters about May 1, and are observed to some extent as late as the end of September. These shad are smaller and presumably younger than those running up the rivers, and are commonly known as "sea shad." Of the 64,490 taken during 1896, 6,110 were caught with drift nets, 40,325 with seines, and 18,055 with trap nets and weirs.

Gill nets are used mostly in Quahog Bay and the coves of Harpswell Sound, near the northeastern end of Casco Bay. They range in length from 60 to 75 yards each, 35 to 45 meshes deep, with from 4 to 4¾ inch mesh. Most of the nets are drifted in the current of the long, narrow bays or sounds, but at times they are set near the mouths of the coves. In 1896 there were 64 gill nets in Casco Bay, aggregating 4,228 yards in length and $885 in value, requiring 18 boats, manned by 20 men. From June 20 to August 31 they caught 6,110 shad, valued locally at $355. About one-fourth of these were salted, the remainder being sold fresh.

The trap nets and weirs in the eastern half of Casco Bay take many small shad each season, the largest catch being obtained in those between Small Point and the mouth of New Meadows River. The nets are set from early in the spring until late in the fall, and their yield of shad is obtained at intervals from the first of May until late in September. In 1896 there were 46 pound nets, trap nets, and weirs in those waters, the value approximating $12,840. They required the services of 88 men and $5,347 worth of boats, and yielded 18,055 shad, valued

locally at $1,208. During June and July, 1896, the schooner *Robert and Carr*, 51.85 tons, of Cundys Harbor, fished for shad with a mackerel purse seine in Casco Bay and east thereof. The seine was of the ordinary type used in the mackerel fishery, 320 yards long, 36 yards deep, with 2-inch mesh. The yield numbered 40,325, which were salted, filling 322 barrels, and sold mostly in Portland at $6.25 per barrel.

KENNEBEC RIVER.

This river has its sources in Moosehead Lake, the largest body of fresh water in Maine, at an elevation of 1,023 feet above sea level; thence it flows in a general southerly direction 155 miles to its entrance into the sea immediately east of Casco Bay. It is tidal and navigable for large vessels from the mouth to Augusta, a distance of 44 miles. Nine miles below Augusta it receives its principal tributary, Androscoggin River, and expands into a wide area known as Merrymeeting Bay. At that point the water is usually fresh, but when the river is low it is brackish as far as Richmond. At Augusta the Kennebec is crossed by an insurmountable crib dam 17 feet high and 956 feet long, rebuilt in 1870. A fishway has been placed in this dam at its eastern end, but it does not appear to be used by shad. A second dam at Waterville, 17 miles above Augusta, was built in 1869, and is 7 feet high and 750 feet in length. There are several dams above Waterville, the principal ones of which are at Kendall Mills, Somerset Mills, Skowhegan Falls, Norridgewock, Madison Bridge Falls, etc.

For half a mile or more immediately below the Augusta dam there are gravelly shoals which afford suitable spawning areas for shad; hence the erection of that dam has not been so injurious to this species as to the salmon. Merrymeeting Bay, by reason of its broad, sandy flats, is also a favorable place for shad spawning. The greatest injury to shad in the Kennebec has been the vast quantities of sawdust run into the river from numerous sawmills, covering the river bottom in many places, so that areas formerly eligible for spawning-grounds are no longer suitable. The fishermen state that this refuse is so abundant in Merrymeeting Bay that at times the bottoms of their weirs are covered several feet therewith.

Shad formerly ascended Kennebec River as far as Norridgewock Falls, 84 miles from the sea, where they turned aside into a small tributary known as Sandy River. At Ticonic Falls and at Skowhegan there were productive dip net fisheries. It is on record that at the former place four men dipped 6,400 shad in one day, and that 1 man, with the assistance of 3 boys, caught 1,100 shad and 20 salmon in one afternoon. The catch in a weir at Abagodasset Point for several years following 1820 ranged from 3,000 to 10,000 annually.[1] A weir operated in Merrymeeting Bay yielded during the ten years ending in 1835 an average of 5,961 shad annually, while in the eleven years from 1837 to 1848 (omitting 1844, the record for which is lacking), the aver-

[1] Fishery Industries of United States, sec. v, vol. i, p. 719.

age was 3,120 per year. In 1867 the catch of shad by 40 weirs, several seines, and an unknown number of drift nets was 180,000. In 1880, 44 weirs, 2 seines, and 60 or more drift nets took 105,000 shad. At present the shad fisheries of Kennebec River are the most important on the Atlantic coast north of Hudson River, and the yield is greater than in all the remaining waters of the New England States. They extend from the mouth of the river nearly to Augusta, the forms of apparatus employed being weirs and drift nets. The catch in 1896 by the weirs numbered 205,542 and by drift nets 45,787, making a total of 251,329, valued at $22,806. The yield of shad in 1867 was estimated at 225,000, of which 200,000 were taken in weirs and 25,000 in other forms of apparatus.

The weir fishery is carried on in the Kennebec chiefly between Iceboro, about 3 miles above Swan Island, and the Chopps, a narrow part of the river below Swan Island. In addition thereto there are a few weirs in the vicinity of South Gardiner and 3 or 4 in the lower part of the river below Bath. In Merrymeeting Bay there are numerous weirs, and a number in Eastern and Androscoggin rivers, which enter the Kennebec at Merrymeeting Bay. The following description of these weirs is furnished by Mr. Ansley Hall:

In form of construction these weirs are similar to the ordinary pound nets, but they are operated on the principle of brush weirs. They cost from $10 to $40 each, according to their size. Instead of lifting them to remove the fish a seine of 1½-inch mesh is used for that purpose. The seine has a staff at each end and is furnished with purse lines. It is about 25 feet in length and varies in width according to the depth of the water in the weir in which used. If two or more adjacent weirs are of about the same size and depth, one seine may be used for them all; otherwise there is a seine for each weir. The leader of each weir consists of stakes driven about 18 inches apart and interwoven at the top with maple sprouts or brush to form a sort of binder for support. Where the tide is unusually strong large stakes are driven a short distance from the leader stakes and the leader guyed to them with lines. The length of the leaders varies according to the width of the river, but where the stream is of sufficient width it is 100 feet or more, but it is usually from 50 to 100 feet. From a point near the shore, where the water is about 2 feet deep at low tide, the leader may be extended a distance not greater than one-eighth of the width of the river channel. The weir has three pounds, viz, the big or pasture pound, the second pound, and the fish pound. The big pound is at the end of the leader and the other two are always on the down-river side of the big pound. The depth of water in which the pounds are located varies from 18 to 30 feet at low water, but is ordinarily about 22 feet, except in Merrymeeting Bay and the tributary streams, where the depth is less. The stakes forming the pound are from 20 to 45 feet in length, depending on the depth of water. They are driven 3 or 4 feet apart and twine with 2½ or 3 inch mesh is hung on the outside of them, this twine being sufficiently deep to extend about 1 foot above the surface at high water. An iron chain is attached to the lower edge of the twine to keep it close to the bottom of the river. The principal part of each pound is made with a single piece of netting. The length of the netting in the big pound is from 140 to 145 feet, in the second pound about 100 feet, and in the fish pound from 135 to 140 feet. Small stakes are driven outside the twine and bound to the large stakes with cords at intervals as far down as practicable, thus serving to hold the twine in place. The weir is braced by guy lines made fast to piles (known as "pointers") driven on the upper side of the big pound. The cost of a completed weir varies from $100 to $800, averaging perhaps $200.

The boats used in the weir fishery are flat-bottomed skiffs, about 15 feet long and square at each end, this form being the most convenient for operating the small seine. Large scows, 20 to 30 feet in length, are used in building the weirs and sailboats are employed in transporting the fish caught. In 1896 there were 114 weirs, valued at $20,400, operated on the Kennebec by 118 men, using 209 boats, valued at $6,483. The season for shad began about May 1 and ended about June 25, the catch numbering 205,542, valued locally at $17,780.

Drift nets are operated in Kennebec River from the mouth to Merrymeeting Bay, but most extensively in the vicinity of Bowdoinham, North Bath, Bath, and Georgetown. The length of these nets ranges from 200 to 400 feet, averaging slightly more than 300 feet. The mesh varies from 4⅝ to 5¼ inches, the mesh of those operated below Bath being a trifle smaller than those above that town. The drift-net season is coincident with the season in which shad are taken in the weirs, and extended in 1896 from May 1 to June 25. During that year there were 47 boats employed in this branch of the shad fishery, manned by 72 men and using 107 drift nets, aggregating 10,838 yards in length and $1,568 in value. The catch numbered 45,787 shad, valued at $5,026.

Androscoggin River.—This river, the principal tributary of the Kennebec, has its sources partly in Maine and partly in New Hampshire, whence it flows 160 miles to its entrance into the broad expanse of Kennebec River, known as Merrymeeting Bay. It is navigable for a distance of 6 miles from the mouth to the falls at Brunswick, where it is crossed by two dams, each about 14 feet high. At Lisbon Falls, 8 miles above Brunswick, there is a dam 10 feet in height. At Lewiston, 40 miles by the river course from the ocean, there is a natural fall of 38 feet in a distance of 600 feet, at the head of which there is a dam with an average height of 12 feet. At present the shad fisheries of the Androscoggin are confined to the lower end below Brunswick Falls. Of the 13,410 shad taken on this river in 1896, 5,500 were caught in a seine, 1,530 in 5 drift nets, and 6,380 in 2 weirs. The seine was 90 yards in length with 3¼-inch mesh, and was operated during the month of May and the first three weeks of June. The drift nets were 80 yards in length with 3⅛-inch mesh, and were used by one man each, the season being coincident with that of the seine fishery. The two weirs were much smaller than those in Kennebec River, both of them being valued at only $125, and required four men to operate them.

Eastern River.—In Eastern River, which enters the Kennebec a short distance below Richmond, there are quite a number of shad taken by weirs and a few by drift nets. The first report of the commissioner of fisheries of the State of Maine states:

> In Eastern River thirty years ago there were 8 or 9 weirs, each of which took 6,000 or 8,000 shad per year, and about the same amount was taken by seines and drift nets, indicating a catch of 100,000 shad annually. In 1846 one seine took 4,719 shad; in 1847, 3,319, and in 1852, 2,500.—(Reports of the Commissioners of Fisheries of Maine for 1867 and 1868, p. 46.)

The weirs used in 1896 were smaller than those on the Kennebec, but resembled them in every other particular. Seventeen were set in the lower end of this tributary, approximating $2,815 in value, and yielding 22,383 shad, valued locally at $1,974. These weirs also caught 60,216 alewives, worth $448. Six drift-net boats were used on Eastern River, manned by an equal number of men and using 12 nets, aggregating 900 yards in length, with 5⅛-inch to 5¼-inch mesh. Their catch from May 1 to June 25 numbered 3,000 shad, valued at $270.

East of the Kennebec River there are no established runs of shad up any of the rivers of the United States. They appear to pass northward along this stretch of coast during May and June, and to return southward in August and September. During both the spring and the fall run, especially the latter, small schools enter the bays and the lower estuaries of the rivers. In only a few localities, however, do they appear with sufficient regularity to induce fishermen to make special preparation for them, among which are Harrington and Pleasant rivers. In other localities, as Penobscot Bay, Dyer Bay, Narragaugus Bay, etc., they are taken incidentally in brush weirs and other apparatus set for herring, etc.

PENOBSCOT RIVER AND BAY.

This stream is the largest on the United States coast north of the Connecticut. Its sources are in the extreme western part of Maine near the Canadian boundary, whence it flows a distance of over 200 miles to its entrance into Penobscot Bay, 30 miles below Bangor. It is navigable for large vessels from the mouth to Bangor, a short distance above which it is crossed by a dam 10 feet in height. Within the next 12 miles the fall of the river approximates 70 feet, an average of nearly 6 feet per mile. Four miles above the first dam there is a second dam 8 feet in height, and above this point there are numerous other obstructions.

It is stated that originally shad was the most abundant fish in the Penobscot. At Oldtown Falls, a short distance above Bangor, there were extensive fisheries eighty years ago, which yielded far more shad than was necessary for the local demand, the price averaging but $1 per 100. On the lower part of the river many shad and salmon were caught in weirs and sold to the vessels, mostly from Connecticut, which made annual trips to this river for salt fish. There was little decrease in the abundance until the erection of the dam a short distance above Bangor in 1830. Then came the erection of the Great Works dam, and in 1834 the Veazie dam was built. When the shad came up in the spring of 1835 and found the impassable barrier to their further progress they wandered in confusion below the obstruction, and many loaded with ripe spawn were taken in weirs in the town of Bucksport, which was reported as a most unusual occurrence. The Penobscot, unlike the Kennebec, has no available spawning-grounds below the dams, and furthermore the water is frequently brackish all the way to Bangor, and whatever

spawning-grounds would be otherwise available in the Penobscot are covered with sawdust. During the few years following the construction of the dams shad were taken in abundance in the lower end of the river, then they decreased, and within a few years more they were comparatively scarce. In 1867 the yield of shad in the Penobscot had decreased to 5,000. Mr. S. B. Rich, of Bucksport, fished with a drift net about 1830, and would sometimes catch 300 shad in a single night; in 1867 he tried it again, but caught no more than 3 shad in any one night, and sometimes 2, 1, or none. The decrease in yield of shad in these waters has continued up to the present time, the entire yield in Penobscot River and Bay in 1896 being only 114 shad, worth $27, all of which were caught in weirs set in the vicinity of Whitmore Island.

PLEASANT AND HARRINGTON RIVERS.

On Pleasant River shad have been caught to a greater or less extent during the past thirty years, and for the last ten years from 5,000 to 10,000 have been taken annually by drift nets. In 1896 there were 14 boats, worth $178, and manned by 15 men, engaged in drifting nets on this river near the town of Addison. The nets used numbered 31, with an aggregate length of 1,860 yards and value of $186, the mesh being 4¾ inches. The season extends from July 1 to September 15, and the catch of shad numbered 9,000, worth $720.

In Harrington River there were 6 men who caught shad in 1896, using 6 boats, worth $30, and 9 drift nets, 540 yards in length, with 4¾ inch mesh, worth $54. The catch approximated 3,000, most of which were salted and sold at $8 per barrel.