A STUDY OF THE MARINE RESOURCES of the WESTPORT RIVER

John D. Fiske, John R. Curley
and Robert P. Lawton

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Monograph Series
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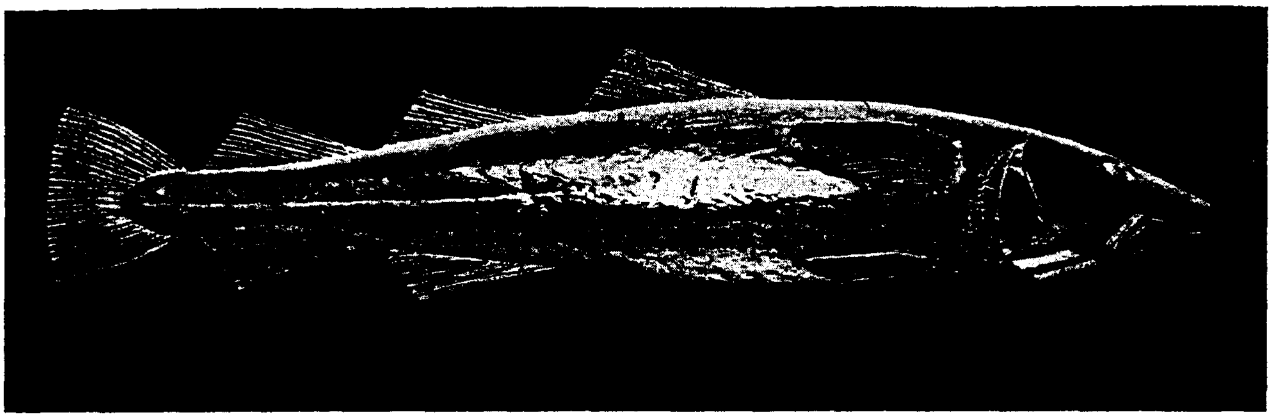
DIVISION OF MARINE FISHERIES
Department of Natural Resources
The Commonwealth of Massachusetts

THE COMMONWEALTH OF MASSACHUSETTS

Department of Natural Resources



On March 17, 1784, Mr. John Rowe, of Boston, merchant, arose from his seat in the Representatives' Hall of the Old State House, and offered a motion. "That leave might be given to hang up the representation of a Codfish in the room where the House sits, as a memorial of the importance of the Cod-Fishery to the welfare of this Commonwealth, as had been usual formerly". Leave was accordingly granted; and the same wooden emblem presented by genial Johnny Rowe, having followed the Great and General Court to Beacon Hill, still faces the Speaker's desk.

SAMUEL ELIOT MORISON

The cod is no longer, "as had been usual formerly", preeminent in the fisheries of Massachusetts. Yet this does not indicate that the fisheries have lost any of their importance in the economic life of the Commonwealth. Approximately 500 million pounds of fish, with a dock-side value of nearly 50 million dollars, are landed annually by commercial fishermen at Massachusetts ports. Boston, Gloucester, New Bedford and Provincetown each land more than one million dollars worth of fish yearly. About 85% of the total fish landed are represented by species normally fished in offshore waters; namely: haddock, whiting, ocean perch, flounder, cod, pollock, and other species which are used for reduction or animal food. Seasonally or periodically some of these species move into inshore waters and contribute to the inshore fishery. Also, millions of pounds of alewives, winter flounder (blackback), fluke, mackerel, menhaden, scup, shad, tuna and many other species are commercially harvested annually within the so-called three-mile limit. In addition to the commercial interests, each year more than two hundred and fifty thousand Massachusetts salt water sport fishermen take better than ten million pounds comprised of striped bass, winter flounder, tuna, mackerel, smelt, bluefish, fluke, pollock, cod, shad, tomcod, white perch and scup.

The Division of Marine Fisheries in the Department of Natural Resources is responsible for the management of the Commonwealth's living marine resources. These resources include such diverse forms as giant Bluefin Tuna, which may weigh one-half ton or more, to small plants called Irish Moss (a commercially marketed seaweed).

In addition to its licensing powers over most of the coastal fisheries, the Division also aids with the promotion and development of the commercial fishing industry which employs more than 8,500 fishermen whose landings are valued at about $50,000,000 annually. Tens of thousands of sports fishermen benefit from the biological investigations of the Division's marine scientists, and both commercial and sports fishermen, as well as the general public, are served by the Division's activities in the protection, through restrictive legislation, of the estuarine and coastal environment which is essential to the productivity of our renewable marine fishery resources.

The Division fulfills its responsibilities by an extensive, varied program of research, management, extension and informational services to the resource users and the interested public. To function, it employs a staff that seasonally reaches 65 or more, 27 of whom are professionally trained scientists or technicians. Additionally, through contracts, consultants and specialists are hired to assist and perform functions beyond the fisheries' oriented scope of the Division's staff.

In recent years, one of the foremost projects of the organization has been the Estuarine or Coastal Research Program. These studies are centered upon inventories of the major coastal bays and estuaries to determine their extent and the variety and value of the marine resources within each area. The effects of man's activities and impact on the catalogued resources, and their complex environment is an integral part of the program. To this time, seven comprehensive reports have been published and five others are in various degrees of completion. (These publications, called Monograph Series, are available free from the Division of Marine Fisheries, State Office Building, Boston, Mass.) The compiled results of these studies will form the basis for more effective management in future years through a better understanding of our resource components and needs.

The Division maintains a Lobster Hatchery and Research Station on Martha's Vineyard. Here, larval lobsters are reared annually from naturally hatched eggs and later released in suitable coastal waters to augment the natural supply. A further activity of the Hatchery is research into the life history of this invaluable crustacean. The laboratory and hatchery

The Commonwealth of Massachusetts

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF MARINE FISHERIES

Boston, Massachusetts
May, 1968

To the Commissioner and Board of Natural Resources:

Sirs:

We respectfully submit this report entitled "A Study of the Marine Resources of the Westport River" for your consideration. This study was conducted by biologists of the Division of Marine Fisheries operating under the Estuarine Research Account.

Respectfully submitted,

FREDERICK C. WILBOUR, JR.
Director, Division of Marine Fisheries

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A STUDY OF THE MARINE RESOURCES OF THE WESTPORT RIVER ESTUARY

INTRODUCTION

Since 1963, the Massachusetts Division of Marine Fisheries has conducted an intensive estuarine research program. The program originated under the efforts of the Marine Fisheries Advisory Commission which was formed in 1960. The Commission is composed of nine members, each of whom is an authority on one or more aspects of marine fishing activities. At the conclusion of a series of public hearings and private sessions, the Commission in December of 1960 submitted to the Governor its final report upon the status of Massachusetts' marine fisheries. The following was contained within the recommendations section of this report:

> The Commonwealth has only limited knowledge as to the physical conditions and basic productivity of its many harbors, bays, river mouths and other estuaries. As these serve as key areas of productivity for many species of marine organisms important to the commercial and recreation industries, it would appear of paramount importance to initiate this basic survey as rapidly as possible.
>
> An additional factor lending further emphasis to the need for detailed studies is the rapid rate of change evident along much of the Massachusetts coastline involving the dredging of channels, construction of hurricane barriers, and filling of tidal marshland for commercial purposes. The Commission recognizes the urgent necessity of prompt investigation before such changes become irrevocable.

In view of the above, the Commission recommended: "A Proposed Program of Marine Research in the Inshore Waters of Massachusetts."

In the spring of 1963, the Legislature passed Chapter 181 of the Acts of 1963 which provided appropriations for the prompt implementation of this program.

As of December 1967, field studies had been completed in ten of our major estuaries. Five of these area studies (Merrimack River, Quincy Bay, North River, Pleasant Bay and Beverly-Salem Harbor) have been made available to the public in documents published by the Division of Marine Fisheries. Two estuarine teams, one of which is located on the north shore and one on the south shore of Massachusetts, are responsible for conducting these studies.

The Westport River was the southernmost area in Massachusetts to be evaluated. Field Studies were initiated in the estuary during the spring of 1965 and were terminated during the spring of 1966.

PERSONNEL AND ACKNOWLEDGEMENTS

This study was conducted by the south shore estuarine team which works out of field headquarters located in Sandwich, Mass. During the greater part of the field study period, the team consisted of John D. Fiske, project leader, and assistant biologists Philip G. Coates and Clinton E. Watson. In December of 1966 Philip Coates was promoted to the position of marine biologist and assigned to flounder studies. He was replaced on the estuarine team by assistant biologist Robert P. Lawton. In the spring of 1967, John R. Curley replaced Clinton Watson who was promoted to the position of marine biologist and assigned to anadromous fish studies. During the summer of 1966, the team was assisted by student biologists Edmond Dinsmore, Michael Byron and Stephen Ezer.

The Department of Public Health has generously shared its findings relative to water quality in the Westport River as well as making its facilities at the Lawrence Experiment Station available for the chemical and bacterial analysis of water samples.

Albert Palmer, Westport shellfish officer, provided invaluable assistance in keeping record of the shellfish harvests in the Westport River during 1966. Without his assistance one of the major objectives of this study could not have been satisfied.

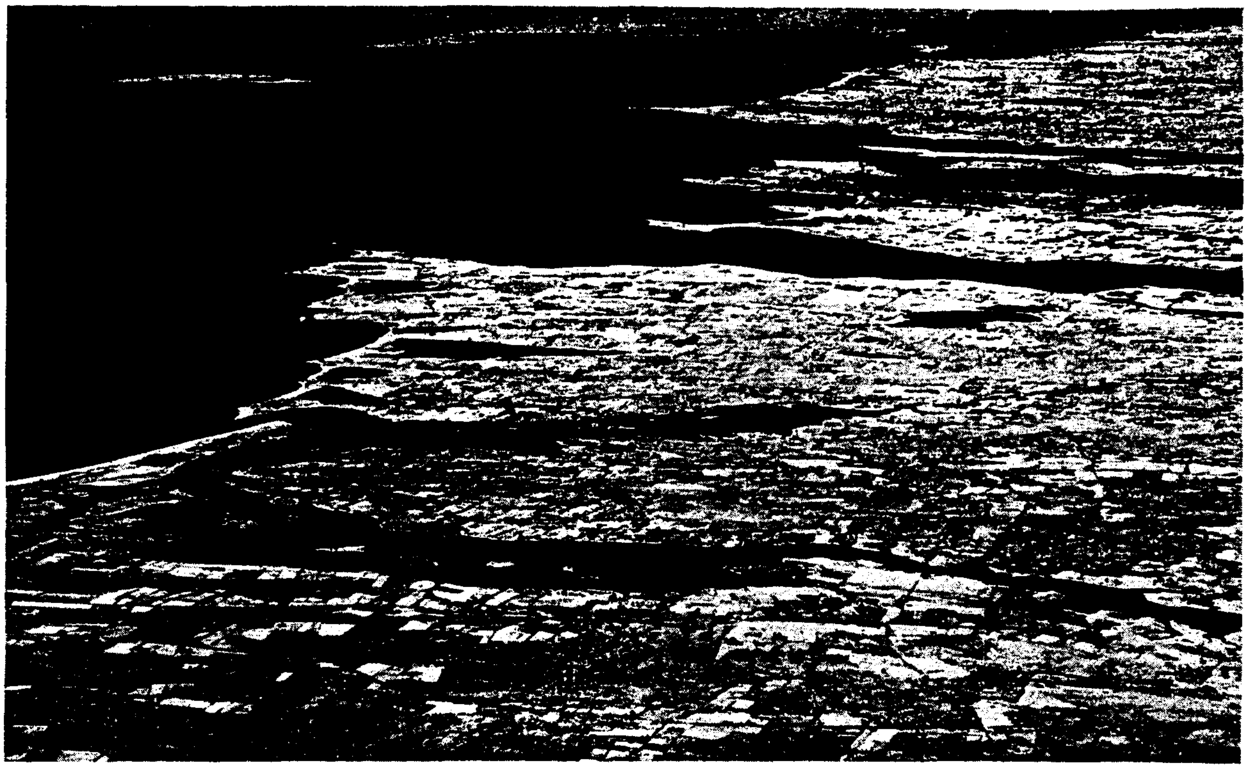
The Division of Marine Fisheries gratefully acknowledges the cooperation and assistance of the many commercial fishermen, wholesale dealers and conservation-minded citizens who facilitated the completion of this study. A special thanks to Mrs. Elizabeth A. Lees for sharing with the authors her historical knowledge of the river and its resources.

THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE WESTPORT RIVER

Methods and Materials

The Westport River estuary in Bristol County is located on the southwest corner of Massachusetts, lying within the town of Westport and adjacent to the state of Rhode Island. Horseneck Beach, consisting of dune sand and gravel, forms the southern boundary of this estuary. The uppermost limits of the resource

PLATE 2.



(*Ben Harrison*)

Aerial photograph of Westport River (foreground).

study area were set at north of Hix Bridge in the East Branch of the river and in the vicinity of Judy Island in the West Branch of the river. Most finfish sampling was limited to salt and brackish water with no sampling being conducted above the previously mentioned bounds. The lower limit of the study area was designated as the mouth of the river adjacent to Horseneck Point.

Morphometric data was obtained from United States Geological Survey topographic maps. The Westport River is contained within the Westport Quadrangle, which has a scale of 1:24,000. Linear distances were obtained with the use of a polar planimeter and the U.S.G.S. maps. A dot grid was used to compute area measurements. Methods for calculating morphometric data were taken from Welch (1948). Depth data and bottom contour profiles were obtained from the United States Coast and Geodetic Survey's hydrographic map of the Westport River.

On July 25, 1966, biologists conducted a survey of the surface and bottom waters of the river at both ebb and flood tides. The analysis of water samples from this survey was performed by the Massachusetts Department of Public Health. Information from the study is included in this report.

At each of the six finfish sampling stations and the four water chemistry stations, salinities and water temperatures were recorded using a GM wide-range hydrometer and thermometer. A Nansen water bottle was used to collect bottom water samples.

Water chemistry data was obtained by use of the Hach Portable Water Analysis kits. Model CA10 Kit was used for the determination of dissolved oxygen, carbon dioxide, and hydrogen ion concentration. The Winkler Method for determination of dissolved oxygen was checked against Model CA10 Kit's determination of same. The results of both were in agreement. Model ABS2 Kit was used for the determination of alkyl benzene sulfonate (detergent). The following monthly water chemistry stations were established: Westport Light Beach, Hix Bridge boat ramp, Half-moon Flat, and in the upper West Branch off Rivei Road.

Morphometric Data

Findings

The following data summarizes the more pertinent morphometric measurements made of the east and west branches of the Westport River:

WEST BRANCH OF RIVER

Maximum Length:

The length of the straight line which connects the two extremities of the study area:
3.62 statute miles (3.15 nautical miles)

maximum length:
Mean high water—0.53 statute miles (0.46 nautical miles)
Mean low water—0.48 statute miles (0.42 nautical miles)

Total Surface Area:

The total surface area of the study area:
Mean high water—1,237.91 acres (1.93 sq. miles)
Mean low water—1,097.60 acres (1.71 sq. miles)

Salt Marsh Area:

Acreage of salt marsh which drains into the Westport River study area:
228.00 acres (0.36 sq. miles)

Shoreline Length:

The length of shoreline enclosing the study area:
Mean high water—15.08 statute miles (13.11 nautical miles)
Mean low water—13.71 statute miles (11.92 nautical miles)

Maximum Depth:

The maximum depth known:
Mean high water—28.90 feet
Mean low water—26.00 feet

Mean Depth:

The volume of the study area divided by its surface area:
Mean high water—7.00 feet
Mean low water—4.10 feet

Volume:

The total volume of water contained within the study area:
Mean high water—283,758,000.00 cu. feet
Mean low water—133,608,000.00 cu. feet

EAST BRANCH OF RIVER

Maximum Length:

[illegible]
miles)

Total Surface Area:

Mean high water—1,986.66 acres (3.10 sq. miles)
Mean low water—1,909.49 acres (2.98 sq. miles)

Salt Marsh Area:

775.00 acres (1.21 sq. miles)

Shoreline Length:

Mean high water—36.23 statute miles (31.60 nautical miles)
Mean low water—32.94 statute miles (28.73 nautical miles)

Maximum Depth:

Mean high water—22.00 feet
Mean low water—19.00 feet

Mean Depth:

Mean high water—6.10 feet
Mean low water—3.10 feet

Volume:

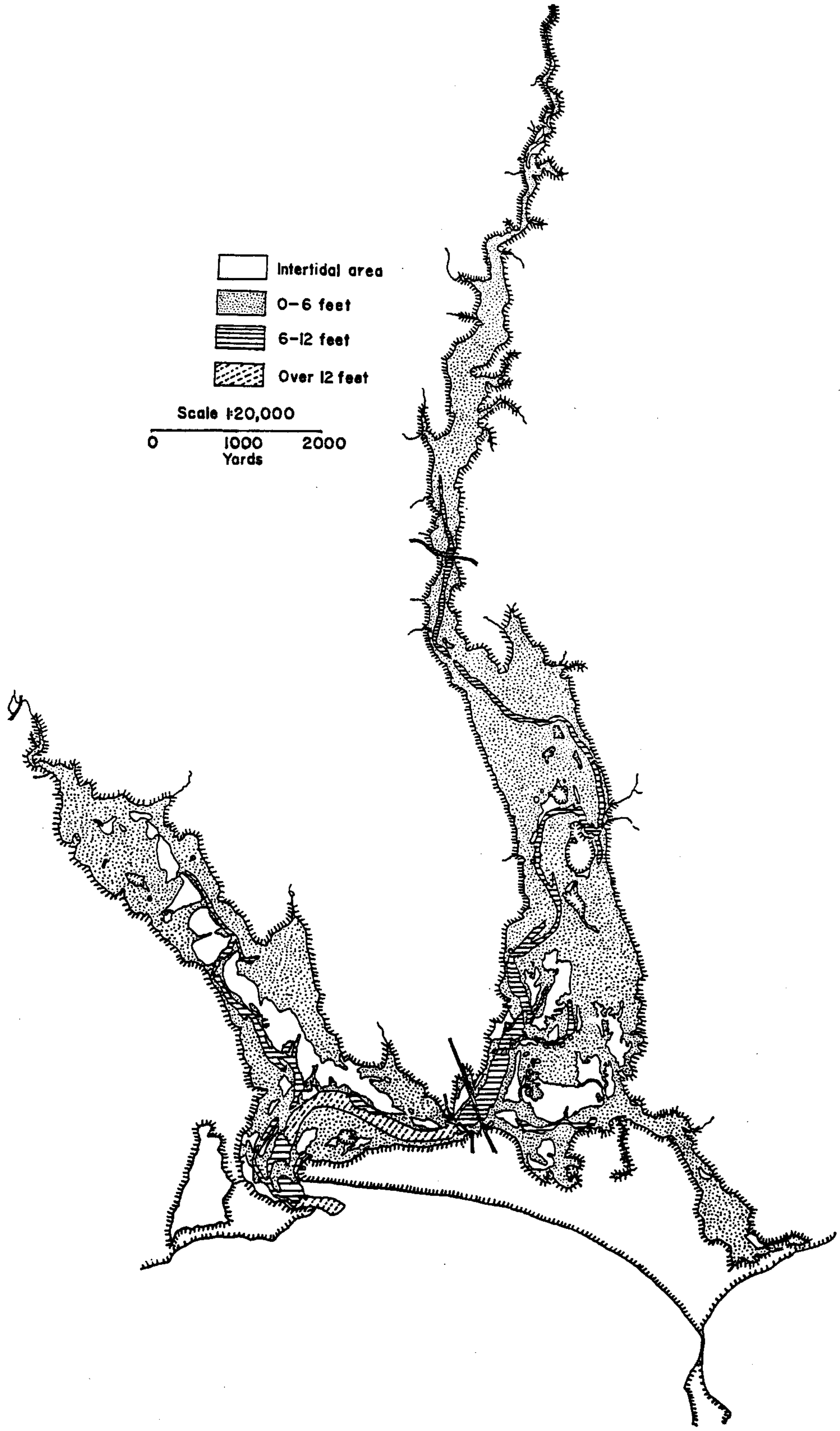
Mean high water—357,568,000.00 cu. feet
Mean low water—128,414,000.00 cu. feet

DISCUSSION

An estuary is a semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water derived from land drainage (Pritchard, 1964). Westport River is a typical estuary in that it receives considerable freshwater drainage and reflects salinity variation from its headwaters to its mouth. Geologically, the branches of the Westport River are defined as drowned river valleys. Following the glacial period of some 10,000 years ago, the sea level rose flooding the two valleys which now constitute the east and west branches of the estuary.

At mean high water, the surface area of both branches combined is 3,224.57 acres. At mean low water, there is an approximate seven percent loss in water surface area. As compared to five other estuarine areas which have been evaluated and reported upon by the Division of Marine Fisheries, the West-

Figure 1.



Outline Map of the Westport River Estuary showing depth contours.

port River is the second smallest. The following table lists the surface acreage of the six study areas at mean high tide:

Beverly-Salem Harbor	9,051 acres
Quincy Bay	7,772 acres
Pleasant Bay	7,285 acres
Merrimack River	3,957 acres
Westport River	3,225 acres
North River	533 acres

Westport River is a relatively shallow estuary. At mean low water, nearly 88% of the water area is six feet or less in depth. Less than 9% of the area exceeds 12 feet in depth at low tide. The shallowness of the river is an important factor in the primary biological production of this estuary. Shallow depths result in a rapid turnover of nutrients, a high photosynthetic rate, and a consequent rapid production of aquatic plants which are the primary producers in the estuarine system. The extensive shallow water in the river also maintains warm water temperatures during the spring-fall period. The reproduction and growth of such economic species as the quahog and scallop are benefited by an extended period of warm water.

Accelerated shoaling of the river through the years has hampered man's activity in the river. At the mouth of the river leading to Westport Harbor, sand deposits have built up to the extent that navigation has been impeded. In the mid-nineteenth century, large vessels running up into hundreds of tons and drawing eight to 12 feet of water, moved freely into Westport Point (*New Bedford Standard Times*, June 26, 1938). However since 1938, only small fishing and pleasure craft could navigate safely the river's mouth.

In 1938, the Army Corps of Engineers proposed to deepen the main channel in the river to allow large vessels to come into Westport Point. This task, which was previously attempted and failed, was not accomplished because the town's cost of the project was not appropriated. The Commonwealth of Massachusetts dredged to a 14-foot depth in 1957 and 1964 in the outer harbor through the shoal area west of Halfmile Rock and in the inner harbor west of Horseneck Point. The harbor mouth and channel dredging is still needed in order to improve the navigability of the river.

The percentage of change in water volume between high and low water in both branches of the river is 47.09% in the west branch and 35.91% in the east branch. These figures are considerably smaller than that encountered in Pleasant Bay (58.3%) and similar to that of the North River (40.7%).

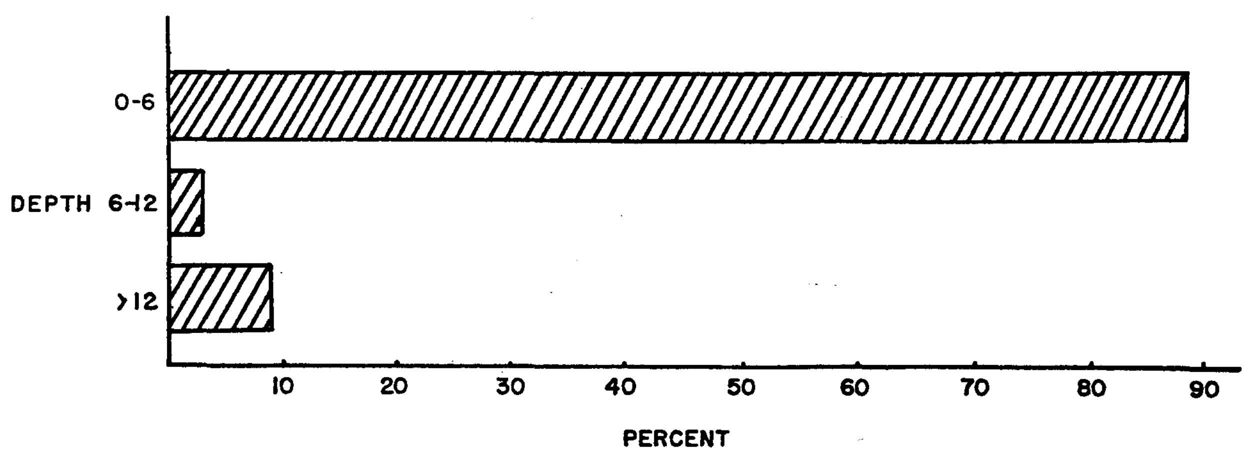
Both branches of the river are bordered by extensive marshland while the upper east branch is edged by agricultural land. The total salt marsh acreage within the study area was 1,003 acres. The following table lists the salt marsh acreage of the six study areas:

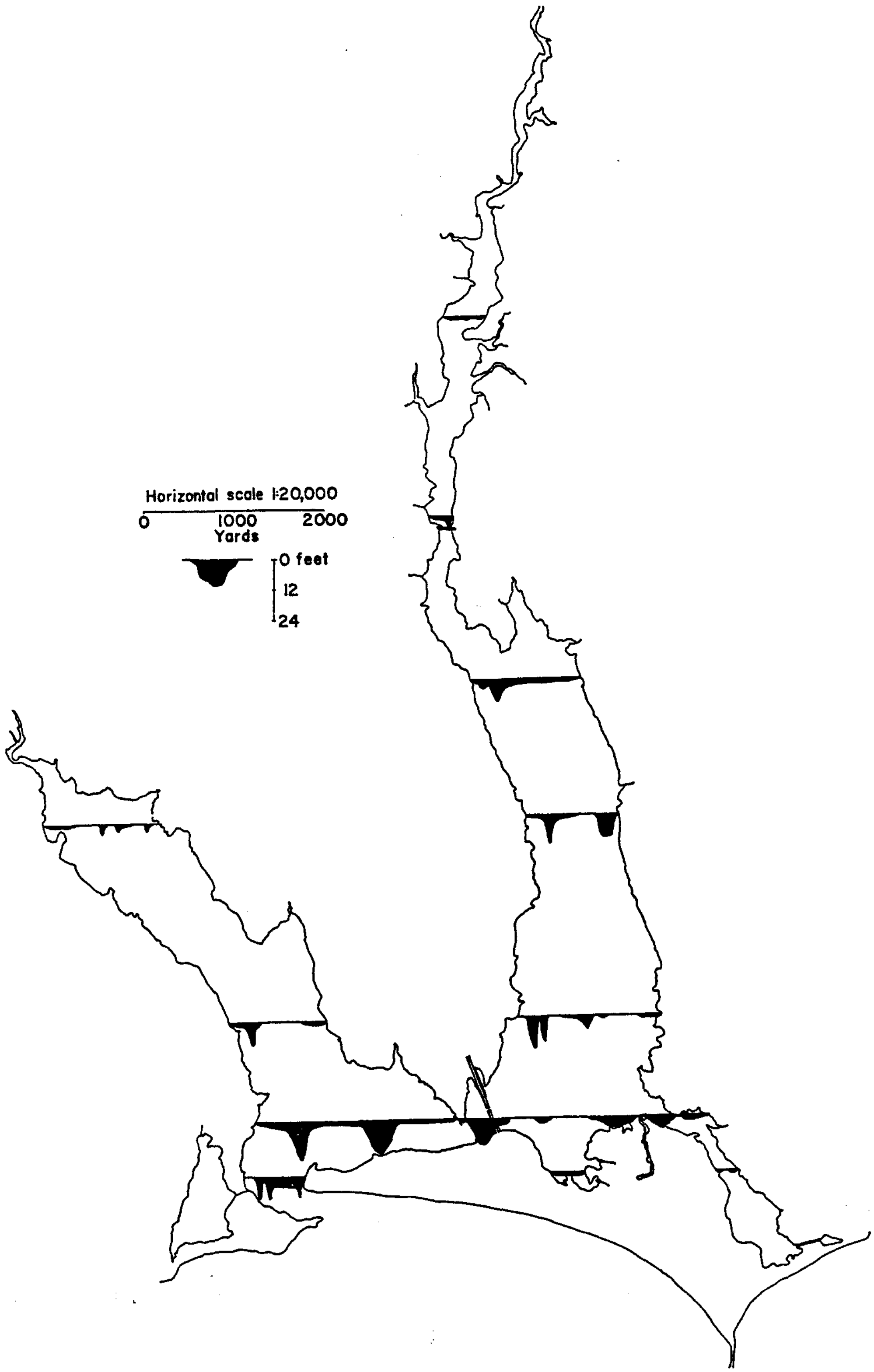
Merrimack River	4,208 acres
North River	1,540 acres
Pleasant Bay	1,203 acres
Westport River	1,003 acres
Quincy Bay	209 acres
Beverly-Salem Harbor	182 acres

The importance of the salt marsh areas of the river and their present protective status is discussed in a later section of this report.

FIGURE 2.

PERCENT OF AREA IN EACH 6-FOOT DEPTH CONTOUR (AT MEAN LOW WATER), WESTPORT RIVER (BOTH BRANCHES)





Profiles showing cross sectional outline.

Temperature

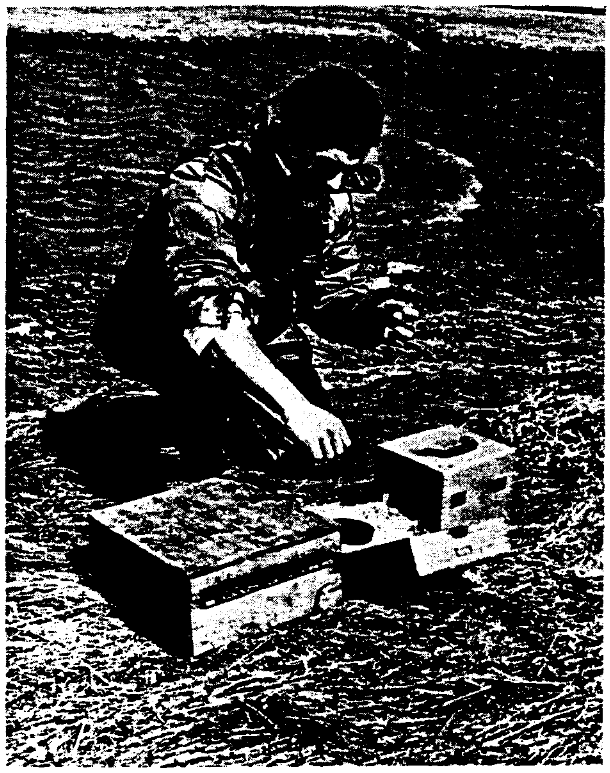
Temperature readings were recorded each month at the six finfish sampling stations and at the four water chemistry stations (Tables 1 and 2). The temperatures recorded at each finfish station are given in Table 2. The temperatures recorded at the three stations in the east branch exhibit a greater range than those in the west branch; this difference is primarily due to the higher maximum temperature readings recorded at the east branch stations. The lower readings in the west branch may be due to the greater influence of ocean water within that branch. The high reading of 83.3°F taken at Halfmoon Flat may be explained by the shallow nature of this station and its location within the marsh away from the direct influence of the river current.

The surface water temperatures recorded at the four water chemistry stations, listed in Table 1, indicate that the maximum temperatures occurred in July and August and the minimum temperatures occurred in February. The station at Westport Light Beach exhibited the narrowest temperature range over the year (31 degrees) due to the stabilizing influence of the adjacent ocean waters. The upper west branch station which had the least tidal influence exhibited the greatest range in temperature (45 degrees).

On July 25, 1966 water chemistry data was collected at both high and low tide from stations along the length of each branch of the river. A day was selected when the tidal rise and fall would coincide with the mean tidal range (3 feet) of the Westport River. The results of this work are presented in Table 3. The temperature data is shown graphically in Figure 4. This graph indicates that in the upper end of both branches of the estuary the temperature was warmest on the high tide and in the lower estuary the temperature was warmest on the outgoing low tide. The graph also indicates tnat on this day in the west branch at a point between 2.3 and 3.7 miles from the mouth and the east branch at a point between 2.8 and 5.7 miles from the mouth, the water temperature did not fluctuate greatly with the changing tide. The water in the lower estuary is coldest on the high tide due to the influx of the cold ocean water. At the same time the incoming tidal water pushes the warmer river water into the upper estuary raising the water temperature in this area on the high tide. On the low tide the temperature in this section of the estuary is low due to the influence of cold freshwater runoff.

It can also be seen from the data present in Table 3 that there does not seem to be any strong vertical

PLATE 3.



Water chemistry analysis at Halfmoon Flat, Westport.

temperature stratification within the estuary. At all the stations sampled the difference between surface and bottom temperatures on both the high and low tide was not greater than one degree. This suggests that the water is well mixed throughout the estuary.

Listed below are the temperature ranges encountered over a one-year period in six estuarine areas evaluated by the Division of Marine Fisheries.

Westport River	32°–83.3°F
Merrimack River	32°–75°F
Beverly-Salem Harbor	29°–72°F
Quincy Bay	32°–70°F
North River	31°–77°F
Pleasant Bay	29°–78°F

Salinity

The salinity of estuarine waters is an important limiting factor to the number of fish species which will be found in the estuary. Only those species (euryhaline) that are able to adjust to great and frequent fluctuations in the salt concentration are capable of living in the estuary. In the Westport River salinity readings were taken once a month at six finfish sampling stations and again at the four water

Table 1. Water Analysis Data Collected at Westport Light Beach, Westport, 1966.

Date	pH	Dissolved Oxygen (ppm)	Detergent (ppm)	Water Temperature (°F.)	Salinity 0/00	Tidal Stage
6/22/66	8.0	8.0	0.0	64.0	28.0	Low +5 hrs.
~~7/25/66~~	8.0	5.8	0.0	72.0	29.5	Low
8/ 9/66	8.0	8.0	0.1	70.0	29.5	Low +1
9/27/66	8.0	9.0	0.0	60.0	30.0	Low −1½
10/18/66	8.0	8.5	0.1	58.0	32.0	High
11/29/66	8.0	9.0	0.1	50.0	31.5	High +2
12/13/66	8.0	9.0	0.1	43.0	33.0	High +2
1/10/67	8.0	10.0	0.1	38.0	32.0	Low
2/16/67	8.0	11.0	0.1	38.0	30.0	High −1
3/10/67	8.0	10.0	0.1	41.0	23.0	Low −1
4/14/67	8.0	11.0	0.2	42.0	32.0	High +1

Water Analysis Data Collected at the Upper West Branch, Westport, 1966.

Date	pH	Dissolved Oxygen (ppm)	Detergent (ppm)	Water Temperature (°F.)	Salinity 0/00	Tidal Stage
6/22/66	8.0	10.0	0.1	74.0	15.0	Low +4 hrs.
~~7/25/66~~	8.4	5.5	0.0	80.0	25.5	Low
8/ 9/66	8.0	6.0	0.0	75.0	25.0	Low +1½
9/27/66	8.0	10.0	0.1	62.0	18.0	Low −2
10/18/66	8.0	9.0	0.15	51.0	28.0	High −1
11/29/66	7.8	9.0	0.15	50.0	9.0	High +1½
12/13/66	7.0	10.0	0.1	38.0	12.0	High +3
1/10/67	6.5	13.0	0.1	35.0	5.0	Low
2/16/67	6.0	13.0	0.2	34.0	0.0	High −1½
3/10/67	6.0	11.0	0.2	42.0	0.1	Low
4/14/67	7.0	11.0	0.2	52.0	5.0	High +1½

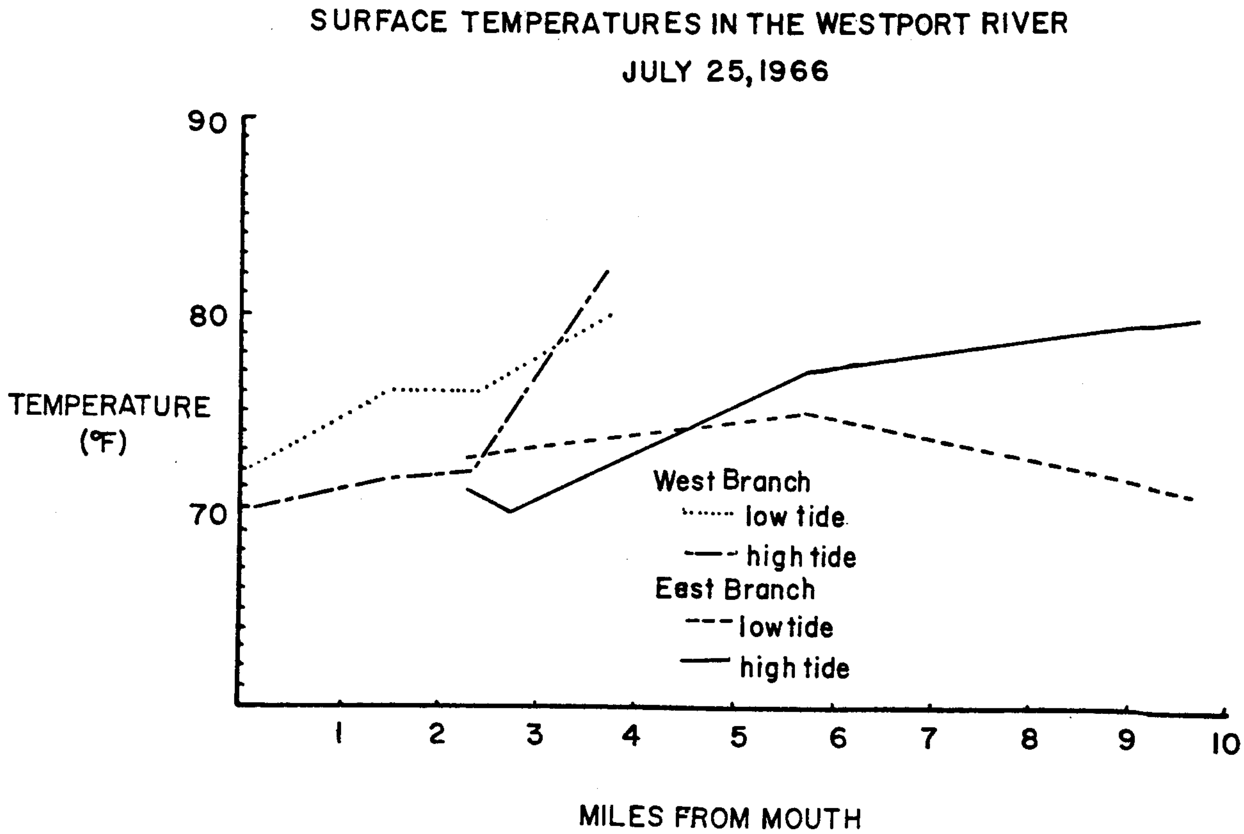
Water Analysis Data Collected at Halfmoon Flat, Westport, 1966.

Date	pH	Dissolved Oxygen (ppm)	Detergent (ppm)	Water Temperature (°F.)	Salinity 0/00	Tidal Stage
6/22/66	8.0	12.0	0.1	74.0	24.0	Low +1 hr.
~~7/25/66~~	—	—	—	—	—	—
8/ 9/66	8.0	10.0	0.1	76.0	27.0	Low +3
9/27/66	8.0	8.0	0.0	60.0	29.0	Low
10/18/66	8.0	10.5	0.15	54.0	31.0	High +1
11/29/66	8.0	9.0	0.0	50.0	30.0	High +3
12/13/66	8.0	8.0	0.1	37.0	30.0	Low
1/10/67	8.0	6.0	0.1	38.0	31.0	Low
2/16/67	8.0	12.0	0.2	34.0	26.0	High
3/10/67	8.0	13.0	0.2	48.0	27.0	Low
4/14/67	8.0	11.0	0.1	49.0	27.0	High +3

Water Analysis Data Collected at Hix Bridge, Westport, 1966.

Date	pH	Dissolved Oxygen (ppm)	Detergent (ppm)	Water Temperature (°F.)	Salinity 0/00	Tidal Stage
6/22/66	8.0	10.0	0.2	74.0	19.0	Low +3 hrs.
~~7/25/66~~	8.4	6.2	0.1	75.0	25.5	Low
8/ 9/66	8.0	6.0	0.1	75.0	27.0	Low +2
9/27/66	8.0	8.0	0.0	59.0	26.0	Low −1
10/18/66	8.0	9.5	0.1	53.0	29.5	High +1½
11/29/66	—	9.0	0.0	49.0	24.0	High +2½
12/13/66	8.0	11.0	0.1	39.0	20.0	Low
1/10/67	7.5	12.0	0.2	37.0	21.5	Low
2/16/67	8.0	13.0	0.0	34.0	18.0	High
3/10/67	6.0	12.0	0.2	39.0	2.0	High +6
4/14/67	8.0	12.0	0.2	48.0	15.0	High +4

FIGURE 4.



chemistry stations. The over-all salinity range for the river was from 0.0 0/00 in the upper estuary to 33.0 0/00 near the mouth. The maximum and minimum salinity readings recorded at each finfish sampling station are presented in Table 2. It can be seen from these figures that there is a fluctuation in salinities at each station, the least range occurring at the Westport River mouth which is under the greatest influence of the open ocean. The salinity data collected at the water chemistry stations is presented in Table 1. It can be seen from this data that the salinities were generally lower during the late winter and early spring. The low reading of 0.0 0/00 in the upper west branch in February was due to the melting ice that was present at that time. The other low salinity readings during this time of the year may be attributed to thawing conditions and increased freshwater runoff. During the summer months the salinities in the upper west branch, and in the other stations as well, were relatively high due to the reduction in freshwater run-off during that time of the year.

On July 25, 1966 the salinity was recorded at both

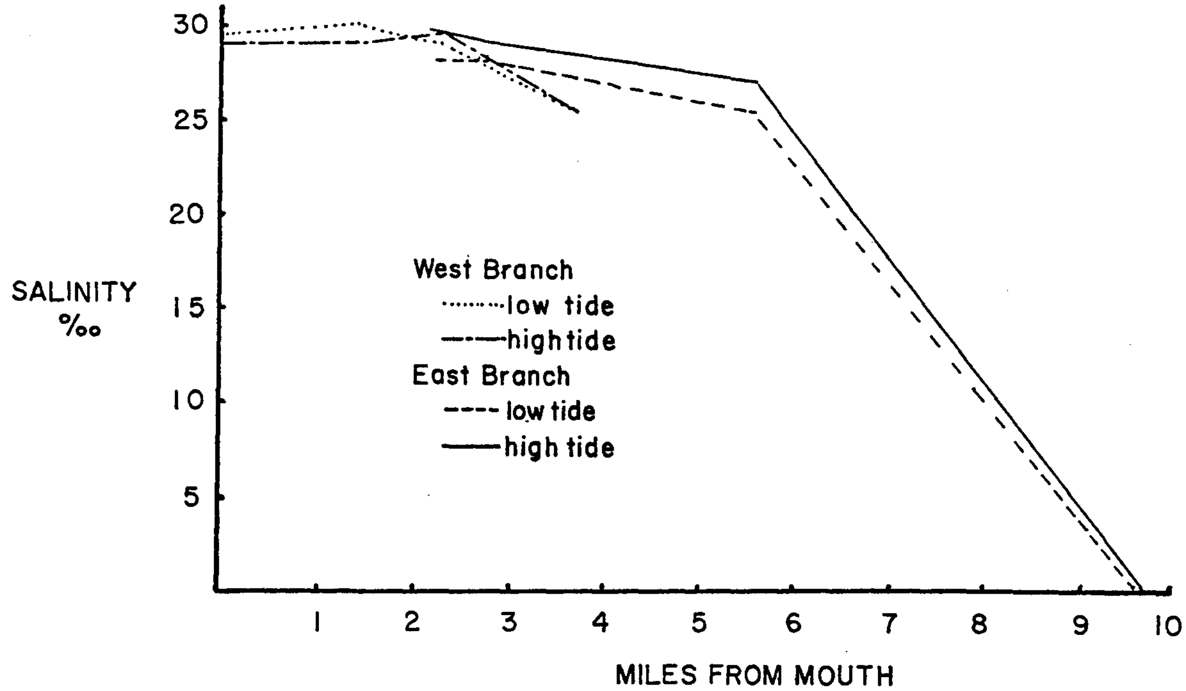
Table 2. Surface Temperatures and Salinities Recorded at the Six Finfish Sampling Stations in the Westport River.

		May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April
Westport River Mouth	F°	55.0	64.4	67.6	—	69.0	58.0	49.0	41.0	—	38.0	36.0	42.0
	0/00	31.0	30.0	29.0	29.5	29.0	31.0	28.0	31.0	—	30.0	27.0	32.0
Westport Harbor	F°	—	62.6	68.0	70.0	67.0	59.0	50.5	48.0	35.0	—	36.0	43.0
	0/00	—	26.0	30.5	29.3	30.5	31.0	28.0	33.0	29.5	—	20.0	26.0
Judy Island	F°	48.0	64.9	73.0	73.0	71.0	56.0	51.0	45.5	36.0	—	36.0	44.0
	0/00	30.0	24.5	29.0	28.5	30.0	30.0	29.0	31.0	29.0	—	12.0	24.0
Halfmoon Flat	F°	65.0	75.2	83.3	72.0	73.0	67.0	50.0	32.8	41.0	—	22.5	—
	0/00	25.5	24.0	23.0	29.0	24.0	28.0	28.5	30.0	29.5	—	—	—
Great Island	F°	—	65.7	78.3	—	60.0	—	50.0	45.0	37.0	—	36.0	—
	0/00	—	22.2	25.6	29.5	28.0	31.0	31.0	33.0	32.0	—	10.0	—
Hix Bridge	F°	—	72.5	73.6	76.5	72.0	61.0	41.0	32.3	—	—	43.0	—
	0/00	—	23.0	26.0	26.0	26.0	14.0	13.0	19.0	—	—	15.0	—

FIGURE 5.

SURFACE SALINITIES IN THE WESTPORT RIVER

JULY 25, 1966



tidal stages on the entire length of both branches of the estuary. This data is presented in Table 3. The data indicates that there is no appreciable vertical salinity stratification within this estuary at this time of the year. There was no more than a 1.0 0/00 difference in surface and bottom salinity readings at any of the stations on either the high or the low tide. The surface salinity also appears to remain quite stable through the tidal changes. The difference in surface salinities at high and low tide at each station was no greater than 1.5 0/00. The gradient of surface salinities from the river mouth to the head of the west branch was 29.5 0/00 to 25.5 0/00 on the high tide and 29.0 0/00 to 25.5 0/00 on the low tide. In the early spring, as mentioned above, the gradient would probably be greater due to a lower salinity near the headwater due to spring thaw and increased fresh-water runoff. The gradient of surface salinities in the east branch was from 29.5 0/00 at station #5 to 0.0 0/00 at station #8 on the high tide. On the low tide the range was from 28.0 0/00 to 0.0 0/00. Station #8 was about 9.5 miles from the river mouth and was beyond the range of tidal influence.

Water Quality

Pollution of our coastal waters is one of the greatest menaces confronting marine resources and their utilization. In Massachusetts, approximately 25% of the coastal shoreline has already been closed to the harvesting of shellfish because of the careless discharge of domestic sewage and industrial wastes. The devastating effect that such pollution can have upon the utilization of marine resources is documented in two estuarine studies conducted on the north shore of Massachusetts.

Inventories of soft-shell clam populations in the Merrimack River (Jerome, *et al*, 1965) and Quincy Bay (Jerome, *et al*, 1966) in 1964 showed that a potential harvest of 40,000 bushels of clams valued at $400,000 could not be utilized from these areas because of domestic sewage pollution. Due to pollution, none of the shellfish-producing beds in the Beverly-Salem area are open to unrestricted digging (Jerome, *et al*, 1967).

Pollution and its destructive aspects have been most profound on the north shore of Massachusetts, paralleling intensive shoreline settlement of man and his industries. However, eight towns in Bristol County have certain waters designated as polluted and have been closed to shellfishing. Fortunately, Westport waters are still considered to be free from pollution.

Coliform bacteria counts provide public health workers with criteria for determining various water uses. This method is widely used in determining the safe utilization of shellfish such as the quahog and soft-shell clam. Under the standards established by the Cooperative Interstate Shellfish Program, the following designations regarding shellfish areas have been made:

Degree of Contamination of Overlying Water
(*Coliform Bacteria Content*)

0–70/100 ml	clean
71–700/100 ml	moderately contaminated
over 700/100 ml	grossly contaminated

On July 25, 1966, biologists collected numerous water samples throughout the Westport River estuary. Each sample was examined for the presence of coliform bacteria at the Lawrence Laboratory by workers of the Massachusetts Department of Public Health. The findings of this survey are listed in Table 3. Of the 26 water samples examined for the presence of coliform bacteria, 24 were found to be relatively clean and two suggested gross contamination. The two contaminated water samples were taken at station #8 which is located at the head of Westport. Samples taken in this area in 1962, 1964 and 1965 by the Massachusetts Department of Public Health were also indicative of gross contamination. Among the noted potential sources of pollution were drainage from an amusement park and from cesspools constructed in close proximity to tidal waters.

It should be noted that intermittent high coliform bacteria counts are commonly encountered in water which is generally believed to be free of pollution. High counts may be attributable to either multiplication of bacteria within the sample from the time of collection to the time of analysis, or to localized concentration in the water of organic substances. The classifying of water use on the basis of coliform bacteria is finally accomplished only when relatively consistent results are obtained from a substantial number of samples. However, when known constant sources of pollution exist, the area is automatically designated as polluted. The survey conducted on July 25 was an inventory of conditions existing throughout the estuary. At each of the eight sampling stations water samples were collected and later analyzed for: dissolved oxygen, pH, detergent (ABS), water temperature, salinity, nitrate, phosphate, and pesticide concentrations (Table 3).

The dissolved oxygen concentrations at the monthly water chemistry stations are recorded in Table 1. It can be seen from the table that the concentrations were highest during the winter months. This phenomena was expected because of the greater solubility of oxygen in cold water. At no time in the year did the oxygen concentration at any of the monthly sampling stations fall below 5.5 ppm.

The analysis of pH (hydrogen ion concentration) describes the relative acidity or alkalinity of water. The chemical analysis of the entire length of the estuary on July 25 revealed a pH range on the high tide from 8.1 at the river mouth to 8.7 in the upper west branch and 7.0 in the upper east branch; the latter was in fresh water. None of the pH readings were below 7.0. In fact, all but two of the readings were above 8.0, indicative of a slightly alkaline condition which is normal for sea water. This corresponds to the generally high salinity levels which are maintained throughout the estuary.

The pH values recorded at the four monthly water chemistry stations are presented in Table 1. The two stations in the lower estuary, Westport Light Beach and Halfmoon Flat had uniform pH values of 8.0 for each month of the year. These readings could be expected because of the proximity of these stations to the ocean water. The upper west branch station exhibited low pH values (6.0) during the winter and spring indicating the influx of the more acidic fresh-water runoff into the estuary at those times of the year. The pH values from Hix Bridge were also low in the early spring due to fresh-water influence. All of the pH values encountered in the Westport River were within a range that is suitable for fish life. Recorded levels of ABS (alkyl benzene sulfonate) were negligible and did not indicate any significant detergent pollution.

Although no pesticides were found to be present in any of the water samples analyzed on July 25, 1966, a further monitoring of the river for pesticides is recommended. Because of a lack of analysis equipment and facilities, extensive pesticide monitoring of the river was not conducted.

Table 3. Summary of Westport River Water Chemistry, July 25, 1966 (Analysis by the Department of Public Health).

Station	Approximate Location	Tide	Depth (ft.)		Water Temperature (°F.)	Salinity 0/00	Dissolved Oxygen (ppm)	Coliform Bacteria (MPN/100 ml)	Nitrate N	Chlorides (mg/L)	Phosphate Total Ortho	Detergent (ppm)	Pesticide	pH
1	Mouth of River	ebb	1.25	surface	72.0	29.5	5.8	<10	0.0	16,500	0.2	0.0	—	8.2
	" " "	ebb	10.00	bottom	73.0	30.0	7.7	<10	0.0	17,000	0.1	0.0	—	8.4
	" " "	flood	1.25	surface	70.0	29.0	8.3	—	—	—	—	0.0	—	8.1
	" " "	flood	10.00	bottom	70.0	28.0	8.2	<10	0.0	16,000	0.3	0.0	—	8.2
2	Sanford Flat	ebb	1.25	surface	76.0	30.0	6.6	<10	0.0	17,000	0.1	0.0	—	8.5
	" "	ebb	15.00	bottom	75.0	29.0	6.4	<10	0.0	16,500	0.1	0.0	—	8.3
	" "	flood	1.25	surface	71.5	29.0	8.5	<10	0.0	16,000	0.1	0.0	—	8.2
	" "	flood	15.00	bottom	71.0	29.5	7.6	<10	0.0	16,000	0.1	0.0	—	8.3
3	West of Judy Island	ebb	1.25	surface	76.0	29.0	7.8	<10	0.0	16,500	0.1	0.0	—	8.5
	" " " "	ebb	—	bottom	75.0	29.0	7.6	<10	0.0	17,000	0.1	0.0	—	8.5
	" " " "	flood	1.25	surface	72.0	29.5	8.6	<10	0.0	16,000	0.1	0.0	—	8.3
	" " " "	flood	—	bottom	72.0	30.5	8.4	<10	0.0	17,000	0.1	0.0	—	8.3
4	Upper West Branch off River Road	ebb	1.25	surface	80.0	25.5	5.5	10	0.0	16,000	0.2	0.0	.000	8.4
	" " " " " "	ebb	4.00	bottom	No Sample Taken			—	—	—	—	—	—	—
	" " " " " "	flood	1.25	surface	82.0	25.5	—	—	0.0	16,000	0.1	0.0	.000	8.7
	" " " " " "	flood	4.00	bottom	No Sample Taken			—	—	—	—	—	—	—
5	Halfmoon Flat	ebb	1.25	surface	72.5	28.0	6.4	<10	0.0	17,000	0.2	0.0	—	8.4
	" "	ebb	5.50	bottom	72.8	28.0	7.0	<10	0.0	17,000	0.1	0.0	—	8.5
	" "	flood	1.25	surface	71.0	29.5	8.4	<10	0.0	17,000	0.1	0.0	—	8.4
	" "	flood	5.50	bottom	71.0	30.0	8.4	<10	0.0	17,000	0.2	0.0	—	8.3
6	Southwest of Gunning Island	ebb	1.25	surface	73.0	28.0	7.2	<10	0.0	16,000	0.1	0.0	—	8.4
	" " " "	ebb	15.00	bottom	73.5	28.0	7.9	<10	0.0	16,500	0.1	0.0	—	8.5
	" " " "	flood	1.25	surface	70.0	29.0	8.2	<10	0.0	17,000	0.1	0.0	—	8.3
	" " " "	flood	15.00	bottom	70.0	29.0	8.1	<10	0.0	17,000	0.1	0.0	—	8.2
7	Hix Bridge	ebb	1.25	surface	75.0	25.5	6.2	10	0.0	15,000	0.1	0.0	.000	8.4
	" "	ebb	9.00	bottom	74.0	25.0	6.0	<10	0.0	14,000	0.1	0.0	.000	8.4
	" "	flood	1.25	surface	77.0	27.0	9.7	<10	0.0	17,000	0.1	0.0	.000	8.6
	" "	flood	9.00	bottom	77.0	27.0	9.3	<10	0.0	17,000	0.1	0.0	.000	8.7
8	Head of Westport	ebb	1.25	surface	71.0	0.0	7.4	5100	0.0	280	0.2	0.0	.000	7.0
	" " "	ebb	2.50	bottom	No Sample Taken			—	—	—	—	—	—	—
	" " "	flood	1.25	surface	80.0	0.0	7.3	1500	0.0	300	0.1	0.0	.000	7.0
	" " "	flood	2.50	bottom	No Sample Taken			—	—	—	—	—	—	—

FINFISH

Objectives

In view of the increasing recreational and commercial importance of the marine finfisheries of Massachusetts, an examination of this resource in the Westport River is included in this report. The major objectives of this study were: to determine the number and relative abundance of the finfish species occurring in the estuary; to evaluate the extent and value of the commercial and recreational fisheries of the area; to assess the status of the existing anadromous fishways within the river system with regard to limitations and possible improvements, and to evaluate the finfish resource with regard to proper conservation and utilization to insure its availability to future generations.

In order to evaluate the finfish stocks six sampling stations were established within the estuary (Figure 7) and sampled on a monthly basis. A total of 39 finfish species were collected from the estuary and the classification of these species is presented in Table 4.

Historical Background

The branches of the Westport River flow to the sea from the head of Westport, Massachusetts on the east and Adamsville, Rhode Island on the west. It has been recorded that Bartholomew Gosnold explored its shores in 1602 and that prior to that the Wampanoag and Seaconnet Indians of the area utilized the fish and wildlife resources that abounded in the river and its adjacent woodlands. Kirby, in her unpublished manuscript, *History of Westport*, reported: "The Wampanoags, whose headquarters were at Mount Hope, had villages in the northern part of Westport. The Seaconnets, who had headquarters at Little Compton, had a village in the southern part of the town."

According to Hall and Sowle (1914): "Here and there in this district interesting traces of these Indians can be found. Even after these many years the plow often turns up an arrow head. On the point of land west of the village, known as Cape Bial, there is a pile of shells which tradition says are the relics of Indian clambakes, and all along the lower or Drift Road are traces of the Indian settlement. There is an Indian burial ground not far up the Drift Road. The original name of Westport Point was Paquachock, and the beach known as Horseneck Beach is evidently a corruption of the Indian word 'Hassanegk.' This word means 'a house made of stone.' In a field near the let where the sea very long ago had its entrance, there is an old stone cellar. There seems little doubt the cellar has given the beach its name."

Late in the seventeenth century the early white settlers caught an abundance of furbearing animals from the woods and made large catches of fish from both the east and west branches of the river. In 1787 a small village was built at Westport Point which separates the east and west branches of the river. At this time the whaling industry, which was later to make this village a large and prosperous one, was in its infant stage. There were, however, boats which sailed out from this port to catch cod in the surrounding waters. The catches of cod were salted and put to dry on racks, later to be traded for other merchandise. Near the shore was a salt works where the windmills pumped the water from the river into huge vats which were exposed to the sun. The coarse salt which remained after evaporation was used in curing the fish (Kirby, *op. cit.*).

After 1787, shipyards were built at the Head and at the Point in Westport. In the shipyards, whaling vessels were built and the town grew because of the prosperous whaling industry. A large fleet of from 20 to 30 whaling vessels sailed from this port. Many settlers of Westport then turned from cod fishing to the pursuit of whales. (Hall and Sowle, *op. cit.*)

As early as 1806 there were records of whaling voyages, while the period between 1835 to 1857 chronicled the golden age of whaling voyages. The oldest of a prosperous fleet of sloops was the *Union* with Thomas Case as Master, which sailed from the Point in 1775. Hall and Sowle (*op. cit.*) reported: "In May, 1836, two ships which had finished loading at Westport Harbor, discovered whales, a cow and a calf of the humpback species, just outside the breakers near the Horseneck. Alfred Davis notified the people on the point. Captains Thomas Mayhew and Edward Sowle, with others, went out in three boats and towed the whales into the Point wharf. While they were killing them, the calf whale stove one boat and the crew were nearly drowned. The oil was sold in shares. The price of sperm oil at this time was $2.60 to $2.70 per gallon. The average price in 1859 for sperm oil was $1.36¼, and whale oil sold for $0.48½. When kerosene came into use, the price of sperm oil fell to $1.28 per gallon and whaling began to decline."

The last whaling voyage was made by the bark *Mattapoisset* on June 10, 1873 under command of Captain Orlando Tripp. (*New Bedford Standard Times*, June 26, 1938).

Methods and Materials

Six finfish sampling stations were established in the Westport River. Two of these stations were sampled with a 60-foot haul seine which was four feet deep and had a mesh size of ⅛ inch; one was sampled with a 360-foot 1-inch mesh haul seine and three were sampled with a 30-foot shrimp trawl. The trawl had a 25-foot headrope and a 30-foot footrope. The 10-foot cod end contained a ⅜-inch mesh liner. The trawl doors measured 15 by 32 inches. Each site was sampled once a month during the study period. Westport Light Beach and Half Moon Flat stations were sampled with a 60-foot beach seine. At the former station the seine was hauled parallel to the shore for a distance of 30 feet. At the latter station the seine was placed across the inlet mouth and hauled 50 feet to the end of the inlet. The 360-foot haul seine was used for sampling at the Hix Bridge station. The seine was flaked from the stern of a row boat, set in a semi-circular pattern and pulled onto shore by four men.

Inside Westport Harbor, Great Island and Judy Island, stations were sampled by means of the 30-foot shrimp trawl. Each tow was made for a distance of approximately 600 feet. All samples were placed in 10% formalin solutions and returned to the laboratory for examination. In the laboratory species were identified and numerical counts and total lengths were recorded. Fish were classified according to the American Fisheries Society's Special Publication No. 2, *A List of Common and Scientific Names of Fishes from the United States and Canada* (1960). Surface temperature and salinity were noted at each location at the time of sampling.

Findings

STATION #1. WESTPORT RIVER MOUTH (Beach Seine)

This station, located near the mouth of the estuary, was sampled monthly with a 60-foot beach seine. The sampling site is characterized by a course sand bottom which slopes rapidly into the river channel.

Sampling was conducted at this station in all 12 months of the study period. A total of 19 species were captured. The relative abundance of these species is given in Table 5. The largest number of species captured in any one month was seven which were taken in October. Due to the shallow inshore nature of this station most of the fish taken consisted of small forage fish which abound in such habitat. The Atlantic silverside was the most abundant species, making up 78% of the total finfish captured; these fish ranged in size from 35 mm to 147 mm total length. The next most abundant species, the American sand lance (58 mm–155 mm) was represented in the catch in the greatest numbers during the spring and fall months. This station accounted for 83% of all the sand lances caught during the study. Only three winter flounder were taken here, one each during the months of October, November and December; the size range was from 110 mm to 168 mm. Two anadromous fish species were sampled; nine juvenile alewives (61 mm–76 mm) were taken in October and one juvenile blueback herring (50 mm) was taken in August. The blueback herring was the only representative of that species to be taken during the study. One Atlantic herring was also captured. This individual was taken in May and was 80 mm in total length.

The most abundant invertebrate species taken with the finfish samples was the shrimp, *Crangon septemspinosus*. Other invertebrates included in the samples were the isopod, *Idotea baltica* and amphipods, *Gammarus spp.*

Table 4. Classification of Fish Species Taken or Reported from the Westport River, 1966/1967.

Class: CHONDRICHTHYES
- Order: Rajiformes (Batoidei)
  - Family: Rajidae
    - *Raja ocellata* (Mitchill) — winter skate

Class: OSTEICHTHYES
- Order: Clupeiformes (Isopondyli)
  - Family: Clupeidae
    - *Alosa pseudoharengus* (Wilson) — alewife
    - *Alosa aestivalis* (Wilson) — blueback herring
    - *Clupea h. harengus* (Linnaeus) — Atlantic herring
  - Family: Engraulidae
    - *Anchoa hepsetus* (Linnaeus) — striped anchovy
  - Family: Osmeridae
    - *Osmerus mordax* (Mitchill) — American smelt
- Order: Myctophiformes (Iniomi)
  - Family: Synodontidae
    - *Synodus foetens* (Linnaeus) — inshore lizardfish
- Order: Anguilliformes (Apodes)
  - Family: Anguillidae
    - *Anguilla rostrata* (LeSeur) — American eel
- Order: Beloniformes (Synentognathi)
  - Family: Belonidae
    - *Strongylura marina* (Walbaum) — Atlantic needlefish
- Order: Cyprinodontiformes (Microcyprini)
  - Family: Cyprinodontidae
    - *Fundulus heteroclitus* (Linnaeus) — mummichog
    - *Fundulus majalis* (Walbaum) — striped killifish
    - *Cyprinodon variegatus* (Lacepede) — sheepshead minnow
- Order: Gadiformes (Anacanthini)
  - Family: Gadidae
    - *Microgadus tomcod* (Walbaum) — Atlantic tomcod
    - *Pollachius virens* (Linnaeus) — pollock
    - *Urophycis tenuis* (Mitchill) — white hake

Order: Gasterosteiformes
Family: Gasterosteidae
Apeltes quadracus (Mitchill) — fourspine stickleback
Gasterosteus aculeatus (Linnaeus) — threespine stickleback
Pungitius pungitius (Linnaeus) — ninespine stickleback
Family: Syngnathidae
Syngnathus fuscus (Storer) — northern pipefish

Order: Perciformes (Percomorphi; Acanthopterygii)
Family: Serranidae
Roccus saxatilis (Walbaum) — striped bass
Roccus americanus (Gmelin) — white perch
Family: Carangidae
Caranx hippos (Linnaeus) — crevalle jack
Family: Sciaenidae
Menticirrhus saxatilis (Bloch and Schneider) n. kingfish
Family: Sparidae
Stenotomus chrysops (Linnaeus) — scup
Family: Labridae
Tautogolabrus adspersus (Walbaum) — cunner
Tautoga onitus (Linnaeus) — tautog
Family: Scombridae
Scomber scombrus (Linnaeus) — Atlantic mackerel
Family: Triglidae
Prionotus carolinus (Linnaeus) — northern searobin
Family: Cottidae
Myoxocephalus aeneus (Mitchill) — grubby
Family: Cyclopteridae
Cyclopterus lumpus (Linnaeus) — lumpfish
Family: Dactylopteridae
Dactylopterus volitans) Linnaeus) — flying gurnard
Family: Ammodytidae
Ammodytes americanus (DeKay) — American sand lance
Family: Mugilidae
Mugil cephalis (Linnaeus) — striped mullet
Family: Atherinidae
Menidia menidia (Linnaeus) — Atlantic silverside

Order: Pleuronectiformes
Family: Bothidae
Scophthalmus aquosus (Mitchill) — windowpane
Family: Pleuronectidae
Pseudopleuronectes americanus (Walbaum) — winter flounder

Order: Tetraodontiformes (Plectognathi)
Family: Balistidae
Alutera schoephfi (Walbaum) — orange filefish
Family: Tetraodontidae
Sphaeroides maculatus (Block and Schneider) — northern puffer

Order: Batrachoidiformes
Family: Batrachoididae
Opsanus tau (Linnaeus) — oyster toadfish

STATION #2. WESTPORT HARBOR (Shrimp Trawl)

Sampling at this subtidal station was conducted with a 30-foot shrimp trawl which was towed along the channel bottom for a distance of 600 feet. The bottom at this station was smooth sand and relatively free of submerged algae and rocks. Water depths ranged from 10 to 15 feet.

This station was sampled each month except May, February and March. Of all the sampling locations the fewest number of species were captured at this station. This scarcity of individuals may be accounted for by the lack of vegetation and the swift current that characterized this area. Only nine finfish species were captured here, with five species in June representing the greatest number taken in any one month. The Atlantic silverside (47 mm–145 mm) was the most abundant species; all were captured from August to December. The 18 cunners, 17 of which were taken in June, represent 54% of all individuals of this species taken during the study. The only winter skates taken in the sampling came from this station. Two individuals were captured in the period June to December. A list of species taken at this station in order of relative abundance is given in Table 5.

Invertebrate species collected with the finfish samples were the hermit crab, *Pagurus pollicaris;* the broad claw hermit crab, *Pagurus longicarpus;* the calico crab, *Ovalipes ocellatus;* the common spider

Table 5. The Rank of Fish According to Their Abundance at Each Station in the Westport River Study Area in 1966–1967.

Station 1. Westport River Mouth
Atlantic silverside
American sand lance
striped killifish
mummichog
threespine stickleback
alewife
fourspine stickleback
winter flounder
grubby
Atlantic herring
blueback herring
cunner

Station 2. Westport Harbor
Atlantic silverside
cunner
American sand lance
windowpane
winter flounder
winter skate
tautog
fourspine stickleback
grubby

Station 3. Judy Island
Atlantic silverside
winter flounder
fourspine stickleback
northern pipefish
American sand lance
threespine stickleback
alewife
cunner
windowpane
mummichog
tautog
striped bass
grubby
winter skate
orange filefish
northern puffer
northern sea robin
inshore lizardfish
white hake
oyster toadfish
lumpfish
scup
American smelt

Station 4. Halfmoon Flat
mummichog
striped killifish
fourspine stickleback
Atlantic silverside
threespine stickleback
Atlantic needlefish
American eel
northern pipefish
striped mullet
sheepshead minnow
oyster toadfish
ninespine stickleback
winter flounder

Station 5. Great Island
American sand lance
Atlantic silverside
winter flounder
American eel
cunner
windowpane
grubby
crevalle jack
oyster toadfish
American smelt
lumpfish

Station 6. Hix Bridge
scup
alewife
fourspine stickleback
mummichog
Atlantic silverside
winter flounder
Atlantic tomcod
oyster toadfish
northern pipefish
American eel
northern puffer
crevalle jack
northern sea robin
striped killifish
tautog
threespine stickleback
white perch
Atlantic herring
flying gurnard
windowpane

crab, *Libinia emarginata;* the green shrimp, *Hippolyte zostericola;* the isopod, *Idotea baltica* and the common starfish, *Asterias forbesi.*

STATION #3. JUDY ISLAND (Shrimp Trawl)

This was the uppermost fish sampling site in the west branch of the river. Trawling was conducted in the channel which ranged in depth from 6 to 10 feet. The channel is bordered on the west side by a marsh island. Large amounts of eel grass and the algae *Fucus visiculosus, Enteromorpha plumosa* and *Agardhiella tenesco* cover the bottom of this site.

Samples were taken in all months except May and February. The 23 species collected represent the largest number of finfish species taken at any one station. The Atlantic silverside (43 mm–200 mm) was the most abundant species taken. The largest catches of silversides occurred in August and November. The second most abundant species, winter flounder, was captured in each sampling except in June and August. There was a marked increase in winter flounder abundance in November with the largest number (35) being captured in March. Ripe males and females were present in the catch from December to March. Striped bass (267 mm–400 mm), white hake (51 mm), orange filefish (153 mm–204 mm) and inshore lizard fish (157 mm) were captured only at this location in the estuary. The three orange filefish and the inshore lizard fish were taken in November. One American smelt (209 mm) and one lumpfish (75 mm) were some of the other less common species encountered at this station. A list of all species captured at this station in order of relative abundance is given in Table 5.

Invertebrate species taken during sampling at this station were the common hermit crab, broad claw hermit crab, the green crab, *Carcinus maenus;* the blue claw crab, *Callinectes sapidus;* the calico crab, common spider crab, the rock crab, *Cancer irroratus;* the grass shrimp, the green shrimp, the common prawn, *Paleo-*

Table 6. Numerical Rank by Month of All Species Taken at the Six Sampling Stations in the Westport River, 1966–1967

	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.*	Mar.	Apr.	Total
Atlantic silverside . . .	6	11	89	481	580	8,567	1,286	1,305	92		9	1	12,427
mummichog.	1,029	352	294	43	730	6,052	557	536	194			2	9,805
American sand lance.	125	724	4	32	3	1,078	864	84	550				3,464
striped killifish.	141	314	351	7	969	513	261	1			2		2,559
fourspine stickleback.	142	267	58	70	9	90	1,019	3	7		16	486	2,167
threespine stickleback	129	86	5	7	6	18	59	6	14		4	5	339
winter flounder.	8	3	12	3	3	10	20	34	10		78	8	189
alewife.	1			31		9	1				28	12	81
scup.				62	3								65
northern pipefish. . . .		5	2	14	3	22	2						48
cunner.		18	1	7		3	4						33
American eel.		6	12	12	1	1							32
oyster toadfish.			3	20	5	1							29
Atlantic tomcod.							4	21			1		26
Atlantic needlefish . . .			22										22
windowpane.	3	2	1	1		7	3	4					21
grubby.		1					1	2	3		2	1	10
tautog.		3	6	1									10
northern puffer.				9									9
crevalle jack.				6	1								7
sheepshead minnow. .					2	1	3						6
striped mullet.				2	3	1							6
winter skate.							4	1				1	6
northern sea robin . . .					1	4							5
striped bass.	4	1											5
ninespine stickleback.							3						3
orange filefish.						3							3
American smelt.								1			1		2
Atlantic herring.	1						1						2
lumpfish									2				2
white perch.							2						2
blueback herring. . . .				1									1
flying gurnard.						1							1
inshore lizardfish						1							1
white hake.	1												1

*No sampling was conducted in February.

monetes vulgaris; the American lobster, *Homarus americanus;* the isopod, *Idotea baltica;* the sea squirt, *Bostrichbranchus pilularis;* the bay scallop, *Aequipecten irradians;* the common starfish and the scale worm, *Lepidonatus squamatus.*

STATION #4. HALFMOON FLAT (Beach Seine)

This station was established in order to monitor fishes occurring in an intertidal marsh area. The site varies in water depth from 0 feet to about 4 feet. The flat is partially exposed on extreme low tides. The bottom was composed of soft black mud covered with accumulations of both live and dead eel grass.

This 60 foot beach seine station was sampled each month of the sampling period except February, at which time ice cover prevented seining. Thirteen species of finfish were taken at this location with a monthly high of 9 occurring in both August and October. The most abundant species captured were the mummichog (21 mm–103 mm) and striped killifish (20 mm–157 mm): these fish represent 99% (9,710) and 98% (2,511) respectively of all individuals of these species taken during the study. This location also accounted for the largest numbers of both the threespine stickleback and the fourspine stickleback taken during the study. Four species, Atlantic needlefish, ninespine stickleback, sheepshead minnow and striped mullet, were encountered only at this station. Three young-of-the-year winter flounder were seined here, one in June (23 mm) and two in October (73 mm and 80 mm). The list of species for this station in order of abundance is given in Table 5.

Invertebrate species taken in the samples included the blue crab, the calico crab, the green crab, the prawns, *Paleomonetes vulgaris* and *Paleomonetes intermedius;* the isopod, *Idotea baltica;* the amphipods, *Gammarus* spp. and *Ischyrocerus anguipes* and the sea squirt, *Bostrichabranchus pilularis.*

STATION #5. GREAT ISLAND (Shrimp Trawl)

This subtidal trawl station was located in the east branch of the river about three miles above the confluence of the two branches at the mouth of the estuary. Water depth at this station averaged about 10 feet. On each sampling a shrimp trawl was towed along the channel for a distance of 600 feet.

Sampling was conducted in all months except May and February. Eleven finfish species were captured here with a high of 4 occurring in November, December and January. Forty-four winter flounder, 29 of which were taken in March, were sampled at this station. Ripe males and females were present in the January, March and April samples. Three less common species encountered at this location were the jack crevalle (113 mm), American smelt (120 mm) and lumpfish (45 mm). A list of all species taken at this station in order of relative abundance is given in Table 5.

Invertebrate species captured during finfish sampling were the hermit crab, the broad claw hermit crab, the calico crab, the green crab, the blue crab, two species of spider crab, *Libinia dubia* and *Libinia emargenata;* the grass shrimp; the green shrimp; the common prawn; the isopod, *Idotia baltica;* the sea squirt, *Bostrichobranchus pilularis;* the bay scallop, *Aequivecten irradians* and the common starfish.

STATION #6. HIX BRIDGE (360-Foot Haul Seine)

This site was the northernmost station in the estuary, approximately six miles above the river mouth in the east branch. Shore to midchannel water depths ranged from about 4 to 11 feet. The bottom at this site was hard with considerable rock and accumulations of oyster shells. Many clumps of live oysters also occupy the bottom of this site.

PLATE 4.

Making set with shrimp trawl.

PLATE 5.

Recording otter trawl sampling catch.

No sampling was carried on at this station during the months of May, January, February and March. However, during the remainder of the year, a total of 20 finfish species were taken at this location. A list of these species in order of relative abundance is given in Table 5. Scup was the most abundant species sampled; of the 65 individuals captured during the entire study, 62 were taken at this station in the August sampling. Two additional individuals were sampled here in September. Alewives were also captured in the greatest numbers at this station with 31 individuals taken in August and 28 in March. Atlantic tomcod were sampled only at this station. In December, 81% (21) of the individuals were captured. Two white perch taken here in November were the only representatives of this species taken in the sampling. In the late summer and early fall a small number of northern sea robin (54 mm–74 mm) were represented in the catch. Small numbers of winter flounder were present in all sampling months, with a peak of 14 occurring in March. Most of these fish were under 200 mm in length and in their second year of life. One male and two females from the March catch were in a ripe condition. Six crevalle jack were taken in the August sampling. Juveniles of this southern game fish species are regular visitors to southern Massachusetts although they are not common here. Two other southern species were taken at this location in the estuary. A flying gurnard (157 mm) was taken in the October samples and a northern kingfish was captured at this station in May. The latter species is a regular visitor to southern Massachusetts waters but is found only as a stray north of Cape Cod. It is most numerous from Chesapeake Bay to New York.

Invertebrates taken during sampling were the grass shrimp; the mud crab, *Neopanope taxana sayi;* the blue claw crab; the prawns, *Paleomonetes vulgaris*, *Paleomonetes pugio* and *Paleomonetes intermedius* and the ascidian, *Botryllus schhosseri.*

Discussion

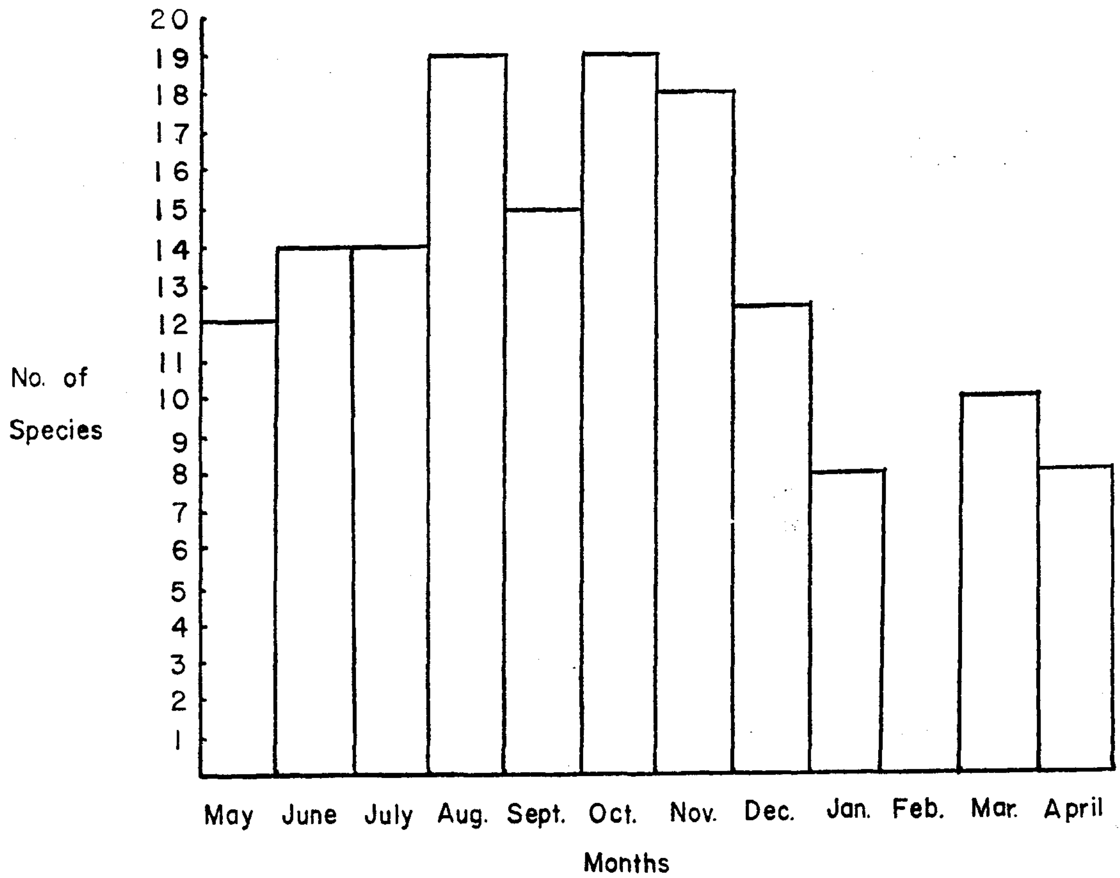
A total of 39 finfish species were captured during the 12-month study of the Westport River estuary. Thirty-five of the species were collected at the 6 monthly sampling stations; the remaining 4 were taken at various times throughout the year during supplemental sampling at other locations within the river. The latter four species include pollock, striped anchovy, northern kingfish and Atlantic mackerel. The most numerous species of fish taken were the small bait fishes which, in order of abundance, were the Atlantic silverside, mummichog, American sand lance and striped killifish. These species are important links in the food chain being utilized by many of the larger and more economically important sport and commercial species.

In order to compare the number of finfish species taken in the Westport River with those taken from the seven other estuaries studied by the Division of Marine Fisheries it was necessary to determine an equal basis upon which to compare the various areas since sampling was conducted in the freshwater segment of some and not in others and outside the estuary in some and not in others. To accomplish this the 84 species of finfish collected from all of the estuarine areas were classified according to McHugh's (1967) categorization of fish species (Table 7). In making the comparison only groups 2–5 were used because of the greater estuarine dependence of the species in these groups as compared to the other two. The comparison of estuaries is presented in Table 10, in which each estuary is listed with the total number of species captured and the adjusted number.

The relatively large abundance of estuarine species found in the Westport River as compared to the other

Figure 6.

Total Number of Finfish Species Collected at Sampling Stations 1-6, May 1966 - April 1967



estuaries may in part be attributed to its more southern location. Of the 84 species of the study areas six occurred in sampling exclusively in the Westport River. These species were the flying gurnard, inshore lizardfish, northern searobin, orange filefish, striped anchovy and northern kingfish. All of these are species which generally range northward only to the southern shore of Cape Cod and, according to Bigelow and Schroeder (1953), are found only as strays in Massachusetts Bay. Seven other species — northern puffer, oyster toadfish, striped mullet, scup, crevalle jack, sheepshead minnow and Atlantic needlefish — also have their northern limits generally restricted to the waters south of Cape Cod. These fish were only encountered in the three estuaries on the southern shore of Massachusetts — Pleasant Bay, the Wareham River and the Westport River. Of these species whose northern limit is described as Cape Cod a number are represented in these waters by only a relatively few individuals each year. The orange filefish and crevalle jack are described by Bigelow and Schroeder (1953) as being common visitors in these waters during the warmer months of the year, although they are not plentiful. Two species that are considerably more rare are the flying gurnard and inshore lizardfish. One individual of each species was captured; the former was taken on October 24, 1966 at a water temperature of 61°F and a salinity of 30 0/00. The flying gurnard, with a general range of tropical to warm temperate latitudes and common as far north as North Carolina, is reported by Bigelow and Schroeder (1953) as straying to New York and the southern coast of Massachusetts in most years (autumn). The inshore lizardfish, considered rare north of South Carolina (Breder, 1948), is on occasion quite common in some locations further north as indicated by a study on Long Island, New York (Alperin and Schaefer, 1965) where 35 individuals were captured between July 12 and October 10 in 1962.

The Westport River estuary, as is true of most estuaries, was found to serve as a nursery for many fish species. Juvenile winter flounder (66 mm–208 mm) were present in the estuary in all seasons of the year and were taken at all of the sampling stations. The minimum and maximum water temperature and salinity readings at which these juveniles were recorded were 32.0°F–78.3°F and 10.0 0/00–32.0 0/00, respectively. In the August sampling 62 juvenile scup (31 mm–70 mm) were captured at Hix Bridge where the

Table 7. Categories of Fish Species Taken From Six Massachusetts Estuaries

1. Freshwater fishes that occasionally enter brackish waters:

black crappie	golden shiner
bluegill	johnny darter
brook trout	largemouth bass
brown bullhead	pumpkinseed
brown trout	spottail shiner
carp	white sucker
chain pickerel	yellow perch

2. Truly estuarine species which spend their entire lives in the estuary:

Atlantic silverside	oyster toadfish
fourspine stickleback	sheepshead minnow
hogchoker	striped killifish
mummichog	threespine stickleback
ninespine stickleback	twospine stickleback
northern pipefish	

3. Anadromous and catadromous fish species:

alewife	blueback herring
American eel	sea lamprey
American shad	striped bass
American smelt	white perch
Atlantic sturgeon	

4. Marine species which pay regular seasonal visits to the estuary usually as adults:

American sand lance	northern kingfish
Atlantic needlefish	northern puffer
common mullet	northern sea robin
flying gurnard	orange filefish
grubby	scup
inshore lizardfish	striped anchovy
longhorn sculpin	windowpane

5. Marine species which use the estuary primarily as a nursery ground usually spawning and spending much of their adult life at sea, but often returning seasonally to the estuary:

Atlantic menhaden	squirrel hake
Atlantic tomcod	tautog
cunner	white hake
smooth flounder	winter flounder

6. Adventitious visitors, which appear irregularly and have no apparent estuarine requirements:

American plaice	ocean sunfish
Atlantic cod	pollock
Atlantic herring	radiated shanny
Atlantic mackerel	sea snail
Atlantic wolffish	shorthorn sculpin
barndoor skate	silver hake
bluefish	spiny dogfish
crevalle jack	spiny lumpsucker
haddock	winter skate
little skate	witch flounder
lumpfish	yellowtail flounder
ocean pout	

Table 8. Range in Surface Water Temperature and Salinity in Which Various Species of Fish Were Sampled in the Westport River Estuary.

	Water Temperatures, F		Salinities, 0/00	
	Min.	Max.	Min.	Max.
alewife	43.0	76.5	13.5	31.0
American eel	61.0	83.3	14.0	31.5
American sand lance	36.0	69.0	26.5	31.5
American smelt	36.0	45.0	8.5	29.0
Atlantic herring	41.0	55.0	11.3	30.5
Atlantic mackerel	—	—	—	—
Atlantic needlefish	83.3	83.3	27.3	27.3
Atlantic silverside	34.5	83.3	8.5	32.0
Atlantic tomcod	32.3	43.0	11.3	29.5
blueback herring	—	—	29.0	29.0
crevalle jack	60.0	76.5	28.0	29.0
cunner	50.5	73.0	23.5	32.0
flying gurnard	61.0	61.0	14.2	14.2
fourspine stickleback	32.8	83.3	20.5	32.0
grubby	34.5	62.6	8.5	29.5
inshore lizardfish	56.0	56.0	30.0	30.0
lumpfish	36.0	37.0	27.0	31.0
mummichog	32.8	83.3	14.2	31.5
ninespine stickleback	50.0	50.0	27.3	27.3
northern kingfish	58.0	58.0	23.5	23.5
northern pipefish	51.0	75.2	14.2	31.5
northern puffer	72.0	76.5	29.0	32.0
northern sea robin	56.0	56.0	14.0	30.0
orange filefish	56.0	56.0	30.0	30.0
oyster toadfish	61.0	83.3	14.2	32.0
pollock	56.5	68.0	23.5	26.5
scup	71.0	76.5	28.0	32.0
sheepshead minnow	50.0	73.0	27.3	29.5
striped anchovy	50.5	50.5	27.0	27.0
striped bass	60.0	64.9	25.3	29.0
striped killifish	41.0	83.3	25.0	31.5
striped mullet	67.0	73.0	26.5	31.5
tautog	62.6	76.5	25.0	32.0
threespine stickleback	32.8	75.2	8.5	32.0
white hake	48.0	48.0	29.0	29.0
white perch	41.0	41.0	11.3	11.3
windowpane	45.0	65.8	14.2	31.5
winter flounder	32.3	78.3	8.5	32.0
winter skate	43.0	51.0	24.5	31.5

Table 9. Range in Surface Water Temperature and Salinity in Which Juveniles of Various Species of Fish Were Sampled in the Westport River Estuary.

Species	Number	Range mm	Temperature, F	Salinity, 0/00
scup	65	31–110	71.0–76.5	28.0–30.0
winter flounder	61	32–205	32.0–78.3	10.0–32.0
cunner	30	13–176	50.5–73.0	23.5–29.0
pollock	19	52– 76	56.5–68.0	24.0–27.0
alewife	18	61–116	44.0–58.0	24.0–31.0
tautog	8	91–160	72.5–76.5	25.0–29.0
crevalle jack	7	113–192	60.0–76.5	28.0–29.0
striped mullet	6	30– 70	67.0–73.0	26.5–29.0
windowpane	6	42–184	48.0–65.8	26.0–30.0
white hake	1	51	48.0 –	29.0

Figure 7.

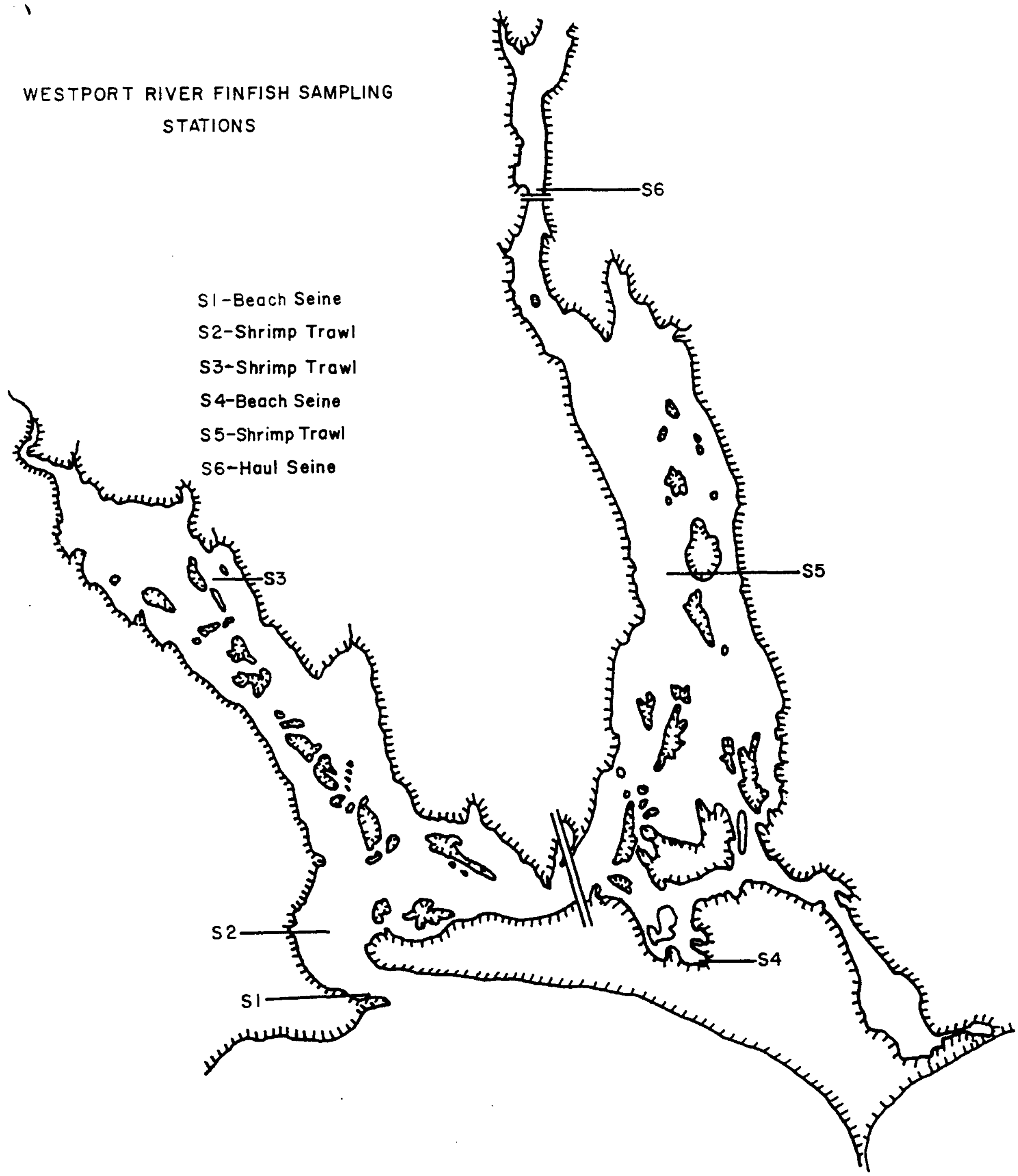
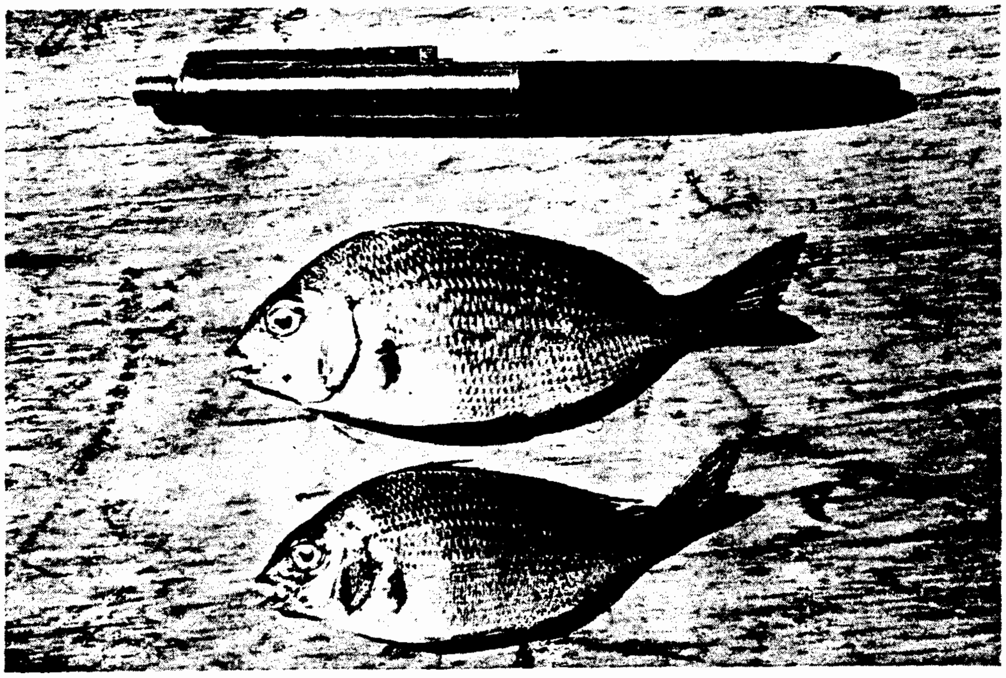

WESTPORT RIVER FINFISH SAMPLING STATIONS
S1-Beach Seine
S2-Shrimp Trawl
S3-Shrimp Trawl
S4-Beach Seine
S5-Shrimp Trawl
S6-Haul Seine
S6
S5
S3
S2
S1
S4

PLATE 6.

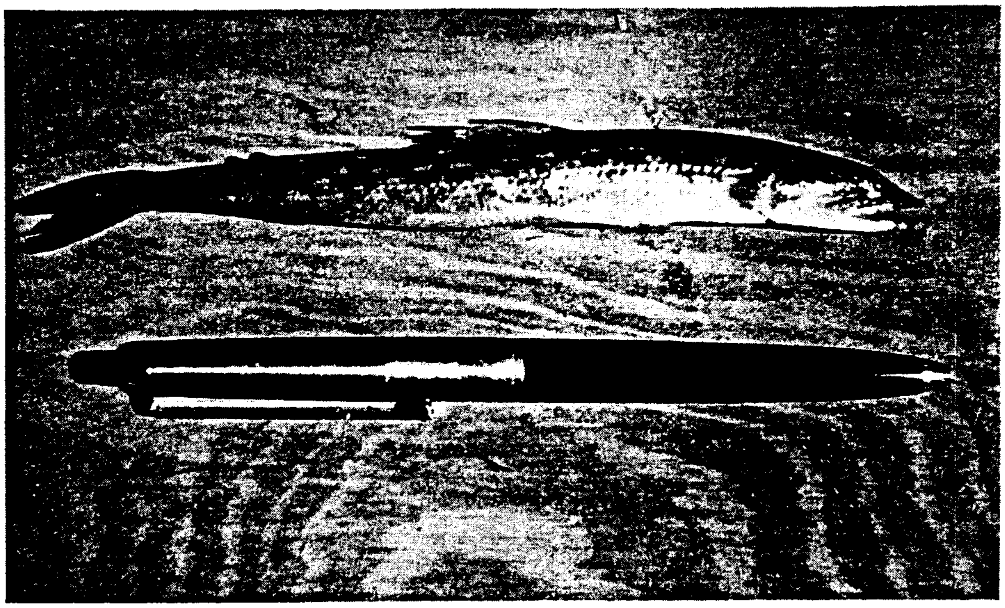
Biologists sampling with 60′ beach seine.

PLATE 7.



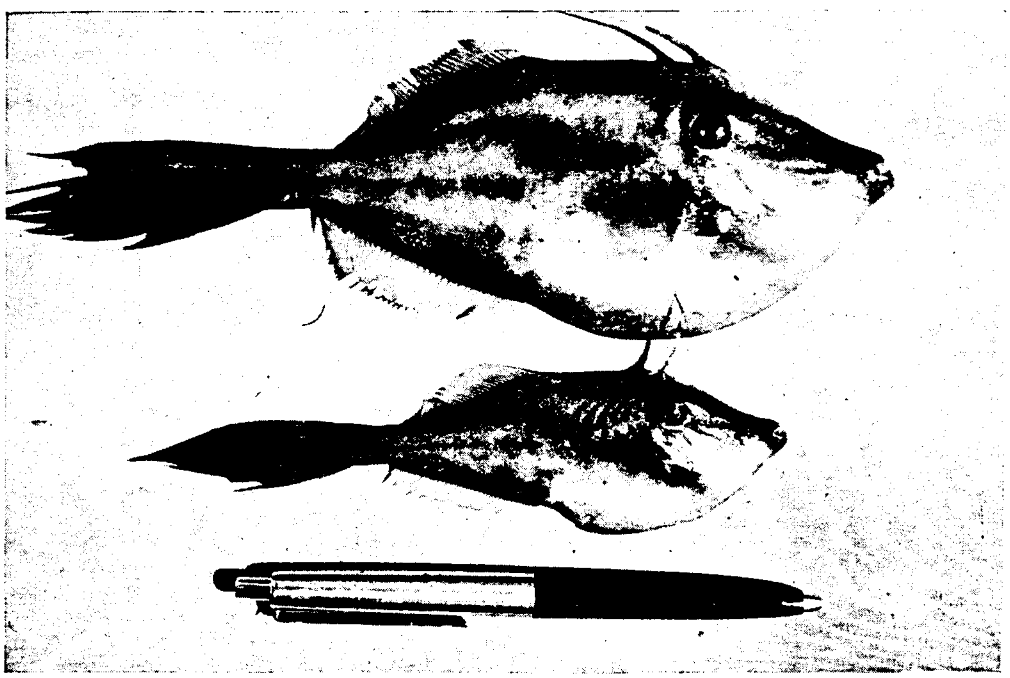
Juvenile scup (Stenotomus chrysops).

PLATE 8.



Inshore lizardfish — Synodus foetens (Linnaeus).

PLATE 9.



Orange filefish — Alutera schoepfi (Walbaum).

water temperature was 76.5°F and the salinity was 26.0 0/00. The young of many other species including alewife, American smelt, blueback herring, cunner, pollock, tautog and white hake enter the shallow estuarine waters of the Westport River where they find an abundance of food and where among the profusion of plant life they find protection from the predators to which they would otherwise be so vulnerable. A list of these species and the temperature and salinity ranges at which they occurred are given in Table 12.

The sport fish encountered in this estuary were the striped bass, bluefish, white perch, winter flounder, tomcod, tautog, Atlantic mackerel, American smelt, scup and pollock. The latter two species occurred in sampling only as juveniles. Two other sport species, northern kingfish and crevalle jack, were also taken during the study, however, both are uncommon in Massachusetts' waters and the latter, when present, is found only in the juvenile stage. Striped bass were seasonally more plentiful than was indicated by the numbers taken during the monthly sampling. In most years, schools of these fish begin to move into the estuary in April or May to feed on the abundance of baitfish and remain until October or November; the largest numbers are present in the spring and the fall months. However, because they are strong and aggressive swimmers, these fish were usually able to elude the sampling gear employed. Only five striped bass were taken in the otter trawl during the study. It is also known that large schools of bluefish enter the river in quest of food but none were taken in the sampling. Both of these species are enthusiastically pursued within this estuary by a large number of sport fishermen.

The winter flounder is utilized by both the sport and commercial fishermen, although there is no extensive commercial fishery for this species within the Westport River. A total of 189 winter flounder were captured during the study period making it the seventh most abundant species captured. Only the four forage species previously mentioned and the fourspine and threespine stickleback were taken in larger numbers. It is reasonable to assume that the number of flounder captured would have been considerable greater if sampling could have been conducted in February, for it is during February and March that the spawning season is at its height and the mature fish have moved into the estuary to spawn. Sampling indicated that the Westport River is utilized by this species as both a spawning and a nursery area. Ripe males and females were present in the catch from December to April with the greatest number (33) occurring in March. Spent flounder of either sex did not occur in the catch until March, at which time seven spent females were taken at station #5, one spent male was taken at station #6 and one spent female was taken at station #3. It is probable that spent flounder would have been taken in February if sampling could have been conducted during that month. Two additional spent females and one spent male were taken at station #5 during the April sampling. Although there is no extensive commercial fishery for winter flounder within the river, the area does serve as a spawning and nursery area and consequently contributes to the adjacent coastal flounder fishery.

Table 10. Numbers of Estuarine Fishes Captured in Coastal Study Areas of Massachusetts.

	Total Number of Species Captured	Species Captured in Groups 2–5
Merrimack River	50	26
Parker River	27	19
Gloucester Harbor	33	20
Beverly-Salem Harbor	31	19
Quincy Bay	27	18
North River	45	23
Pleasant Bay	34	30
Westport River	39	34

The Alewife Fishery

The alewife, or "herring", is the most important anadromous fish species in Massachusetts. Each spring, millions of alewives enter coastal streams and ascend to headwater lakes and ponds to spawn. The young alewives spend their first several months in these lakes but return to the sea in late summer or fall when they have attained a length of 3–4 inches. While making their passage to spawning areas, adult alewives often have to surmount fish ladders which have been constructed at the site of man-made dams. Without these ladders or fishways the fish would not be able to gain access to the spawning ponds or lakes. In many areas, the spring run of thousands of alewives ascending these ladders is a major visual attraction to residents and tourists. In towns where the fish runs are consistently heavy and the fishways wisely managed, fishing rights are often sold and regulated by the town, allowing some of the fish to be harvested commercially for food or bait purposes.

While in its coastal salt water environment, the alewife is extremely valuable as both a commercial species and as a forage fish for such larger fish as the striped bass. During 1966, 6,633,200 pounds of alewives were landed in Massachusetts. This catch was valued at $81,324.

In the Westport River study area, the alewife represents a presently diminished resource with an excellent potential for restoration. Although runs of fish were

little skate	x	x	x	x	x	x	x	
longhorn sculpin	x	x	x	x	x	x	x	
lumpfish	x	x	x	x	x	x		x
mummichog	x	x	x	x	x	x	x	x
ninespine stickleback	x	x	x	x	x	x		x
northern kingfish								x
northern pipefish	x	x	x	x	x	x	x	x
northern puffer								x
northern sea robin								x
ocean pout	x	x	x	x	x	x		
ocean sunfish						x		
orange filefish								x
oyster toadfish							x	x
pollock	x		x	x		x		x
pumpkinseed	x					x		
radiated shanny	x							
rock gunnel	x					x		
scup							x	x
sea lamprey						x		
sea raven	x	x	x	x	x	x	x	
sea snail	x		x	x				
silver hake				x	x			
shorthorn sculpin			x					
sheepshead minnow							x	x
smooth flounder	x							
spottail shiner	x							
spiny dogfish	x	x		x	x			
spiny lumpsucker			x					
squirrel hake	x		x	x				
striped anchovy								x
striped bass	x		x		x	x	x	x
striped killifish				x	x		x	x
striped mullet								x
tautog							x	x
threespine stickleback	x	x	x	x	x	x	x	x
twospine stickleback						x	x	
white hake				x		x	x	x
white perch	x	x						x
white sucker	x					x		
windowpane	x	x	x	x	x	x		x
winter flounder	x	x	x	x	x	x	x	x
winter skate	x	x	x	x	x	x	x	x
witch flounder	x							
yellow perch	x							
yellowtail flounder	x	x	x	x	x	x	x	

Table 12. Range in Surface Water Temperature and Salinity in Which Various Species of Fish Were Sampled in Massachusetts Coastal Waters.

	Water Temperature (°F)		Salinity (0/00)	
	Min.	Max.	Min.	Max.
alewife	43.0	76.5	0.0	31.5
American eel	38.3	83.3	0.0	31.5
American sand lance	31.5	74.0	0.0	32.0
American shad	56.3	76.1	0.0	—
American smelt	36.0	71.0	1.0	32.0
Atlantic cod	36.0	69.8	22.4	33.0
Atlantic herring	41.0	66.0	11.3	31.0
Atlantic menhaden	—	78.3	29.7	—
Atlantic needlefish	68.0	83.3	27.3	31.4
Atlantic silverside	32.0	83.3	0.0	33.5
Atlantic tomcod	32.3	78.3	11.3	33.0
blueback herring	48.0	78.0	0.0	32.0
bluefish	—	75.0	25.5	—
bluegill	47.0	76.1	0.0	5.0
brown bullhead	66.0	74.3	0.0	—
brown trout	56.3	74.5	0.0	—
chain pickerel	68.9	76.1	0.0	23.5
crevalle jack	60.0	76.5	28.0	29.0
cunner	50.5	73.0	23.5	32.0
carp	38.3	75.2	0.0	31.4
flying gurnard	61.0	61.0	14.2	14.2
fourspine stickleback	32.8	83.3	0.0	32.0
golden shiner	74.5	—	0.0	—
grubby	32.6	69.8	4.5	29.5
hogchoker	44.8	75.2	25.3	27.9
inshore lizardfish	56.0	56.0	30.0	30.0
little skate	38.8	55.4	26.8	28.7
longhorn sculpin	32.9	58.0	23.5	31.0
lumpfish	36.0	64.0	25.8	32.0
mummichog	32.8	83.3	0.0	33.0
ninespine stickleback	34.0	75.0	0.0	32.5
northern kingfish	58.0	58.0	23.5	23.5
northern pipefish	44.8	78.3	4.2	31.5
northern puffer	72.0	78.3	27.0	32.0
northern sea robin	56.0	56.0	14.0	30.0
orange filefish	56.0	56.0	30.0	30.0
oyster toadfish	41.0	83.3	14.2	32.0
pollock	50.9	68.0	23.5	26.5
pumpkinseed	66.2	74.5	0.0	—
scup	54.5	76.5	27.5	32.0
sea lamprey	56.3	—	0.0	—
sea raven	39.2	55.4	24.0	28.7
silver hake	62.0	62.0	30.0	30.0
sheepshead minnow	50.0	73.0	25.9	29.5
spottail shiner	64.0	75.0	0.0	—
squirrel hake	52.0	66.0	28.5	30.5
striped anchovy	50.5	50.5	27.0	27.0
striped bass	57.2	64.9	25.3	29.0
striped killifish	39.2	83.3	23.5	31.5
striped mullet	67.0	73.0	26.5	31.5
tautog	50.0	78.3	25.0	32.0
threespine stickleback	32.8	78.3	0.0	33.0
twospine stickleback	33.1	51.8	—	27.5
white hake	48.0	78.3	19.0	31.4
white perch	41.0	71.0	0.0	15.0
windowpane	45.0	65.8	14.2	31.5
winter flounder	32.3	78.3	0.0	33.0
winter skate	43.0	57.2	24.5	31.5
yellowtail flounder	55.4	—	28.7	—

found to occur in both the east and west branches of the river, two dams prevent the fish from reaching favorable spawning headwaters. Field inspections indicate that there are three major areas where proper construction and management could vastly improve the anadromous fishery resources of the estuary. These three areas are discussed below.

1. Cockeast Pond

This shallow pond, of approximately 96 acres, is connected to the Westport River by a narrow 200-foot tidal ditch which bisects the adjacent tidal marsh. Access to the pond by alewives is possible only at high tide when the marsh is flooded up to a connecting culvert under the road. A productive alewife run presently exists at this location. Local residents reported that most of the upstream migration of the adult alewives occurs during the night hours. Alewives are captured after dark by many of the residents for the roe of the female and by lobstermen of the area for bait purposes. Biologists noted that the run is not responsibly supervised by the town and that the harvesting of alewives is allowed with little concern to the regulation of harvest limits. Consideration should be given by the town to properly regulate and manage the existing alewife runs.

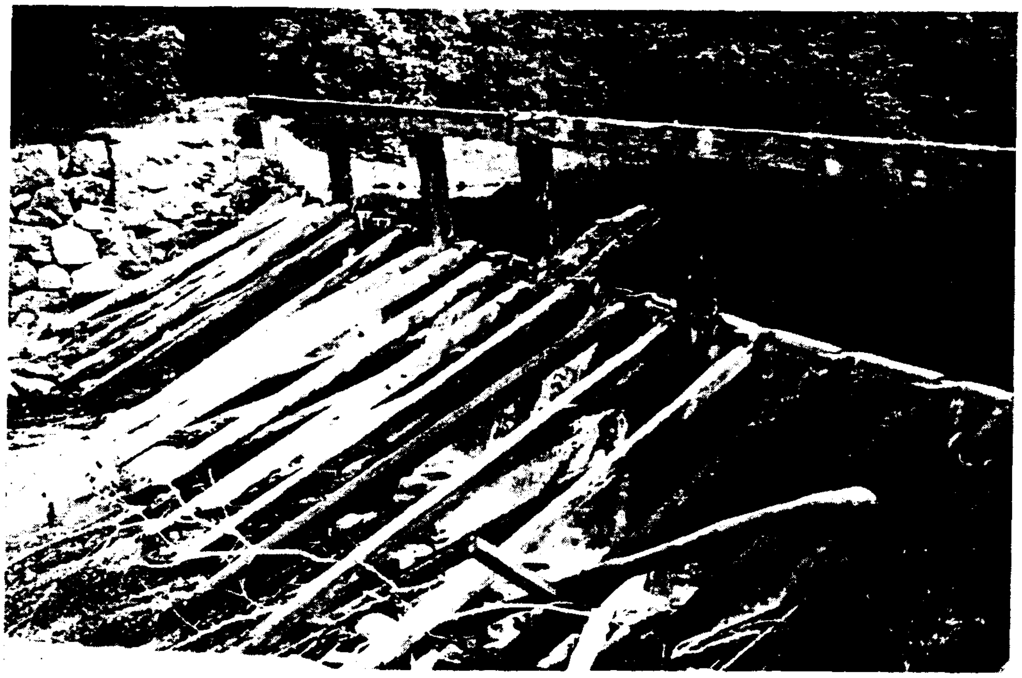
2. West Branch, Westport River

The west branch of the river flows unimpeded from below a dam off Adamsville Road. The river is tidal up to this point and permits passage to anadromous fish up to the base of the wooden dam (Plate 12). During the alewife spawning season, many fish have been noted in the area below the dam, unable to ascend into the headwater pond. It is believed that these fish are river spawners since some fish appear in this location each year. The pond, although of relatively small size (2.7 acres) could provide spawning area for a minor but possibly important population of alewives. Recommendations for the improvement of the run would include construction of a suitable fish ladder at the dam site to provide passage for spawning alewives. Stocking the pond for three years, together with closure of the run for this period would also be desirable.

3. East Branch, Westport River

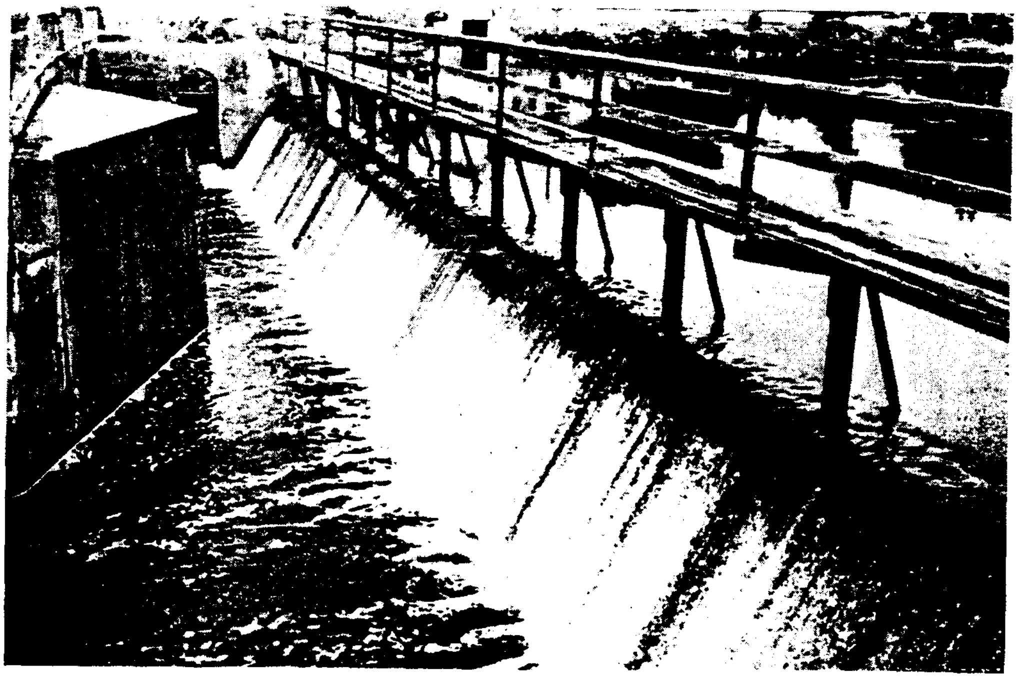
The east branch of the river is presently supporting a population of river spawning alewives, which are seined by local lobstermen for bait during the early spring months. Passage to the headwaters is rendered impossible by a wooden dam at Forge Pond, and a 12-foot-high concrete dam and spillway at Lake Noquochoke (Plates 10 and 11). Forge Pond, of approximately 4.6 acres and especially Lake Noquochoke of 127 acres, could provide considerable alewife spawning area if they were made accessible. Lake Noquochoke has a potential of about 89,000 pounds per year of harvestable alewives. The potentially large population of alewives using this run would add immeasurably to the total productivity of the Westport River.

PLATE 10.

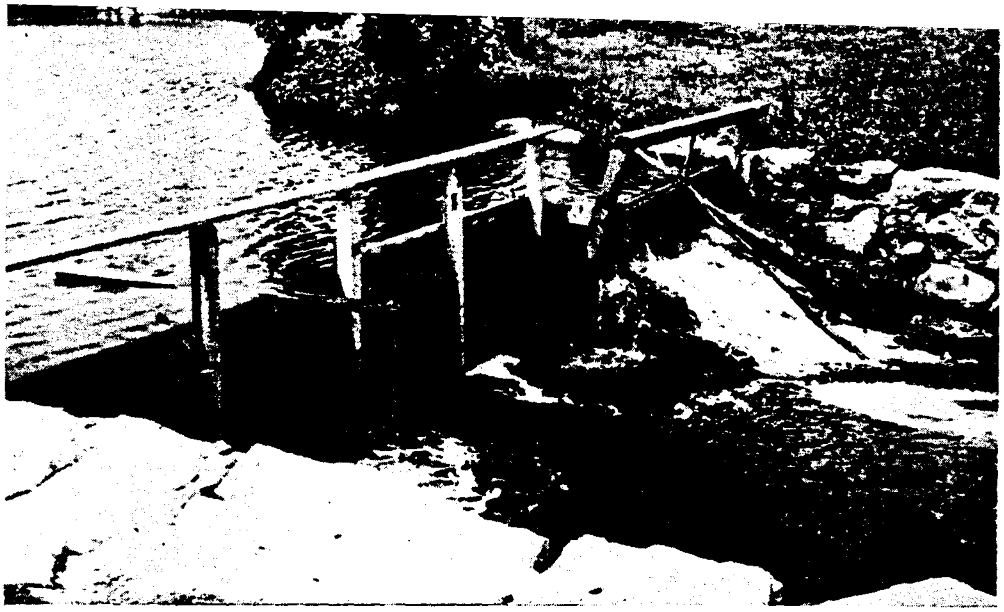


Dam at upper end of East Branch of Westport River at Forge Pond.

PLATE 11.



Dam at East Branch of Westport River at the outlet of Noquochoke Lake.



Dam at upper end of West Branch, Westport River on Adamsville Road, Westport.

Recommendations for restoring this run include construction of fish ladders to provide access to both ponds; stocking of Lake Noquochoke with ripe alewives and closure of the run for three years; adequate management of the fishway by the town; and stream clearance from Forge Pond downstream to the bridges at Head of Westport.

The east branch of the river also provides spawning area for white perch and smelt. White perch are taken by seining in the river in the late winter months. Smelt are frequently taken by anglers from Hix Bridge.

Under the Anadromous Fish Project, the Division of Marine Fisheries should give consideration to the establishing of a shad run in the main branch of the river. Propagation and management procedures would include introducing shad eggs in an area below Forge Pond dam, controlling of pollution in the upper reaches of the river, and cleaning and brushing of the river below the dam to make the area suitable for the spawning of adult shad and accessible to sportfishermen.

Eel Fishery

American eels (*Anquilla rostrata*) were captured at the three sampling stations in the east branch of the river. The eel is a very common estuarine species which, although born far out to sea, spends most of its adult life in coastal bays or estuaries or in tributary rivers and ponds. Upon reaching sexual maturity, eels migrate to an area in the middle Atlantic where they spawn. It is believed that the adult eels die after spawning. The flattened leaf-like eel larvae drift and swim back to our Atlantic shore, arriving off the river mouths at an age of about one year. Prior to reaching shore waters, the flat, almost transparent larvae change to the normal shape of an eel. These young eels, or elvers, have attained a length of about three inches. The eels will spend a dozen or more years in lakes, coastal rivers or estuaries before reaching maturity and returning to the oceanic spawning area.

Although of excellent eating quality, eels are avoided by many Massachusetts residents as table fare, probably because of their reptilian appearance. However, small family and commercial eel fisheries do occur in various parts of our coastal bays and rivers. According to statistics compiled by the U. S. Bureau of Commercial Fisheries, the total catch of the eel fishery in Massachusetts during 1966 was 24,600 pounds. The value of this fishery was approximately $6,345.

Eels are usually caught in specifically designed pots baited with dead fish or shellfish meats. Crushed egg-bearing female horseshoe crabs are also a popular bait for eel pots when available. During the winter when eels have settled into the soft bottom of tidal rivers and ponds, fishermen often capture the eels by spearing, either from boats or through the ice.

During 1966 four individuals fished commercially for eels in the Westport River on a part-time basis. The greater part of the catch was derived from pot fishing during September and October. The eels were stored in live cars for later shipment to Boston during the Christmas holiday season. One fisherman, however, speared eels during the spring and fall for sale to local restaurants and fish markets. ("Eels and johnny cake" is a popular item on the menu of one of the restaurants overlooking the Westport River.)

It was estimated that during 1966 these four eel fishermen caught approximately 4,500 pounds of eels. At an average wholesale price of $.45 per pound, the value of the catch to the fishermen was $2,025.00.

Westport River Sport Fishery

The impact of increasing popularity of salt water sport fishing is as evident in the Westport River as it is in other Massachusetts coastal bays and estuaries. Refinement of fishing tackle and boating equipment along with increasing leisure time is reflected in growing use of our coastal waterways by both shore and boat fishermen. From spring through fall, fishermen pursue striped bass and bluefish in both branches of the Westport River. Considerable shore fishing for these species occurs within the river and from the ocean sides of Horseneck and Gooseberry Neck. The tautog is also a popular sport species in areas off the outer beach.

During 1966, two dealers at Westport Point sold sport fishing bait to fishermen who fish both within and outside the river. The total income from the sale of sea worms, green crabs, quahogs, clam necks and squid was estimated to be about $8,311.00. One dealer also reported an income of $603.00 from the rental of skiffs and outboard motors. One charter boat worked out of the river for bass, bluefish and groundfish during the summer of 1966. The owner of this boat reported that he made about 32 groundfishing trips during the summer of 1966. An average of four fishermen were carried each trip. The charge of $5.00 per individual amounted to gross income of $640. About 16 trips were made for bass and bluefish. Most of these trips were made with only two fishermen who were charged $10.00 each. These trips resulted in income of $320.

Total income derived from bait sales, boat rentals and charter fees was about $9,874.00.

Perhaps the most popular sport fishing site in the upper estuary is at Hix Bridge in the east branch of the river. During the spring and early summer fishermen line the bridge for tomcod, tautog and flounder. Striped bass ("schoolies") are also taken at this site. In recent years from mid-summer to fall bluefish ("snappers") have occurred in abundance in the upper river providing excellent sport to both shore and boat fishermen.

Two public all-tide launching ramps, one at Hix Bridge and one at the junction of the two river branches in the lower estuary, provide fishermen with convenient boat access to favorite fishing areas. While public boat launching facilities are presently adequate to service the traffic of boat fishermen, there is a need for more shore fishing facilities with public access in the upper portion of the east branch of the river. The Division of Marine Fisheries should make further study of the feasibility of providing access and fishing pier facilities in the areas of Hix Bridge and also above the Route 88 Bridge in the east branch. Consideration should be given to cutting through the let and building a rip-rap along both sides of the cut which could serve as fishing sites.

Summary

A total of 39 estuarine fish species (Table 10) were captured in the study area. The species taken in greatest abundance were the Atlantic silverside, mummichog, American sand lance and striped killifish. Six species occurred for the first time in estuarine sampling conducted by the Division of Marine Fisheries. These species were the flying gurnard, inshore lizardfish, northern sea robin, orange filefish, striped anchovy and northern kingfish.

Sampling indicated that the Westport River serves as a nursery area for the juvenile forms of important economic species such as the winter flounder, alewife, smelt, tautog, pollock and white hake. The occurrence of both ripe and recently spent flounder in otter trawl sampling indicated that flounders spawn within the river.

Spring occurrence of alewives was noted in both river branches but in low abundance. A survey indicated that both branches of the river could be highly productive of alewives if headwater ponds were made accessible by the construction of fish ladders.

During 1966 four individuals fished commercially on a part-time basis for eels. It was estimated that the four fishermen caught a total of approximately 4,500 pounds of eels with a value to the fishermen of $2,025.

Sportfishing was noted in the estuary for striped bass, bluefish, winter flounder, tomcod, tautog and mackerel. Several facilities in the river which cater to sports fishermen received a total income of $9,874 in bait sales, boat rentals and charter fees.

THE SHELLFISHERIES OF THE WESTPORT RIVER

Objectives

The major objectives of the shellfish phase of this over-all resource study was to determine the kind and extent of existing economic shellfish populations in the river and the annual volume and value of the shellfishery to family and commercial fishermen.

Secondary considerations included a survey of environmental factors affecting shellfish populations, review of local shellfish management practices, and an inventory of the associated flora and fauna of the shellfish beds.

Historical Background

Although it is known that the residents of Westport have traditionally enjoyed shellfishing within the east and west branches of the Westport River, very little written record has been kept of fluctuations in the shellfish resources of the river. The earliest validated record pertaining to the shellfish of the area came from the 1925 Westport Town Report, which stated that during that year 9 shellfish licenses and 25 resident lobster fishermen's licenses were issued. Until 1955 little else was written of the shellfish resources. In that year 578 bushels of mixed quahogs were planted in Westport waters under the supervision of Shellfish Constable George Hart. In 1956, 804½ bushels more of mixed quahogs were planted and 52½ bushels of small oysters were moved to deep water. In that same year 200 cubic inches of shells were planted on oyster beds to provide setting material for juvenile oysters. In 1957, the shellfish constable indicated planting 592 bushels of quahogs and 300 bushels of oysters. One thousand bushels of scallops were moved to deep water. In 1958 the shellfish officer directed the planting of 275 cubic inches of shell in the river to catch oyster spat. During that same year 10,000 bushels of seed scallops were moved to deep water from off flats in the river.

The east branch of the Westport River has been a natural oyster producing area. Through the years, thousands of bushels of shells have been planted in an effort to catch sets of oysters.

During the early summer of 1959 an effort was made to clean the surface of previously planted shells by towing a drag over the shell beds. Despite this effort, very little oyster set was caught during 1959.

In 1960 a major advance in oyster propagation was achieved with the construction of a large raft for growing oysters in trays and on strings. Growth studies of various strains of oysters were initiated during that year by the shellfish constable and a biologist of the Division of Marine Fisheries. A major objective of the raft project has been to rapidly grow seed oysters which are ultimately planted in the river. Since 1960 about 100 bushels of oysters have been transplanted from the raft to oyster grounds in the river.

An experimental attempt was made in 1961 to improve bottom conditions in areas void of shellfish by applying lime. Fifty-two tons of lime were spread over 12 acres of the river. During that same year fishermen were hired to dredge and remove starfish from the river. Similarly, dredges were used in 1962 to thin out blue mussels which had become a problem by encroachment in mats upon valuable quahog producing bottom.

In 1965 the shellfish officer reported planting 120 bushels of quahogs in the east branch of the river and the moving of oyster and scallop seed from poor to excellent growing areas in the river.

Despite the many worthy attempts to improve the shellfisheries of the Westport River, the overall trend of the quahog and oyster fisheries has been downward. Scallops remain an extremely valuable shellfish of the river, but as is typical of this very short-lived species, it may be extremely abundant one year and scarce the next. The supply of soft shell clams has remained in relatively low abundance; however in recent years, they have occurred in numbers sufficient to satisfy a limited family fishery.

Methods and Materials

General inventory of shellfish beds was accomplished using conventional shellfishing equipment such as clam and quahog rakes and bay scallop dredges. Soft shell clam densities on several intertidal flats were sampled using a steel square foot frame which measured 12 inches x 12 inches x 4 inches deep. The frame was tossed at random and pressed into the sediment at its striking point. The sediment and clams were removed from within the frame and placed on nylon netting material and then shaken and washed in adjacent river water. The clams were then sorted, counted and measured along the anterior-posterior axis to the nearest millimeter with vernier calipers. Note was made of associated fauna, clam mortality and sediment type. On several dates during the summer and fall of 1966, bay scallops were sampled utilizing skin diving equipment.

The volume and value of the 1966 shellfish harvest in the river was compiled from monthly production questionnaires filled out by the Westport Shellfish Constable. Shellfish beds were delineated on a U. S. Geological Survey topographic map (Westport, Mass. Quadrangle) and acreages determined by the dot grid method.

Findings

Bay Scallops

In 1966 an estimated total of 38,495 bushels of bay scallops were harvested from the Westport River. For at least the period that harvest records have been maintained (1954 to present) this was a record harvest. The next largest recorded harvests were an estimated 10,000 bushels in both 1958 and 1960. Scallop abundance in the river, as in other scallop producing areas of the coast, varies greatly from year to year. For instance, although harvestable size scallops were exceedingly plentiful in the fall of 1966, sampling indicated that very little setting occurred during that summer. The observed lack of seed scallops during the summer and fall of 1966 was verified by the complete absence of a scallop fishery in the fall of 1967 when this seed would have reached harvestable size. The following table illustrates the fluctuation in annual scallop setting and success in the Westport River.

Year	Bushels
1956	200
1957	5,500
1958	10,000
1959	200
1960	10,000
1961	0
1962	0
1963	0
1964	0
1965	5,740
1966	38,495

The 1966 scallop harvest in the river occurred on about 457 acres of bottom. Scallops were found as far as 1⅓ miles from the mouth in the west branch and about 2 miles inland in the east branch. Considering the total production of 38,495 bushels, an average of 84 bushels were produced per acre. At an estimated value of $7.00 per bushel, each acre of bottom produced $590 worth of scallops. Fifty-three commercial license holders and 134 family fishermen shared in the scallop harvest valued at $201,179.50.

Temperatures and salinities in the river were found to be favorable for the growth of scallops. Belding (1910) noted that scallop growth occurs in water temperatures above 45°F. Temperatures in the lower Westport River were generally above 45°F from May through November. On several dates in both April and December temperatures above 45°F were also recorded in the lower river. From June through August water temperatures were usually in excess of 70°F. This extended period of high river temperatures provides the scallop with a long growing season.

According to Belding (*op. cit.*), scallops survive and grow well between a salinity range of 10 0/00 and 27 0/00. Only one salinity recording in the scallop producing area of the lower estuary was below 10 0/00. A reading of 8.5 0/00 was taken in March near the surface and most likely was due to the spring thaw and resultant run-off. At the high end of the salinity range the majority of readings exceeded 27 0/00 and occurred as high as 32 0/00.

It has generally been acknowledged that current, or circulation, is of major importance to the growth of the scallop, although certain studies in recent years (Cooper and Marshall, 1963) have suggested that current may not necessarily be the main factor accounting for the condition of the scallop. While no extensive sampling was conducted in the Westport River to compare the size of the scallops from areas of good and poor circulation the shellfish officer and fishermen have reported that scallops growing on the flats among dense growths of eel grass are considerable smaller in size than those growing on the adjacent relatively clean channel bottoms. On September 23, 1966 biologists made a survey of scallops occurring on an extensive shallow eel grass flat in the west branch of the river. This sampling occurred about one week before the opening of the scallop fishing season. The average size (dorso-ventral height) of 60 scallops gathered in the area was 54.8mm. or about 2³⁄₁₆ inches. The "eyes" were notably small and not of commercial quality. Because of the small size of the scallops and the density of eel grass in the area which hampers dredging, fishing during the scallop season was confined to the deeper areas further downstream in the estuary.

Quahogs

The quahog (*Mercenaria mercenaria*) has been the mainstay of shellfish species for Westport shellfishermen, both family and commercial. Although there has been an overall downward trend in the quahog fishery during the past decade, the quahog has remained the most reliable of the economic shellfish species in the river as regards annual availability of harvestable size stock.

During 1966 a total of 1747 bushels of quahogs were harvested by Westport permit holders. The larger portion of the harvest (1,024 bushels) was gathered by about 370 family permit holders. This harvest was valued at $7,741. Nine commercial fishermen harvested a total of 723 bushels valued at about $5,465 ($4.50–$9.60/bushel). This total quahog harvest was estimated to have occurred on about 132 acres of bottom. Thus the average production per acre was 13 bushels of harvestable quahogs. If an average wholesale bushel value of $7.00 per bushel is assigned to the harvest, each acre produced about $91.00 worth of quahogs.

Quahogs occur in scattered beds in the lower reaches of both branches of the river. The distribution of quahogs is generally similar to that of bay scallops and extends about 1½ miles above the harbor area in the west branch and about 2 miles inland in the east branch. However, the greatest abundance of quahogs occurs in the west branch and lower harbor area.

The ranges of water temperature and salinity recorded within the area of quahog production were found to be conducive to the growth and success of this species from May through November when the temperature was in excess of 50°F. In the lower east branch of the river water temperature ranged from 36.0°F to 78.3°F; salinities ranged from 10 0/00 to 33 0/00. In the west branch the ranges were 36.0°F to 73.0°F and 12 0/00 to 31 0/00.

Belding (1931) noted that the quahog spawns when the water temperature has reached about 76°F. On only three dates, two in July and one in August, were temperatures 76°F or greater recorded in the lower estuary. However, from June through September temperatures approach the optimal for spawning and of 70° suggesting that during the summer period water temperatures approach the optimal for spawning and growth of the quahog.

It is generally known that quahogs thrive in slightly diluted sea water which has a salt concentration above 15 0/00. Turner (1953) suggested that the optimal salinity range for the growth of the quahog is from 24–28 0/00. With the exception of readings during the month of March, the recorded salinity range in the lower portion of the Westport estuary was 22–33 0/00. In March, a salinity of 10 0/00 was noted in the lower east branch and 12 0/00 at a station in the west branch. The lowered salinity during this month was undoubtedly due to spring thawing which added considerable fresh water to the estuary. While a few scattered quahogs are found in the east branch above the area designated in Figure 10, the inland extension of quahogs in significant abundance beyond that area is probably limited by the lowered salinities which are common higher in the river, especially during periods of rain and fresh water run-off.

The major factor limiting quahog abundance seems to be lack of favorable bottom. During the past decade eel grass has been rapidly spreading on bottom areas which were formerly productive in quahogs. Quahogs sampled in eel grass areas have reflected poor growth suggesting that the dense eel grass interferes with circulation and food supply to the quahog. Soft bottom and dense eel grass is especially obvious in the west branch of the river. The tendency toward less forceful ebb and flow of the tide in the west branch may be associated with hydrographic changes which have occurred with the gradual filling in of the lower harbor. Future dredging projects may bring about hydrographic changes which will favor the ecology of the quahog.

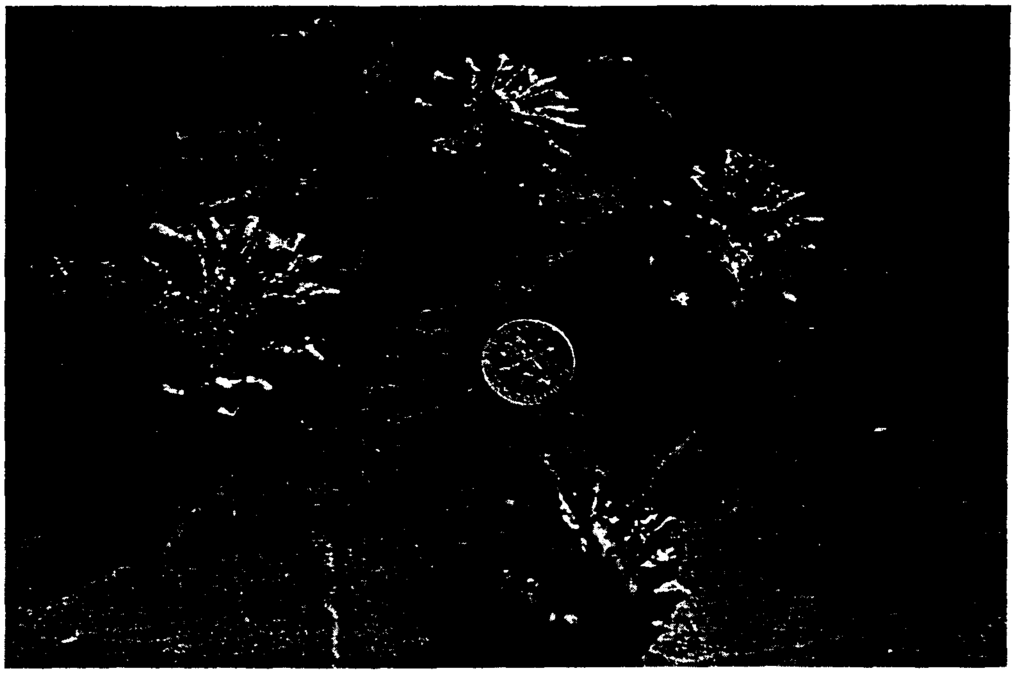
Oysters

The east branch of the Westport River is one of the few areas in the Commonwealth that still supports natural populations of oysters in commercial quantities. This resource occurs in an area from about 2 to 4 miles above the river mouth. In 1966 commercial oystermen harvested 614 bushels of oysters with a total wholesale value of $4,912.00 ($8.00/bushel). Family fishermen harvested 94 bushels of oysters valued at $752.00. The total wholesale value of the commercial and family harvest was $5,664.00. The total 1966 oyster landings in Massachusetts was about 6,280 bushels indicating that the Westport River harvest accounted for about one-ninth of the total state oyster landings.

Oysters occur under a wide range of salinity conditions. The optimum range is from about 10 0/00 to 28 0/00. It is commonly known that oysters fare better in areas where there is considerable dilution of sea water by fresh water tributaries. The area of oyster production in the Westport River falls in this category. During 1966 salinity measurements collected at Hix Bridge ranged from 2.0 0/00 to 29.5 0/00. The lowest recordings occurred from February through April. Salinity data collected during a 1961 oyster study in the vicinity of Hix Bridge ranged from 2.1 0/00 to 22.0 0/00.

Since 1961 a large compartmented raft located above Hix Bridge has been utilized by the town shellfish

PLATE 13.



Yarmouth seed oysters placed on raft in December.

PLATE 14.

Yarmouth oysters in following September showing growth of nine months.

PLATE 15.

Westport oyster raft.

officer and biologists of the Division of Marine Fisheries to conduct various oyster growth studies and to gain fast growth of oyster spat prior to transplanting to other areas of the river. Growth studies conducted from 1961 to 1963 showed that it was possible to grow marketable size oysters (3 inches in length) on the raft in two years from the time of setting. Oyster spat which was placed in trays on the raft attained 2 inches in length in 1 year with an additional 1 to 1½ years required for the oysters to reach 3 inches. Most oysters which reached 3 inches in 2 years were those growing as singles and in uncrowded densities, indicating that selective culling would be very important in achieving maximum growth through the raft tray method. During the study period annual oyster mortality on the raft was less than 9%.

Seed stock grown successfully on the raft included oysters from several areas in Massachusetts (Martha's Vineyard, Wellfleet, Yarmouth, Wareham and Marion) and from areas in Connecticut, New York and New Hampshire. Since 1961 approximately 100 bushels of seed and adult oysters have been transplanted from the raft to fishing grounds in the river.

The raft has also been utilized to catch oyster spat by hanging cultch bags or shell stringers from the sides of the raft.

While low salinities do not interfere with the success of the oyster, they do limit the distribution of the oyster drill (*Urosalpinx cinerea*) which is probably the most distructive natural agent of oysters in Massachusetts. Galtsoff (1964) points out that at summer temperatures very low survival of the drill occurs at salinities of 12 0/00 to 17 0/00. Salinity data collected during the study indicates that salinities below this range frequently occur in the area of the oyster resource. Since no incidence of drill predation upon oysters in the river has been reported it may be assumed that environmental conditions, notably salinity, are unfavorable to the survival of this predator.

Discussion

The Westport River harbours one of the most productive shellfisheries on the south shore of Massachusetts. It is fortunate in supporting significant commercial fisheries for quahogs, scallops and oysters. On occasion soft shell clams are also harvested commercially. In 1966, the total wholesale value of the combined family and commercial shellfish harvest was $224,084.62. Ninety per cent of the harvest value during that year was attributable to the harvest of bay scallops.

Westport River Shellfish Harvest — 1966

	Bushels	*Value*
Bay Scallops		
Commercial	35,011	$182,875.10 ($4.00–$7.00/bus.)
Family	3,484	$ 18,304.40
Quahogs		
Commercial	723	$ 5,465.88 ($4.50–$9.60/bus.)
Family	1,024	$ 7,741.44
Oysters		
Commercial	614	$ 4,912.00 ($8.00/bus.)
Family	94	$ 752.00
Soft Shell Clams		
Commercial	—	—
Family	291	$ 3,492.00 ($12.00/bus.)
Blue Mussels		
Commercial	129	$ 541.80 ($4.20/bus.)
Family	—	—
Total wholesale value		$224,084.62

During the study year 62 individuals derived income from the river by shellfishing on either a part time or full time basis. These fishermen purchased commercial shellfishing licenses from the town at a cost of $15.00 each which accounts for a revenue to the town of $930.00. Five oyster grant owners also renewed grant permits costing $5.00 each amounting to a total of $25.00. Three hundred and sixty-five general family shellfishing permits and 134 permits specific for family scalloping were issued by the town. These permits were levied at $2.00 each. Six $5.00 non-resident permits were issued for fishing in an area restricted to non-residents. Total income from the sale of permits and licenses was $1,958.00.

The record bay scallop crop of the 1966 study year provided income to 53 commercial license holders. Unfortunately, the bay scallop is a "feast or famine" resource which is abundant one year in a given area and scarce the next. In 1967 no commercial scallop licenses were purchased in Westport because of the lack of scallops. Similarly, scallops were scarce in the river from 1961 to 1964.

The precise cause for the fluctuation in annual sets of scallops is not known but is probably associated with adverse environmental conditions during the spawning season. These conditions might include currents which carry the larvae out of the estuary or sudden salinity or temperature changes which are unfavorable to the survival of the larval scallops.

Because of its short life (20–26 months) and the unpredictability of its spawning success, little can be done to improve the status of the bay scallop resource. The scallop matures rapidly, being of harvestable size when about 15 months old. Most scallops die at an age of about 20 months. Consequently, the scallop resource cannot be perpetuated by restricting harvest limits or maintaining propagation areas which would be opened and closed on a rotational basis. At present, the only practical technique utilized to increase scallop supplies is the moving of seed scallops from shallow areas to deeper waters where the scallops will grow better and be less subject to winter freezing. Such transplantings have often been made in the past by the Westport Shellfish officer.

Hopefully, with the advancement of successful artificial culture of this shellfish, it may some day be possible to supplement poor natural setting with seed scallops mass-produced in laboratories.

The quahog fishery in the Westport River has tended to gradually decline. The following lists the combined annual family and commercial quahog harvest from 1956 to 1967 as reported by the shellfish constable.

1956 — 8,500 bushels	1962 — 4,000 bushels
1957 — 6,000 "	1963 — 3,500 "
1958 — 5,000 "	1964 — 3,300 "
1959 — 3,500 "	1965 — 4,860 "
1960 — 4,500 "	1966 — 1,747 "
1961 — 4,150 "	1967 — 1,804 "

With the exception of the slight annual increase in 1960, 1965 and 1967 the trend of the fishery appears to be downward, from 8,500 bushels in 1956 to 1,804 bushels in 1967. Because of the decreasing supply of quahogs, purchases of shellfish licenses and permits by the townspeople declined drastically. In 1956 licenses purchased to harvest quahogs commercially numbered 43; in 1966 there were only 8 such licenses. During the same period family permits declined from 798 to 365.

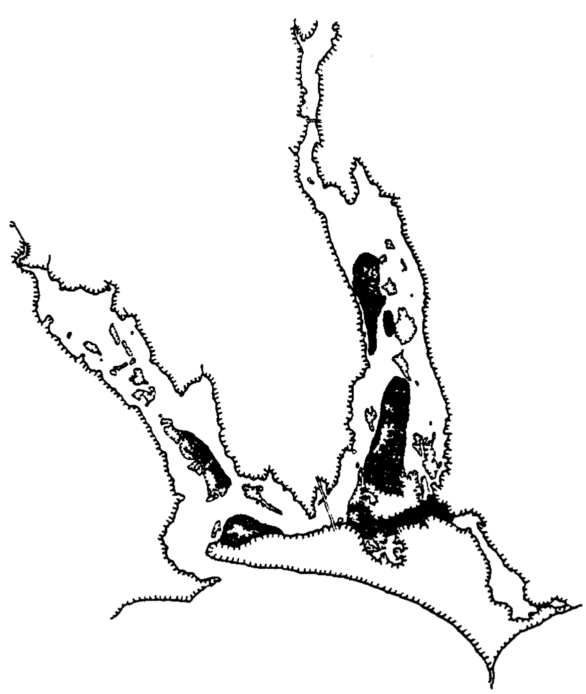
The main factors contributing to the decrease of the resource have been the encroachment of eel grass upon productive quahog bottom and the lack of natural quahog setting. However, examination of the policy of the Westport shellfish program has indicated that the quahog fishing regulations are excessively liberal and do not serve to control further depletion of the resource. For instance, family and commercial permit holders are allowed to gather quahogs on every day of the year and in any portion of the river. Because of the increasing number of people going to the shore each year to gather shellfish most towns on the south shore of Massachusetts have found it necessary to firmly regulate shellfishery seasons and harvest limits. Without restrictive regulations, the quahog resource in many other towns would be rapidly over-exploited. Other towns have also further regulated the quahog fishery by opening and closing areas on a rotational basis thusly insuring that at least one rich quahog fishing area is available to the fishermen each year. By keeping one or two productive areas closed, the town is assured of always having new areas that can be opened when another has become depleted. Quahog populations in closed areas should be supplemented with transplantings of purchased seed quahogs or quahog stock from contaminated waters.

It is obvious that new propagative measures and management regulations must be adapted if the quahog industry is to be revived. A broad approach to restoring the quahog resource to its former abundance should include the following measures.

1. Selection of quahog grounds in both the east and west branches of the river that could be managed as separate units. Final determination of the most potentially productive grounds could be made by a cooperative effort of the shellfish constable and the state shellfish biologist of the Division of Marine Fisheries and the estuarine team which conducted the present study.

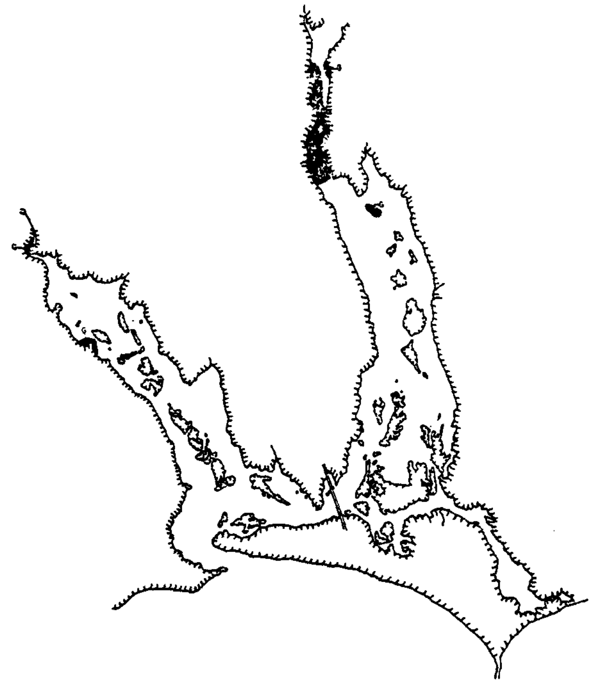
2. Immediate closure of up to 50% of the selected management grounds. These areas should remain closed for at least two years. Both family and commercial fishing should be prohibited during the closure.

Figure 8.



MAJOR BAY SCALLOP BEDS.

Figure 9.



OYSTERS.
(G = Private Grant)

3. Periodic survey of the closed area should be made by the shellfish constable to gather information relative to setting success, growth and mortality rates, natural predation and encroachment of eel grass.

4. While the areas are closed attempts should be made by the town to obtain quahog stock, preferably seed, for transplanting to the area. The Division of Marine Fisheries would assist in attempting to find sources for the procurement of such stock. Once planted, the areas should remain closed for at least two years.

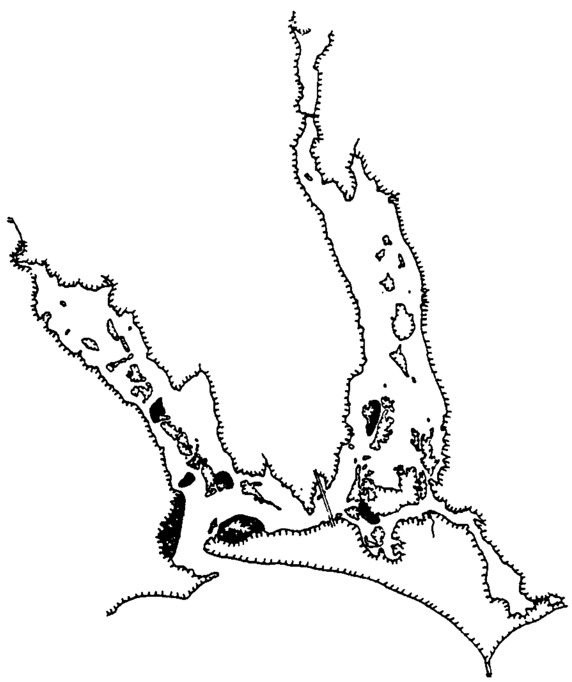
5. Family fishing should be restricted to two or three days per week. Limiting the allowable number of fishing days per week is especially important during the summer period when fishing pressure increases because of the influx of summer residents.

6. Allowable daily and weekly harvest limits of both commercial and family fishermen in open areas should be reduced. Family permit holders should be restricted to one peck per day and not more than ½ bushel per week. Commercial harvest limits should be adjusted according to the abundance of harvestable stock within the managed commercial fishing area.

From 1956 to 1967 the annual oyster harvest has ranged from a high of 2,000 bushels in 1958 and 1959 to a low of 450 bushels in 1965. During the period from 1960 to 1966 the trend of the fishery was downward with annual harvests of less than 1,000 bushels. However, in 1967 the supply of adult oyster stock again increased and provided a harvest of 1,654 bushels. Since the turn of the century oysters have been decreasing throughout most of their natural range along the Atlantic Coast. Many investigators attribute the decline of the fisheries to overfishing without early adoption of compensatory propagation and management measures. In many areas south of Massachusetts, negative factors such as disease, predation by natural enemies, and loss of environment through pollution have acted to the further detriment of the resource. Fortunately, in Massachusetts the natural oyster producing areas are still largely free of pollution and destructive disease. While predation by the oyster drill has presented a problem in some areas, its detriment to the resource in the Westport River is relatively small.

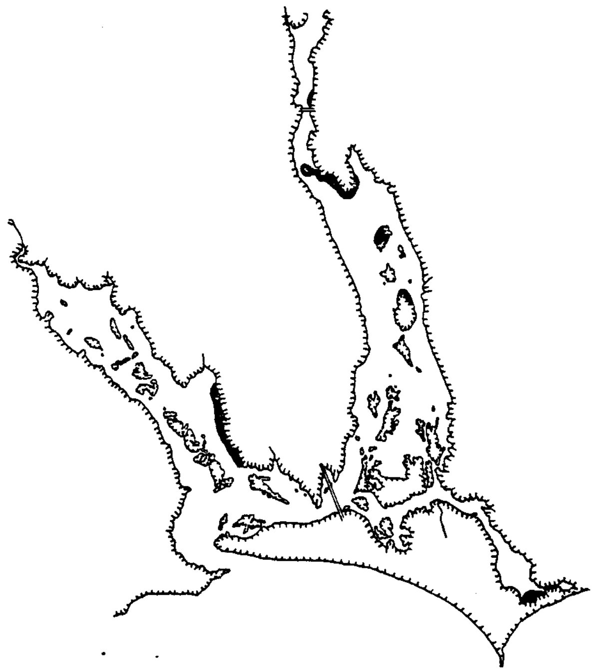
Probably the most important natural factor limiting oyster production in Westport, as elsewhere, has been the inconsistency in the occurrence of dense annual oyster sets. While the Westport River is one of the best natural oyster areas in the Commonwealth, annual sets do not always occur and consequently there are many years when no new year class of oysters enters the fishery.

Figure 10.



MAJOR QUAHOG BEDS.

Figure 11.

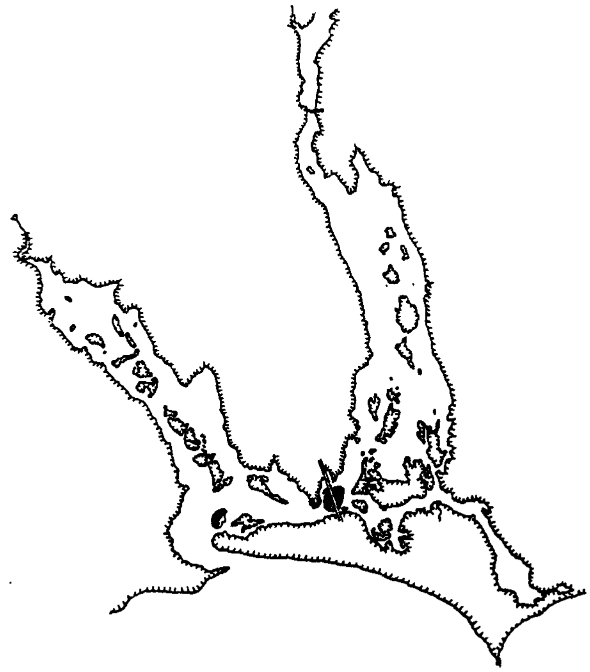


MAJOR SOFT SHELL CLAM BEDS.

The main management problem of the Westport oyster fishery is common to that of the entire industry of Massachusetts — lack of coordinated effort by the towns and the state to institute a comprehensive seed oyster propagation program. Such a program would be an oyster propagation plan for the south shore of Massachusetts that would increase the availability of oyster seed to both the towns in which the state beds were located and to other towns involved in the program. At the same time, the maintenance of multiple seed areas would aid in establishing a consistent supply of seed oysters. Belding (1919), in discussing the problems of the Wellfleet oyster industry pointed out that the future success of the Massachusetts oyster industry would depend not only on producing oysters of good quality but also upon the raising of seed oysters.

Similarly, the need for intensive propagation of native seed oyster stocks in Barnstable County was emphasized in the comprehensive report *A Study of the Marine Resources of Barnstable County, Massachusetts* by Matthiessen and Toner (1963). In that report the authors pointed out that the feasibility of farming oyster seed on grants could perhaps best be proven by creating a state oyster farm system that would be managed by the Division of Marine Fisheries. Suggested management measures included the estab-

Figure 12.



MAJOR BLUE MUSSEL BEDS.

lishing of an area with a natural oyster bed suitable for oyster culture; the providing of cultch in proximity to oyster beds; experimentation with oyster rafts, and elimination of predators by physical or chemical means.

The Division of Marine Fisheries in cooperation with the towns should give consideration to the creating of state oyster beds in the most potential oyster setting areas of Massachusetts. The towns of Westport, Wareham and Wellfleet are three such natural oyster producing areas.

SUMMARY

The total wholesale value of the 1966 shellfish harvest in the Westport River was $224,084.52. Ninety percent of this value was attributable to a record harvest of bay scallops valued at $201,179.50. Fifty-five commercial fishermen derived income from the shellfish from the river. The major economic shellfish species of the Westport River are bay scallops, quahogs and oysters, all of which are harvested by both family and commercial fishermen. A minor family fishery occurs for soft shell clams. In recent years blue mussels have been harvested by several fishermen and sold as sportfishing bait.

A cooperative effort should be made by the Division of Marine Fisheries and the Town of Westport to expand the quahog and oyster resources through intensive application of propagation and management techniques.

LOBSTER AND CRAB FISHERIES

Lobsters

The principal lobster fishery occurs seasonally outside the river. Only about 100 pots are set within the river. The lobster fishing season extends from about the first of April to the end of December.

Catch reports submitted to the Division of Marine Fisheries by licensed lobstermen indicated that 12 lobstermen worked out of Westport during 1966. The reports indicated that 2,075 pots were fished in coastal waters adjacent to the Westport River with a catch of 45,393 legal size lobsters (63,347 pounds). The value of this catch to the fishermen was approximately $50,677.00. While moderate in scope the Westport inshore lobster fishery is vital to those individuals engaged in it for a livelihood.

The Prelude Lobster Company, using Westport as a base of operations, fishes outside of Massachusetts' coastal waters from April through January from Cox's Ledge to the Nantucket Shoals and beyond to the edge of the Continental Shelf. This operation is rather unique in many ways. The boat used by the Prelude Company, as pictured in plate 18, is of open stern construction. The stern can be closed if necessary with removable planks. A 450 H.P. diesel engine powers this boat to the offshore fishing grounds where a total of 1,100 pots are set in 100 pot trawls. The Prelude tows a floating trailer carrying 100 pots behind its stern. The pots used are about twice the size of those used by inshore lobstermen.

The lobsters are retailed by the company and wholesaled to restaurants and stores within the town. Lobsters are also sold to restaurants and stores in the cities of Boston and New York.

The future plans of this lobster company include the building of a 100 foot boat and expansion of fishing operations. The company may have to leave Westport as a base of operations unless needed dredging of the river and harbor is accomplished.

Green and Calico Crabs

A part time green and calico crab fishery exists within the channels of the East and West branches of

Westport River. The green crab ranges from southern Maine to New Jersey. The calico crab is found from Cape Cod to Florida. Both of these small crustaceans are members of the swimming crab family which inhabit shoal waters of our estuaries. Although not commonly thought of as being important economically these crabs are sought after by sport fishermen for use as bait when fishing primarily for tautog.

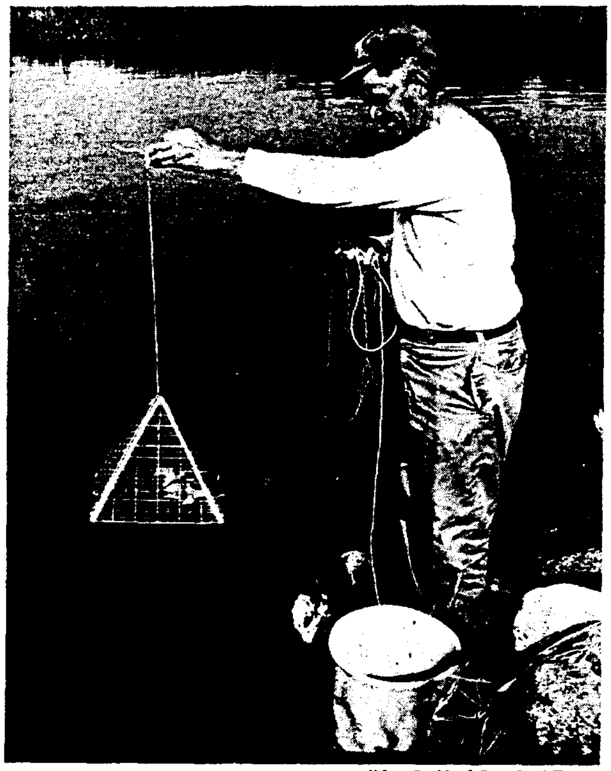
The green and calico crab fishery in Westport is seasonal, coincident with their availability within the estuary and with their demand as bait for sport fishing. This season extends from about May through October. A total of about 200 pots are set in the river with approximately 50 bushels of crabs being taken per week. The green crab constitutes the larger portion of this catch. Although this is a limited fishery, the crabs are sold wholesale for about $0.80 per gallon which totaled $6,400.00 for the six month period. The retail price was about $1.25 per gallon for a total of $10,000.00 for the same period.

Blue Claw Crabs

The Westport River is one of the few areas on the south shore of Massachusetts where blue claw crabs (*Callinectes sapidus*) still occur in numbers sufficient to support a family fishery. During the late summer and fall the fishery is especially evident at Hix Bridge where people gather with baited lines, dip nets and sometimes tray-like devices to catch the succulent crustaceans. The most popular method of capturing crabs is by simply tying a fish head or other raw meat to the end of the line and tossing it into the water and letting it settle to the bottom. Once feeding on the bait the crabs tend to hold on so tenaciously that they can be pulled into shallow water where they are scooped up with a dip net. Because of the sporadic nature of the fishery it was not possible to gain any estimate of the volume of the blue crab catch. By state regulations (General Laws Relating to Marine Fish and Fisheries, Chapter 130) up to 50 edible crabs can be caught by an individual in a single day from April 1 to November 30.

Blue crabs were taken coincident with finfish sampling in both the west and east branches of the river during the late summer and fall. On August 13, 42 blue crabs were taken while sampling with the 160 yard haul seine above Hix Bridge. Blue crabs were also taken at the otter trawl and 60 foot haul seine stations from August to November. Biologists also noted that blue crabs were taken in pots coincidental with lobster fishing in the lower estuary during the fall.

PLATE 16.



(New Bedford Standard Times)

Trap used to capture blue claw crabs.

The blue claw crab is a species which was formerly abundant on the south shore of Massachusetts but has been declining in numbers for at least the last decade. Such decline has also been observed in waters south of Massachusetts. Jeffries (1966) noted that the blue crab began to decline in Rhode Island in the mid-1930's and that by 1938 they had diminished to the point that it was no longer profitable to fish for them commercially. The cause of the decline of this crab in our waters is unknown. Many fishermen along the shore have expressed the belief that the loss of blue claw crabs — also fiddler crabs (Uca spp.) is due to the careless use of pesticides in coastal areas. While it is certainly possible that pesticides have had a detrimental effect upon crab populations no conclusive evidence has been documented in this regard.

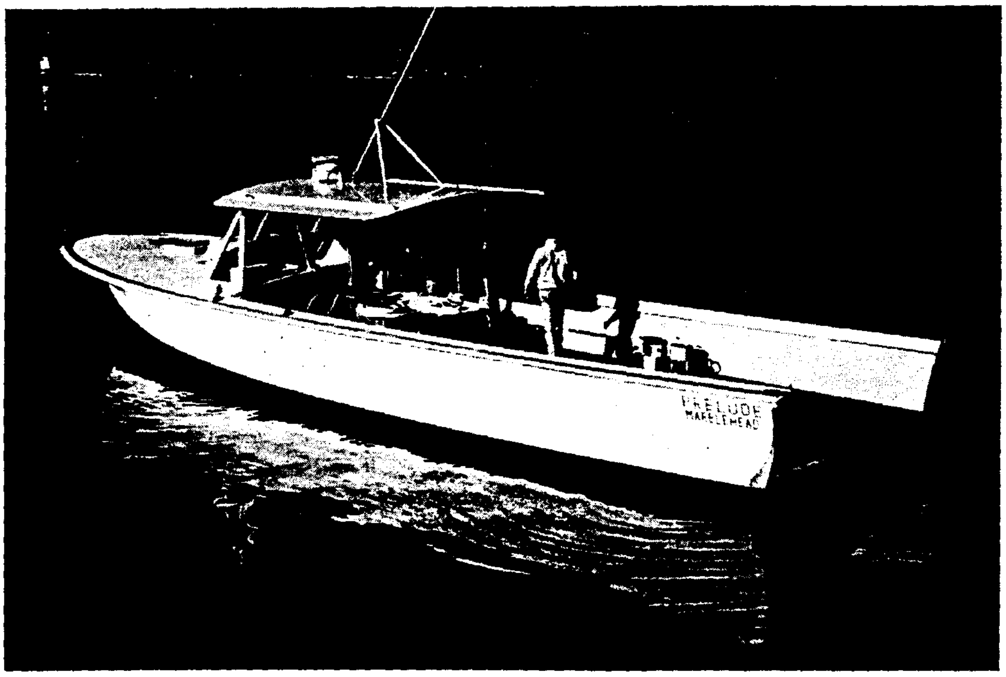
Practically no investigative work has been conducted relative to the blue crab and its ecology in Massachusetts. Such work should be initiated in an attempt to determine the cause of the decline of this resource and management practices needed to restore it to its former abundance.

PLATE 17.

(*New Bedford Standard Times*)

Handlining for blue claw crabs at Hix Bridge.

PLATE 18.



Unfinished open stern boat owned and operated by the Prelude Lobster Company, Westport.

THE WESTPORT RIVER TIDEMARSHES

Introduction

The tidemarshes of the Westport River provide scenic beauty consistent with the coastal atmosphere of the Westport community as well as playing host to a variety of wildlife species. The marsh flats and islands with their variety of grasses and algae are vitally important in the over-all ecology of the estuary. The role of tidemarshes to estuarine productivity is summarily described in the following passage by Fiske et al., 1967.

"Coastal wetlands, or tidemarshes, serve as natural buffer zones between the land and the sea and provide unique and irreplaceable habitat for many species of plant and animal life. The arterial creeks of the marsh provide essential spawning, feeding, or nursery grounds for a variety of commercial, sport and forage fish species. The intertidal shores and shoal waters of the tidemarsh are vital nesting and wintering habitat for many species of shorebirds and waterfowl.

"The tidemarsh plays an important role in the over-all biological productivity of the estuary and its adjacent coastal waters. Ecological studies have shown that the tidemarsh is prodigious in its manufacture of organic matter and essential nutrient salts. The production and utilization of these products involves a complex web of interactions between nutrients, plants and animals of the estuarine system. This cycle may be summarized in the following manner.

"As marsh plants die and decompose, detritus (fine particles of organic matter) is formed. This material may be utilized directly in the food chain by various mollusks, crustaceans, or worms, or may break down further into nutrient salts such as nitrates and phosphates which are essential to the total productivity of the estuarine environment.

"These nutrients nourish the living marsh grasses and the microscopic phytoplankton which constitute the primary step in the food chain of the sea. The phytoplankton is consumed by many types of organisms from tiny zooplankters to the larger fishes of the sea. Mollusks and finfish which are utilized by man might be considered end products of this complex food chain.

"With the realization that our tidemarshes have been indiscriminately altered or destroyed in the past by private or commercial exploitation, citizen and professional conservationists of Massachusetts have acted concertedly with legislators to enact laws which regulate the dredging and filling of our tidemarsh areas. Studies have been conducted by the Department of Natural Resources to evaluate the extent and status of all our coastal wetlands to develop programs of tidemarsh protection (Fiske, 1964)."

Because of the high recreational, scenic and biological values associated with the Westport River marshes, a specific marsh survey was conducted as part of this over-all resource study. Inventory was made of the marsh flora occurring in a typical section of marsh and notation made of the transition of plant species within the intertidal area up to the upland border. Algae and submerged vascular plants in the waters adjacent to the marsh were also collected and identified. The total marsh acreage in the study area was determined and a survey made of its present ownership and degree of protection.

Methods and Materials

The acreage of the tidemarsh was determined from a U. S. Geological Survey topographic map (Westport Quadrangle, 1963). Surface area was calculated with a compensating polar planimeter and linear distance measured by a map rotometer. The amount of publicly owned or regulated marsh acreage was obtained from records in the Westport Town Hall and through communication with Mr. Medeiros, Chairman of the Westport Conservation Commission.

The field investigation of a typical section of salt marsh was carried out on a randomly chosen salt marsh area. Sampling of flora was conducted in May and again in August of 1967. Most of the algae collected were taken by beach seine, dredge, and otter trawl while in the process of sampling shellfish and finfish populations.

Texts used for identification of marsh plants included: *Marine Algae of the Northeastern Coast of North America* (Taylor, 1957) and *Gray's Manual of Botany* (Fernald, 1959).

Findings and Discussion

A randomly selected plot of salt marsh on the east branch of the Westport River was chosen for a survey of marsh flora. The most common plant species on the marsh was found to be salt water cord grass (*Spartina alterniflora*). This species extends from the water's edge approximately to the middle of the marsh where it is replaced by the thickly matted salt meadow grass (*Spartina patens*), which is immersed by the high tides less frequently than the cord grass. Spike grass (*Distichlis spicata*) is found growing just above the salt meadow grass and is the uppermost species of the marsh, growing just below the beach grass (*Ammophila breviligulata*) of the upland border.

Within the area of spike grass were found scattered specimens of sea blite (*Suaeda maritima*), orach (*Atriplex patula*), sand spurry (*Spergularia canadensis*), and marsh elder (*Iva frutescens*). The common marsh rosemary (*Limonium carolinianum*) was found scattered within the cord and meadow grass areas. The annual glasswort (*Salicornia europaea*) was also found in both

FIGURE 13.

WESTPORT RIVER TIDEMARSHES

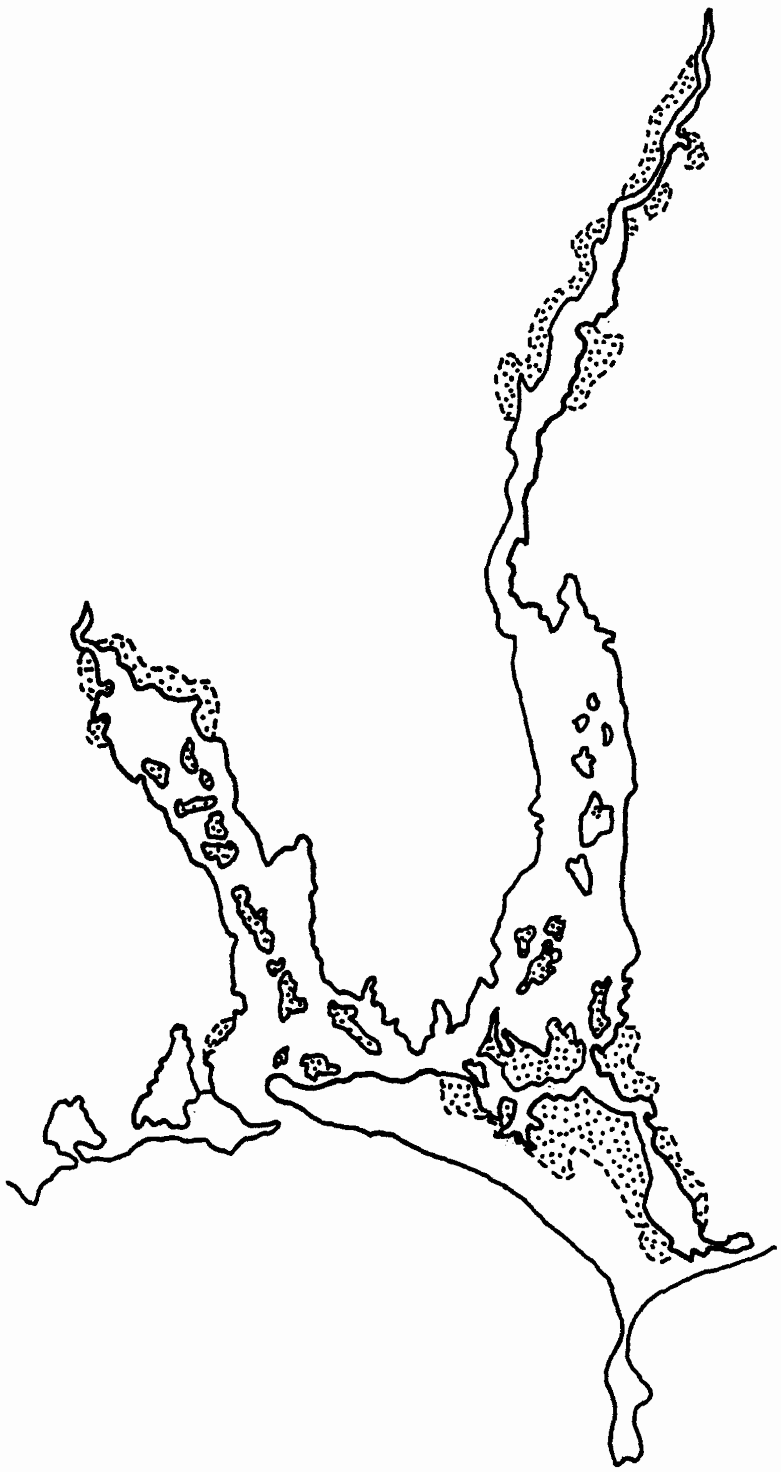
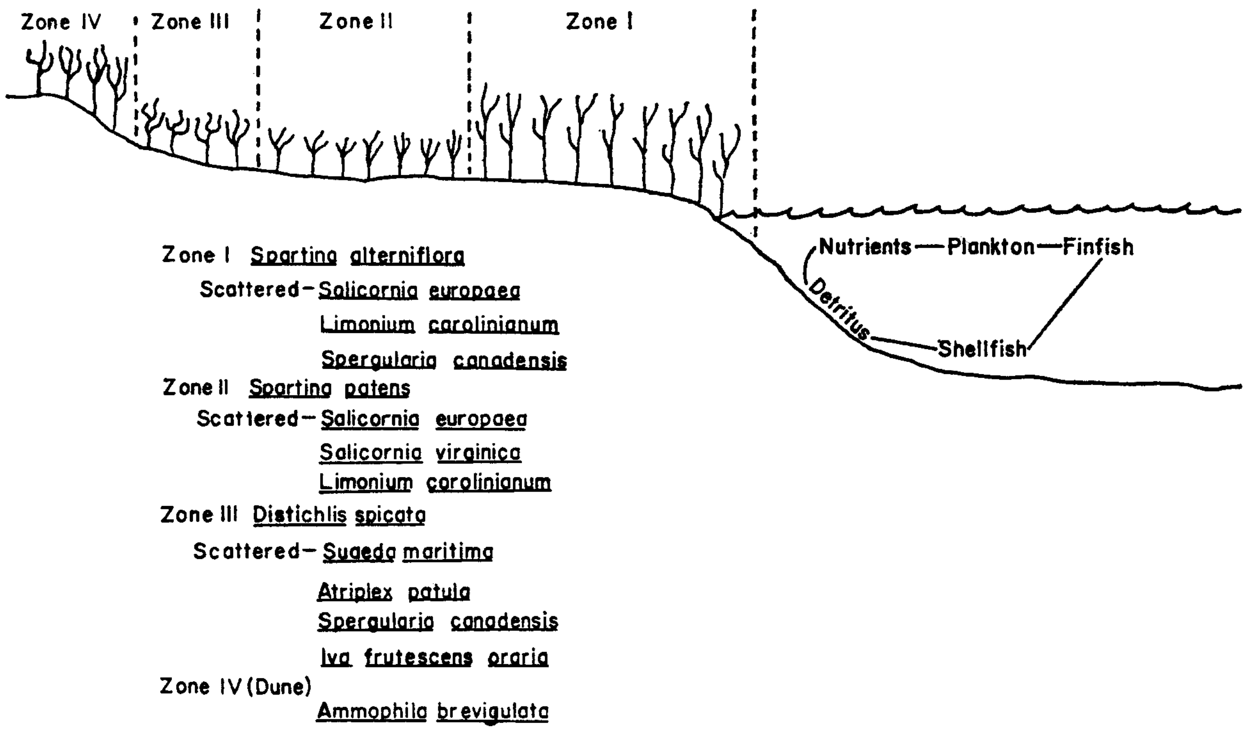


FIGURE 14.

PLANT ZONATION IN A WESTPORT RIVER TIDE MARSH



the cord and meadow grass areas. The perennial glasswort (*Salicornia virginica*) was found only in the salt meadow grass zone. The glassworts are tolerant both to salt and long periods of desiccation. A sample of sand spurry was also found in the salt water cord grass zone.

A total of ten plant species were collected incidental to sampling at the finfish stations. These included: eel grass, three species of green algae, two red algae, and four brown algae. A complete list of plants collected within the study area is presented in Table 13.

Eel grass

Below mean low water, eel grass (*Zostera marina*) is the most prevalent vascular plant growing in the Westport River. In recent years eel grass has been rapidly spreading in the Westport River just as it has in other protected bays and estuaries of Southern Massachusetts. In moderate density, eel grass is beneficial to many forms of marine animals. For instance, baitfishes and the juvenile forms of large species find shelter amidst the eel grass clumps. Young bay scallops, upon reaching the setting stage, anchor themselves to the grass blades. Decomposing eel grass forms detritus which is fed upon by many mollusks and crustaceans.

Starting in about 1931, an epidemic destroyed eel grass along the entire Atlantic Coast. With the loss of eel grass in Massachusetts, a noticeable drop in bay scallop production occurred and did not improve until eel grass began to reestablish itself. Today, the distribution of eel grass in Massachusetts is perhaps more extensive than it has ever been in the last century.

While eel grass in moderate density is favorable in many respects to marine life, excessive growths in many of our coastal areas are hampering commercial shellfishing operations by clogging scallop dredges and interfering with the raking and tonging of quahogs and oysters on what was once clear bottom. Although eel grass is favorable to the setting of juvenile scallops, it has been noted that mature scallops growing amidst eel grass tend to be smaller in size than those growing in adjacent open areas where the current is unimpeded and the scallops receive a constant new food supply.

Detriment to shellfisheries also occurs when dead eel grass accumulates in dense mats and smothers beds of shellfish.

Because of the increasing growth of eel grass on shellfish beds, considerable research is presently being conducted to find an effective method of control. To date, no attempted methods have proven themselves completely practical. One town on the south shore of Massachusetts has attempted to cut eel grass with an underwater mower designed for cutting submerged vegetation. At best, this method is only temporary since the plant stalk is cut off above the substrate surface leaving the stems and roots to produce new growth. Experimentation by various agencies with herbicides is presently being conducted. While certain chemicals such as 2,4-D have effectively destroyed eel grass, the toxicity of the chemicals to associated fauna is not clearly known. Similarly, it is still not known to what degree herbicide residues may accumulate in the live bodies of shellfish within and adjacent to the treatment area. Further investigation and analysis may pave the way for future practical and safe use of herbicides in the estuarine environment. Until such time, no herbicides should be introduced indiscriminately into our coastal bays and rivers.

Table 13. A check list of marine vegetation collected in the Westport River study area, 1966

Scientific Name	Common Name
ALGAE	
Class: CHLOROPHYCEAE	GREEN ALGAE
Enteromorpha marginata	
Enteromorpha plumosa	
Ulva lactuca	sea lettuce
Class: RHODOPHYCEAE	RED ALGAE
Agardhiella tenera	
Ceramium rubriforme	
Class: PHAEOPHYCEAE	BROWN ALGAE
Ascophyllum nodosum	rockweed
Fucus edentatus	rockweed
Fucus spiralis	rockweed
Fucus vesiculosus	rockweed
VASCULAR PLANTS	
Ammophila breviligulata	beach grass
Atriplex patula	orach
Distichlis spicata	spike grass
Iva frutescens oraria	marsh elder
Limonium carolinianum	marsh rosemary
Salicornia europaea	annual glasswort
Salicornia virginica	perennial glasswort
Spartina alterniflora	salt water cord grass
Spartina patens	high water cord grass
Spergularia canadensis	sand spurry
Suaeda maritima	sea blite
Zostera marina	eel grass

Current Ownership and Protection

In a 1964 coastal wetland study (Fiske, op. cit.) conducted by the Department of Natural Resources, the Westport River marshes were listed among the priority wetland areas of the Commonwealth which are in need of permanent protection. The marshes of the east and west branches of the river were found to be of high value to finfish, shellfish and waterfowl. Similarly, the Westport Master Plan (Economic Development Associates, Inc., 1964) stressed the importance of preserving the wildlife, scenic and recreational value of the river marshes. Study findings of the Master Plan determined that the maintenance of Westport's natural coastal character is of economic importance to the town and that marshland protection should be a major consideration in its policy of future land use. Recommendations included: acquisition of marshlands by the Commonwealth and donation of marshland to the Conservation Commission. The plan also suggested that marshland purchase be a high priority of the Conservation Commission.

Of the 1,003 acres of marsh in the river, few are publicly owned. At the present time only Bryant's Marsh of seven acres in the east branch of the river has been acquired by the Conservation Commission. The remaining 996 acres of marshland are privately owned and not under any permanent plan of protection.

State Legislation Affecting Coastal Wetlands

In 1963 the state adopted legislation relative to the control of dredging and filling in coastal waters (Section 27A, Chapter 130). As one of its provisions the law prohibits alteration of tidemarsh without written application to the city or town authorities, the Massachusetts Department of Public Works, and the Division of Marine Fisheries. If the proposed alteration would have a detrimental effect upon marine fisheries, the director of the Division of Marine Fisheries has the authority to impose project conditions for their protection. Since the passage of this law, many tidemarsh areas have been spared from indiscriminate destruction.

During 1965, a more comprehensive coastal wetlands protection bill (Chapter 768) was enacted by the Massachusetts Legislature. Among the major provisions of this act were the following:

1. Granting the Department of Natural Resources greater authority in regulating the use of coastal wetlands;

2. Providing towns with the authority to take conservation lands by eminent domain after approval by a two-thirds vote by the towns-people.

Section 27A, Chapter 130. An Act Relative to Removal, Filling and Dredging in Coastal Waters. (Chapter 426, Acts of 1963) (Amended by Chap. 375, Acts of 1965)

No person shall remove, fill or dredge any bank, flat, marsh, meadow or swamp bordering on coastal waters without written notice of his intention to so remove, fill or dredge to the board of selectmen in a town or to the appropriate licensing authority in a city, to the state department of public works, and to the director of marine fisheries. Said notice shall be sent by registered mail at least fourteen days prior to any such removing, filling or dredging. The selectmen or, in the case of a city, the licensing authority, shall hold a hearing on said proposal within twenty days of the receipt of said notice, notice of which hearing shall be given by them by publication in a newspaper published in such town or city, or if there be no newspaper published in such town or city, then in a newspaper published within the county, and shall notify by mail the person intending to do such removing, filling or dredging, the department of public works and the director, of the time and place of said hearing. The cost of such publication of notice shall be borne by the person filing the notice of intention to so remove, fill or dredge. The selectmen or licensing authority as the case may be, may recommend the installation of such bulkheads, barriers or other protective measures as may protect the public interest. If the department of public works finds that such proposed removing, filling or dredging would violate the provisions of sections thirty and thirty A of chapter ninety-one, it shall proceed to enforce the provisions of said sections. If the area on which the proposed work is to be done contains shellfish or is necessary to protect marine fisheries, the said director may impose such conditions on said proposed work as he may determine necessary to protect such shellfish or marine fisheries, and work shall be done subject thereto.

Whoever violates any provision of this section shall be punished by a fine of not more than one hundred dollars or by imprisonment for not more than six months, or both, and the superior court shall have jurisdiction in equity to restrain a continuing violation of this section.

This section shall not affect or regulate the ordinary and usual work of any mosquito control project operating under chapter two hundred and fifty-two, or under the provisions of a special act. (Effective date: May 22, 1963.)

CHAPTER 768
THE COMMONWEALTH OF MASSACHUSETTS

In the Year One Thousand Nine Hundred and Sixty-five

AN ACT PROVIDING FOR THE PROTECTION OF THE COASTAL WETLANDS OF THE COMMONWEALTH.

Whereas, The deferred operation of this act would tend to defeat its purpose, which is in part to immediately provide for the protection of coastal wetlands against the imminent threat of the development of such lands for industrial and other uses detrimental to their preservation in their natural state, therefore it is hereby declared to be an emergency law, necessary for the immediate preservation of the public convenience.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, as follows:

SECTION 1. Chapter 130 of the General Laws is hereby amended by adding the following section: —

SECTION 105. The commissioner, with the approval of the board of natural resources, may from time to time, for the purpose of promoting the public safety, health and welfare, and protecting public and private property, wildlife and marine fisheries, adopt, amend, modify or repeal orders regulating, restricting or prohibiting dredging, filling, removing or otherwise altering, or polluting, coastal wetlands. In this section the term "coastal wetlands" shall mean any bank, marsh, swamp, meadow, flat or other low land subject to tidal action or coastal storm flowage and such contiguous land as the commissioner reasonably deems necessary to affect by any such order in carrying out the purposes of this section.

The commissioner shall, before adopting, amending, modifying or repealing any such order, hold a public hearing thereon in the municipality in which the coastal wetlands to be affected are located, giving notice thereof to the state reclamation board, the department of public works and each assessed owner of such wetlands by mail at least twenty-one days prior thereto.

Upon the adoption of any such order or any order amending, modifying or repealing the same, the commissioner shall cause a copy thereof, together with a plan of the lands affected and a list of the assessed owners of lands, to be recorded in the proper registry of deeds or, if such lands are registered, in the registry district of the land court, and shall mail a copy of such order and plan to each assessed owner of such lands affected thereby. Such orders shall not be subject to the provisions of chapter one hundred and eighty-four. Any person who violates any such order shall be punished by a fine of not less than ten nor more than fifty dollars, or by imprisonment for not more than one month, or by both such fine and imprisonment.

The superior court shall have jurisdiction in equity to restrain violations of such orders.

Any person having a recorded interest in land affected by any such order, may, within ninety days after receiving notice thereof, petition the superior court to determine whether such order so restricts the use of his property as to deprive him of the practical uses thereof and is therefore an unreasonable exercise of the police power because the order constitutes the equivalent of a taking without compensation. If the court finds the order to be an unreasonable exercise of the police power, as aforesaid, the court shall enter a finding that such order shall not apply to the land of the petitioner; provided, however, that such finding shall not affect any other land than that of the petitioner. The commissioner shall cause a copy of such finding to be recorded forthwith in the proper registry of deeds or, if the land is registered, in the registry district of the land court. The method provided in this paragraph for the determination of the issue of whether any such order constitutes a taking without compensation shall be exclusive, and such issue shall not be determined in any other proceeding, nor shall any person have a right to petition for the assessment of damages under chapter seventy-nine by reason of the adoption of any such order.

The department may, after a finding has been entered that such order shall not apply to certain land as provided in the preceding paragraph, take the fee or any lesser interest in such land in the name of the Commonwealth by eminent domain under the provisions of chapter seventy-nine and hold the same for the purposes set forth in this section.

No action by the commissioner or the department under this section shall prohibit, restrict or impair the exercise or performance of the powers and duties conferred or imposed by law on the department of public works, the state reclamation board or any mosquito control or other project operating under or authorized by chapter two hundred and fifty-two.

No order adopted hereunder shall apply to any area under the control of the Metropolitan District Commission.

SECTION 2. Section 8C of chapter 40 of the General Laws, as amended by chapter 258 of the acts of 1961, is hereby further amended by adding the following four sentences: — For the purposes of this section a city or town may, upon the written request of the commission, take by eminent domain under chapter seventy-nine, the fee or any lesser interest in any land or waters located in such city or town, provided such taking has first been approved by a two-thirds vote of the city council or a two-thirds vote of an annual or special town meeting, which land and waters shall thereupon be under the jurisdiction and control of the commission. The commission may adopt rules and regulations governing the use of land and waters under its control, and prescribe penalties, not exceeding a fine of one hundred dollars, for any violation thereof. No action taken under this section shall affect the powers and duties of the state reclamation board or any mosquito control or other project operating under or authorized by chapter two hundred and fifty-two, or restrict any established public access.

Lands used for farming or agriculture, as defined in section one A of chapter one hundred and twenty-eight shall not be taken by eminent domain under the authority of this section.

SECTION 3. The consent of the Commonwealth is hereby given to the acquisition by the United States, by condemnation, purchase, gift, devise, or lease, of the area, hereinafter described, of land or water, or of land and water, in the Commonwealth, for the establishment of a national wildlife refuge in accordance with the Migratory Bird Conservation Act (16 USC 715-715d, 715e, 715f, 715k, 715l, 715r) and amendments thereof or thereto, reserving, however, to the Commonwealth full and complete jurisdiction and authority over all such areas not incompatible with the administration, maintenance, protection and control thereof by the United States under the terms of said act; provided that the Commonwealth reserves to itself through the state reclamation board and the Plymouth County Mosquito Control Project, and the South Shore Mosquito Control Project, and their successors, the right to provide for control of mosquitoes and greenhead flies in such lands and the right to construct and maintain such ditches, culverts, dams and any other installation on the lands so acquired as may be necessary for the proper control of mosquitoes and greenhead flies. Said area, located in Plymouth county, is bounded and described as follows: — Being approximately 2,300 acres of tidal and fresh marsh, together with included water and contiguous uplands bordering on the North River in the towns of Hanover, Marshfield, Norwell, Pembroke and Scituate, and in general extending from West Elm Street, Barker Street, and state Route 53 in Pembroke downstream along the said North River to its mouth between Third Cliff and Fourth Cliff in the town of Scituate.

SECTION 4. Expenses incidental to adopting and recording orders, and awards of damages for lands taken by eminent domain, under section one hundred and five of chapter one hundred and thirty of the General Laws, as appearing in section one of this act, may be paid out of funds made available under the provisions of chapter five hundred and seven of the acts of nineteen hundred and sixty-four carrying out the provisions of section three of chapter one hundred and thirty-two A of the General Laws.

APPROVED: Novembei 23, 1965

SUMMARY

The tidemarshes of the Westport River are extremely valuable to the over-all biological productivity of the estuary as well as being important to the community from an aesthetic and recreational standpoint. At the present time only seven acres out of a total of 1,003 acres of marsh are under adequate protection. Further acquisition by the Westport Conservation Commission should be attempted and the Department of Natural Resources, acting under the provisions of Chapter 768, should act to place the Westport River marshes under one comprehensive and irrevocable plan of protection.

ECONOMIC VALUES

Westport River

Substantial revenue is derived from the marine resources of the Westport River annually. The wholesale value of the harvest from this estuary in 1966 was $224,084. Bay scallops accounted for 90% of the total value while quahogs and oysters were the next most important species. A limited fishery for softshell clams and blue mussels also existed.

A small eel fishery occurred within the river which was worth $2,025 to several local fishermen.

The lobster fishery within the river and in adjacent coastal waters resulted in a catch worth $50,677 in 1966. Most of this revenue came from lobsters caught outside of the estuary. Additional revenue ($6,400) was also received from the sale of crabs for sport fishery bait.

Due to limitations of time and the number of personnel available to the study no intensive evaluation was made of the extent of the sport fishery within the Westport River. It is known that sport fishermen paid $603 for skiff rentals, and $960 for charter boat fees in this area and that bait sales from two local bait dealers amounted to $8,311. These values, however, represent only a small percentage of the actual expenditures of the sportfishermen in this area.

The study revealed that the minimum total value from the marine resources of the Westport River during 1966 was $293,060.

When the value of these resources is related to the total surface acreage at mean high water (1987 acres) the value per acre is $142.55. This figure is higher than the comparable estimated resource value per acre in the other five areas studied by the Division of Marine Fisheries (table 15). It should be remembered that this figure was calculated using total acreage of the estuary and that specific areas of high production within the estuary exhibit much higher values. For example, scallops were harvested from 457 acres of bottom with an estimated per acre value of $590.

Table 14. Minimum Economic Value of the Marine Fisheries Resources of the Westport River Area During 1966.

Income		
Shellfisheries	$224,084.62	
Lobsters	50,677.00	
Crabs	6,400.00	
Eels	2,025.00	
SUBTOTAL		$291,497.62
Sport Fishery Fees		
Skiff rentals	$ 603.00	
Charter fees	960.00	
SUBTOTAL		$ 1,563.00
GRAND TOTAL		$293,060.62

SUMMARY

A Study of the Marine Resources of the Westport River is the seventh in a series of monographs initiated by the Division of Marine Fisheries in 1963. These reports relate the extent and value of the marine resources of the major bays and estuaries in Massachusetts.

During the year-long study in Westport a total of 39 finfish species were encountered in the study area. Six of these species; flying gurnard, inshore lizard fish, northern sea robin, orange filefish, striped anchovy and northern kingfish, occurred for the first time in estuarine sampling conducted by the Division of Marine Fisheries. It was found that the river serves as a nursery area for such species as winter flounder, alewife, smelt, tautog, pollock and white hake. Sampling also indicated that winter flounder spawn within the estuary in late winter and early spring.

The wholesale value of marine resources harvested in the Westport River in 1966 was $291,497. The shellfish resources accounted for $224,084 of this figure. Of this shellfish revenue 90% was realized from the bay scallop harvest. The lobster and crab fisheries based within the river resulted in a catch worth $57,077 to the fishermen.

Survey of the tidemarshes within the estuary revealed that out of 1,003 acres of marsh, only seven acres are under a permanent plan of protection.

It was noted during the study that the shellfish resources of the river could be benefited by improved regulation and management. The alewife fisheries of the river could be increased with the construction of Fishways and Ladders at two sites.

The Westport River was found to be generally free of pollutants and the water quality favorable to a wide variety of economic marine species.

Summary of Economic Values of Six Estuaries

In attempting to determine the monetary value of our estuaries it is realized that the economic value of estuarine areas is based on a wide variety of marine resources which vary in number and importance from one area to another (Table 15). The shellfish resources constitute one of the greatest sources of income from our coastal areas. Table 15 lists six Massachusetts estuaries, the amount of productive, uncontaminated shellfish acreage and the acre wholesale value of each shellfish species harvested during the year of the study. There is a wide fluctuation in the value of an acre of shellfish bottom depending on its location and the shellfish species involved. In the locations considered, the estimated value of an acre of soft shell clam flat ranged from $78.26 in Quincy Bay to $1,628 in the North River and the value of an acre of scallop bottom ranged from $12.50 to $440.20 in Pleasant Bay and the Westport River, respectively. The wholesale value of an acre of shellfish bottom in general ranged from $12.50 for scallops in Pleasant Bay to $1,628 for soft shell clams in the North River. While in some estuaries the acre unit production of a certain shellfish species was extremely low, the total income from that species in the same estuary was very high due to the extensive acreage from which it was harvested. An example is the low per acre value of $12.50 for scallops in Pleasant Bay in 1965. This species

Table 15. Minimum Wholesale Value of Shellfish Species Harvested in Six Massachusetts Estuaries

	Species	Productive Acreage	Value/acre	Total Wholesale Value
Merrimack River (1964)	soft shell clam	100.0	$ 140.00	$ 14,000.00
Beverly-Salem Harbor (1966)		— No Shellfish Harvested —		
Quincy Bay (1964)	soft shell clam	444.7	78.26	34,800.00
North River (1964)	soft shell clam	9.5	1,628.00	15,468.00
	blue mussel	25.0	371.00	8,025.00
Pleasant Bay (1965)	quahogs	640.0	214.19	137,080.00
	scallops	1577.0	12.50	19,705.00
Westport River (1966)	quahogs	132.0	100.06	13,207.32
	scallops	457.0	440.21	201,179.50
	oysters	121.0	46.81	5,664.00
	soft shell clam	—	—	3,492.00
	blue mussel	—	—	541.80

yielded a total value of $19,705 in that year.

In a number of these six areas presented in Table 16 the stated values are not as great as the potential values which could be realized if existing pollution was abated. In Beverly-Salem Harbor during 1966, where no soft shell clams were harvested for human consumption, there were 457 acres of productive clam flats from which as much as $180,000 could have been realized annually if the waters were free from pollution. The Merrimack River and Quincy Bay estuaries also have extensive areas of contaminated clam flats which, if pollution were controlled could increase the wholesale value of soft shell clam harvest in these estuaries to $300,000 and $100,000, respectively.

Income from the finfish resources of our estuaries is realized from both sport and commercial fisheries. Table 16 summarizes the income from these fisheries in six Massachusetts estuaries. Skiff rentals, chartered boat fees and launching ramp fees represent a large percentage of the money spent by sport fishermen in most estuaries. The high population density in conjunction with the availability of facilities in the northern locations may be the reason for the great expenditures in those areas. Because of their location within the high population density areas Beverly-Salem Harbor and Quincy Bay would probably bring in even greater sport fishing revenue if more public access points and all tide launching ramps were available.

The sport fishery contributes immensely to the revenue realized from the six estuaries. The estimated values are presented in Table 16. Due to limitations of time and the number of personnel assigned to the studies the number of sport fishing trips and therefore the total expenditure by sport fishermen were not determined for Pleasant Bay and the Westport River. However, it is known that extensive sport fisheries exist within these estuaries and considerable revenue is derived from them. Using the available data the minimum estimated revenue realized from the sport and commercial finfisheries in the six study areas was $1,548,325.10.

The lobster is another species contributing to the total value of marine resources in our estuaries. The value of this resource within the six estuaries ranged from $12,370 in the North River area to $244,303.42 in Beverly-Salem Harbor. These figures show that a large percentage of the total value of marine resources in most of these areas is derived from the lobster fishery.

Table 16. Minimum Economic Value of the Finfish Resources of Six Massachusetts Estuaries

	Sport Fishery		Commercial Finfish Fishery
	Fees and Rentals	Total Estimated Expenditure*	
Merrimack River	$326,670.00	$859,371.06	$59,250.00
Beverly-Salem Harbor	89,686.00	361,005.24	34,715.34
Quincy Bay	20,856.00	141,938.46	not available
North River	12,000.00	58,380.00	10,800.00
Pleasant Bay	6,000.00	not available	22,865.00
Westport River	960.00	not available	not available

*Computed using the U. S. Government's revised figure of $8.34 as the cost to the fishermen of an average salt water fishing trip.

Much of the public is unaware of the variety of resources that are harvested from the estuarine environment. For example, in the North River there are extensive flats of blue mussels which are harvested by a small number of fishermen. The value of this resource in 1965 was placed at $371 per acre. A small quantity of these shellfish are also harvested in the Westport River. Although they are plentiful in many other Massachusetts estuaries they are left virtually unused due to limited markets in this section of the country. Another resource that is not commonly known for its commercial value is the American eel. This species is used as a food fish and as bait by sport fishermen. Mummichogs are also harvested in a number of estuaries and utilized as bait. A total of 500 gallons of these fish were harvested in the North River during 1965 with a value of $10,000. Clam worms are harvested in the Merrimack River for sale as bait to sport fishermen. In 1964 the value of clam worms harvested in this estuary was $36,000. Other species that are harvested and sold for bait purposes are the green crab, calico crab and American sand lance (sand eel).

Table 17 represents an attempt to derive acreage values of our estuaries in terms of the total water surface area at mean high tide. The figures in Column I are the estimated average acre wholesale value of marine resources harvested from the estuary. These figures range from $9.32/acre in Quincy Bay to $142.55/acre in the Westport River. The acreage value has been expanded in Column II to include the expenditure of sport fishermen where such information was available.

Table 17. Estimated Marine Resource Value of Six Massachusetts Estuaries.

	Wholesale Value of Resources/acre	*Value of an Average Acre*
Merrimack River......	$ 31.08	$248.38 (1964)
Beverly-Salem Harbor..	34.76	74.65 (1966)
Quincy Bay...........	9.32	27.58 (1964)
North River..........	112.57	243.95 (1964)
Pleasant Bay..........	28.07	28.07 (1965)*
Westport River........	142.55	142.55 (1966)*

*Estimate of sport fishery expenditures not included.

To better emphasize the value of estuaries the total income from these areas should be considered. If the totals of the minimum value of the marine resources from the six estuaries studied by the Division of Marine Fisheries are totaled a figure of $1,510,343 is received. Combining this figure with the close to two million dollars spent annually by the sport fishermen the total minimum revenue realized from these six estuaries is approximately 3.5 million dollars annually.

The prices used in the calculation of resource values were those paid to the commercial fishermen. These prices are subject to increase by wholesale fish dealers and retail dealers, such as fish markets and restaurants, before reaching the final consumer. Therefore the ultimate revenue realized from these resources is of a much greater magnitude than the conservative values used in the text.

RECOMMENDATIONS

The following recommendations are made to aid in the management and wise utilization of the marine resources of the Westport River:

1. . . . that the Division of Marine Fisheries establish acreage in the Westport River and in other natural oyster producing areas of the Commonwealth to be controlled and managed by the state for the propagation of seed oysters.

2. . . . that distinct quahog management beds be established in the Westport River and that these areas be opened and closed to harvesting on a rotational basis. During the initial closing of the areas an effort should be made by the town, in cooperation with the Division of Marine Fisheries, to plant quahogs in the areas with stock obtained from outside the town.

3. . . . that family fishing for quahogs be restricted to two or three days per week.

4. . . . that allowable daily and weekly quahog harvest limits be reduced.

5. . . . that a suitable fish ladder be constructed in the west branch of the river at the dam off Adamsville Road to provide passage for spawning alewives. Stocking of the headwater pond above the dam is recommended for three years, together with closure of the run for this period.

6. . . . that a fish ladder be constructed both at the site of the wooden dam at Forge Pond and the concrete dam and spillway at Lake Noquochoke. Stocking of Lake Noquochoke with ripe alewives; closure of the run for three years; adequate management of the fishery by the town; and stream clearance from Forge Pond downstream to the bridge at the Head of Westport are also recommended.

Table 18. Marine Species Contributing to the Economic Value of Six Massachusetts Estuaries

	Merrimack River	Beverly-Salem Harbor	Quincy Bay	North River	Pleasant Bay	Westport River
American eels	x				x	x
American sand lance	x					
American shad		x		x		
Atlantic cod	x	x	x	x	x	
Atlantic herring		x				
Atlantic mackerel	x	x	x	x		x
bluefish					x	x
cusk	x					
haddock	x			x	x	
pollock	x	x		x	x	
scup					x	x
striped bass	x	x	x	x	x	x
tomcod					x	x
winter flounder	x	x	x	x	x	x
other finfish species		x		x		
blue mussels				x		x
oysters					x	x
quahogs					x	x
scallops					x	x
soft shell clams	x		x	x	x	x
lobsters	x	x	x	x	x	x
green crabs	x					x
edible crabs	x		x		x	x
clam worms	x	x				

7. . . . that the town properly regulate and manage the existing alewife runs.

8. . . . that the Division of Marine Fisheries, under the Anadromous Fish Project, give consideration to the establishing of a shad run in the main branch of the river.

9. . . . that the Division of Marine Fisheries should make further study of the feasibility of providing access and fishing pier facilities in the areas of Hix Bridge and also above the Route 88 Bridge in the East Branch.

10. . . . that the boat launching ramp located at Hix Bridge be reconstructed.

11. . . . that the harbor mouth and channel be dredged in order to improve the navigability of the river.

12. . . . that the Division of Marine Fisheries in cooperation with the Division of Sanitary Engineering, Department of Public Health continue to monitor the bay for the presence of coliform bacteria and pesticides, and for sources of pollution. This should be part of a continuing study along the entire Massachusetts' coastline.

13. . . . that the local Board of Health rigidly enforce regulations pertaining to the discharge of domestic sewage. Where shorefront home construction is to occur, it should be required that cesspools or septic tanks be located within the lot at the maximum practical distance from the river.

14. . . . that the Westport Conservation Commission continue in its efforts to acquire tidemarsh areas of the Westport River to protect them from alteration or destruction.

15. . . . that within 10 years, another study of the Westport River be conducted to determine the status and value of marine resources at that time. The results could be compared with those of the present report and recommendations could then be made for future management of this estuary.

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Hickey

Errata Sheet for

A Study of the Marine Resources of the Westport River by John D. Fiske, John R. Curley and Robert P. Lawton. Monograph Series Number 7, May, 1968.

Page 1. Column 1, paragraph 5 "... the spring of 1965 and were terminated during the spring of 1966."
Should read "... the spring of 1966 and were terminated during the spring of 1967."

Page 2. Column 1, paragraph 2 "... with the use of a polar planimeter.."
Should read "... with the use of a map rotometer.."

Page 5. Column 11, paragraph 3 "North River .... 1540 acres"
Should read "North River ....1690 acres"

Page 7. Column 1, paragraph 2 "(31 degrees)"
should read "(34 degrees)"
Column 1, paragraph 2 "(45 degrees)"
Should read "(46 degrees)"

Page 9. Table 2 Temperature and salinity for Halfmoon Flat in March read F° 22.5 o/oo -

Should read F° 41.0 o/oo 22.5

Page 14. Column 1, paragraph 4 "A total of 19 species were captured."
Should read "A total of 12 species were captured."

Page 29. Column 11, paragraph 3 "A total of 39 estuarine fish species (Table 10) were captured in the study area."
Should read "A total of 39 fish species (Table 4) were captured in the study area."

Page 31. Column 1, paragraph 3 "At an estimated value of $7.00 per bushel each acre of bottom produced $590 worth of scallops."
Should read "At an estimated value of $5.25 per bushel each acre of bottom produced $440 worth of scallops."

Page 35. Column 1, paragraph 1 "Total income from the sale of permits and licenses was $1958.00."
Should read "Total income from the sale of permits and licinses was $1983.00."

Page 39. Column 1, paragraph 1 "... with the 160 yard haul seine.."
Should read "... with the 360 foot haul seine.."

Page 47. Column 1, paragraph 2 "... during 1966 was $293,060."
Should read "... during 1966 was $284,749.62."

Page 47. Column 1, paragraph 3 "When the value of these resources is related to the total surface acreage at mean high water (1987 acres) the value per acre is $142.55. This figure is higher than the comparable estimated resource

value per acre in the other five areas studied by the Division of Marine Fisheries (Table 15) .... for example, scallops were harvested from 475 acres of bottom with an estimated per acre value of $590."
Should read "When the value of these resources is related to the total surface acreage at mean high water (3225 acres) the value per acre is $88.31. This figure is higher than the comparable estimated resource value in four of five other areas studied by the Division of Marine Fisheries (Table 17). ... for example, scallops were harvested from 475 acres of bottom with an estimated per acre value of $440."

Page 47. Column 11, Table 14

Income
:
Subtotal $291,497.62
:
Grand Total $293,060.62

Should read

Income
:
Subtotal $283,186.62
:
Grand Total $284,749.62

Page 47. Column 11, paragraph 3, line 5 "(Table 15)"
Should read "(Table 18)"

Page 48. Column 1, paragraph 2 "Table 16 summarizes..."
Should read "Table 15 summarizes..."

Page 49. Column 1, paragraph 2 "These figures range from $9.32/acre in Quincy Bay to $142.55/acre in the Westport River."
Should read "These figures range from $9.32/acre in Quincy Bay to $112.57/acre in the North River."

Page 49. Table 17 "Westport River .....142.55 142.55 (1966)"
Should read "Westport River ....88.31 88.31 (1966)"