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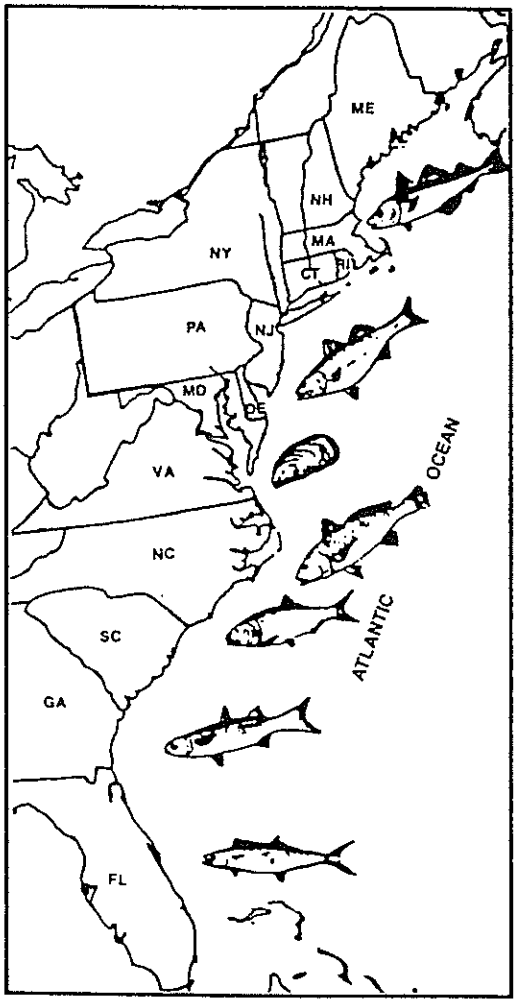

INVESTIGATIONS OF OCEAN LANDINGS FOR AMERICAN SHAD AND RIVER HERRINGS FROM UNITED STATES EAST COAST WATERS

September 1989

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Atlantic States Marine Fisheries Commission
Shad and River Herring S & S Committee
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EXECUTIVE SUMMARY

An ocean (at sea) fishery for American shad (*Alosa sapidissima*) and river herring (*A. pseudoharengus* and *A. aestivalis*) along the eastern seaboard of the USA has harvested an undetermined portion of annual commercial landings of these species in recent years. In addition, an offshore mackerel fishery of both foreign and joint venture origins has been harvesting river herring as by-catch. Information documenting the magnitude and extent of these ocean fisheries was needed to enhance the management of these stocks under the Atlantic States Marine Fisheries Commission's (ASMFC) Interstate Fisheries Management Program (ISFMP). The study described herein was undertaken to investigate the trends in ocean harvest of shad and river herring for each Atlantic coastal state from 1978 to 1988, and present recommendations to enhance management options.

Total commercial landings of American shad along the USA east coast were slightly more than two million pounds in 1978, and reached a peak of almost five million pounds in 1984. Since 1985, landings have been steady at slightly more than 3.5 million pounds. Virginia's fisheries contribute about 26 percent of the total shad harvest annually, followed by New York (18 percent), South Carolina (11 percent), North Carolina (10 percent), and Connecticut (10 percent).

In contrast, ocean landings of American shad have increased more than four-fold since 1978. Ocean harvest contributed about 11 percent of total east coast landings in 1978; this contribution increased yearly to over 43 percent by 1987. Virginia and South Carolina ocean landings contributed about 14 percent of the total east coast harvest of shad. Ocean shad harvest increased in every Atlantic coast state except for Maine and New York during the period of study.

Ocean harvest of shad is dominated by four states -- New Jersey, South Carolina, Virginia and Florida -- which landed over 66 percent of ocean-caught shad during the ten-year period. Only Georgia reported no shad harvest from ocean waters. Three states rely totally on ocean fisheries for shad landings: Maine, Massachusetts, and Rhode Island. Ocean shad harvest in these three states represents approximately 2.4 percent of the total east coast landings annually.

The ocean fishery for shad is primarily gill net; exceptions are floating trap (Rhode Island), bottom otter trawl (Connecticut), and pound net (New York). Harvest for states north of New Jersey is from a by-catch fishery, and from New Jersey south the fishery is directed for shad. All states except Florida have intercept fisheries, which exploit populations of various origins. Florida, however, is probably the only state that exploits local American shad populations.

The shad harvest data provided by NMFS and by each state agency are not comparable in many instances, and in some cases are vastly different. One reason for these discrepancies appears to be variation in definition of "ocean harvest" by NMFS and state agencies. This discrepancy should be clarified before developing ocean harvest regulations for this fishery.

Total commercial landings of river herring along the USA east coast were slightly more than six million pounds in 1978. During the period from 1982 through 1985, total landings were in excess of nine million pounds, then dipped to slightly less than six million pounds in 1987. Fisheries in North Carolina and Maine together constitute approximately 75 percent of all river herring landed annually.

Ocean landings of river herring (based on NMFS data) since 1979 represent a minor component of total harvest, averaging less than two percent. In 1978, over one-tenth of the total east coast harvest was from ocean waters due to a combination of low coast-wide landings and a greater than usual ocean harvest in Massachusetts. On average, Massachusetts represents about 44 percent of the ocean harvest, followed by Virginia (18 percent), New York (15 percent), and North Carolina (11 percent). Four Atlantic coast states do not have river herring fisheries in ocean waters: Delaware, South Carolina, Georgia, and Florida. Apparently, Georgia is the only state that has no river herring fishery.

It appears that the ocean harvest of river herring is from by-catch fisheries of various gear types: dip nets, gill nets, beach haul seine, pound nets, bottom otter trawl, menhaden purse seine, hoop and fyke nets, and handline. Although little is known about river herring migration patterns and overwintering areas, the limited data suggest that ocean fisheries for river herring are probably intercept in nature.

The offshore foreign and joint venture fisheries for mackerel harvest river herring as a portion of the by-catch. At the present time, these fisheries are restricted to a river herring by-catch of 100 metric tons (220,000 pounds). These fisheries should be monitored closely for trends in river herring harvest.

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INTRODUCTION

In recent years, an undetermined portion of the annual commercial landings of American shad (*Alosa sapidissima*) and river herring (*A. aestivalis* and *A. pseudoharengus*) is being harvested along the eastern seaboard of the U.S.A. by a growing ocean (at sea) fishery. Although the ocean migration of American shad has been described in the literature, little evidence exists on how these ocean fisheries exploit the individual spawning populations as they migrate in the nearshore ocean before and after spawning in natal freshwaters. Even less is known about the ocean migrations and patterns of river herring.

Information documenting the magnitude and extent of the ocean fishery was needed to enhance management of the stocks under the Atlantic States Marine Fisheries Commission's (ASMFC) Interstate Fisheries Management Program (ISFMP). The need for an interstate fishery management plan for anadromous alosids was recognized by the ASMFC in 1981, and by 1982 an action plan was in place to meet this objective (ASMFC 1985). Recommendations of the 1985 Interstate Fishery Management Plan for Anadromous Alosids (ASMFC 1985) addressed the need for close monitoring of joint venture and domestic offshore mackerel fisheries for river herring by-catch, and also existing and developing territorial seas fisheries for American shad.

The increase in ocean fishing effort has coincided with a depletion in available spawning areas for anadromous alosids due to habitat degradation from poor water quality, dams with inadequate bypass facilities, turbine mortality, etc. (Rulifson et al. 1982, ASMFC 1985). As a result, stocks of shad and river herring have declined over the years for most eastern seaboard states. Although several rivers on the eastern seaboard are now under restoration programs, the population numbers remain low.

The objective of this study was therefore to investigate the trends in ocean harvest of shad and river herring for each state on the eastern seaboard of the United States. In this instance, ocean landings were considered to be comprised of fish harvested from the Territorial Seas and beyond (0 - 200 miles offshore). For the purposes of this report, we included fish harvested from the seaside bays of Virginia and Maryland, Long Island Sound, and Passamaquoddy Bay as ocean landings. Specifically excluded were the Chesapeake and Delaware Bays and any fish harvested upstream of a river mouth. Landings were defined to be pounds of shad or river herring landed in a port, regardless of the sector of the ocean from where the fish were harvested. Thus, landings are reported for a state if the fish were brought ashore within that state's boundaries, even though the fish might have been captured in the waters of some other state. Of particular interest are those ocean fisheries which have landed 10,000 pounds or more of these species in any given year from 1978 to 1988. The information gathered by this study will be used to assess the potential effects of the offshore and territorial seas harvest on shad and river herring restoration efforts.

American Shad

American shad is an anadromous species native to the east coast of North America, and is found from southern Florida to South Aulatsivik in northern Labrador (Scott and Scott 1988). In the late 1800s, the species was introduced into the Sacramento and Columbia Rivers on the west coast of North America, where it now ranges between southern California and Cook Inlet, Alaska (Scott and Scott 1988).

Shad partake in extensive coastal ocean migrations. As adults, shad move northward after spawning in natal streams. As fall approaches, shad migrate southward to overwinter in the Atlantic Ocean (Neves and Depres 1979). Dadswell et al. (1987) hypothesized that several winter aggregations of shad develop in the Northwest Atlantic Ocean during January and February: on the Scotian Shelf, the Mid-Atlantic Bight, and off the coast of Florida (Figure 1). A summary of tag returns suggest that in February, shad overwintering off Florida begin entering streams from Florida to South Carolina to spawn. In March and April, shad overwintering on the Scotian Shelf and Mid-Atlantic Bight begin onshore and northern migrations, and spawning runs are underway from North Carolina to the Bay of Fundy. Subsequent to spawning, shad from most populations continue to migrate northwards. The northern-most point of the migration is generally reached by late summer, and during autumn and early winter, shad move back south to the overwintering areas (Dadswell et al. 1987). Information gathered by Leggett and Whitney (1972) indicate that pre-spawning shad migrate close inshore along coastal areas south of Cape Cod, but the migratory route north of Cape Cod is less clearly defined. Two northerly migratory routes apparently exist: one which closely follows the coast, and the other further offshore (Neves and Depres 1979). The southerly fall migration route appears to be well offshore, following the 100-m depth contour (Neves and Depres 1979, Dadswell et al. 1987).

No investigations into the ocean migratory habits of shad have confidently identified the various discrete spawning populations as they intermix in ocean waters. However, it is hypothesized that the site of the overwintering area is related to the location of the natal stream. Thus, shad which overwinter on the Scotian Shelf are thought to be primarily of Canadian and northern New England origin (Melvin et al. 1986, Dadswell et al. 1987) and the Mid-Atlantic Bight is a mixture of stocks from Georgia to Quebec (Melvin et al. 1986, Dadswell et al. 1987). The composition of the Florida aggregation is unknown, but there is no evidence to suggest that any populations from north of Cape Hatteras winter with this group (Dadswell et al. 1987).

Subsequent to spawning, however, shad from the three overwintering aggregations appear to intermingle during coastwide migration. Tag returns have been obtained from the St. Johns River in Florida and Nain, Labrador, for shad that were tagged in the Bay of Fundy (Dempson et al. 1983, Dadswell et al. 1987). Therefore, ocean shad fisheries could potentially exploit a variety of populations, depending on the seasonality and location of harvest.

This investigation into the trends of commercial ocean landings for American shad along the eastern seaboard was conducted to discern where ocean harvest may be from intercept

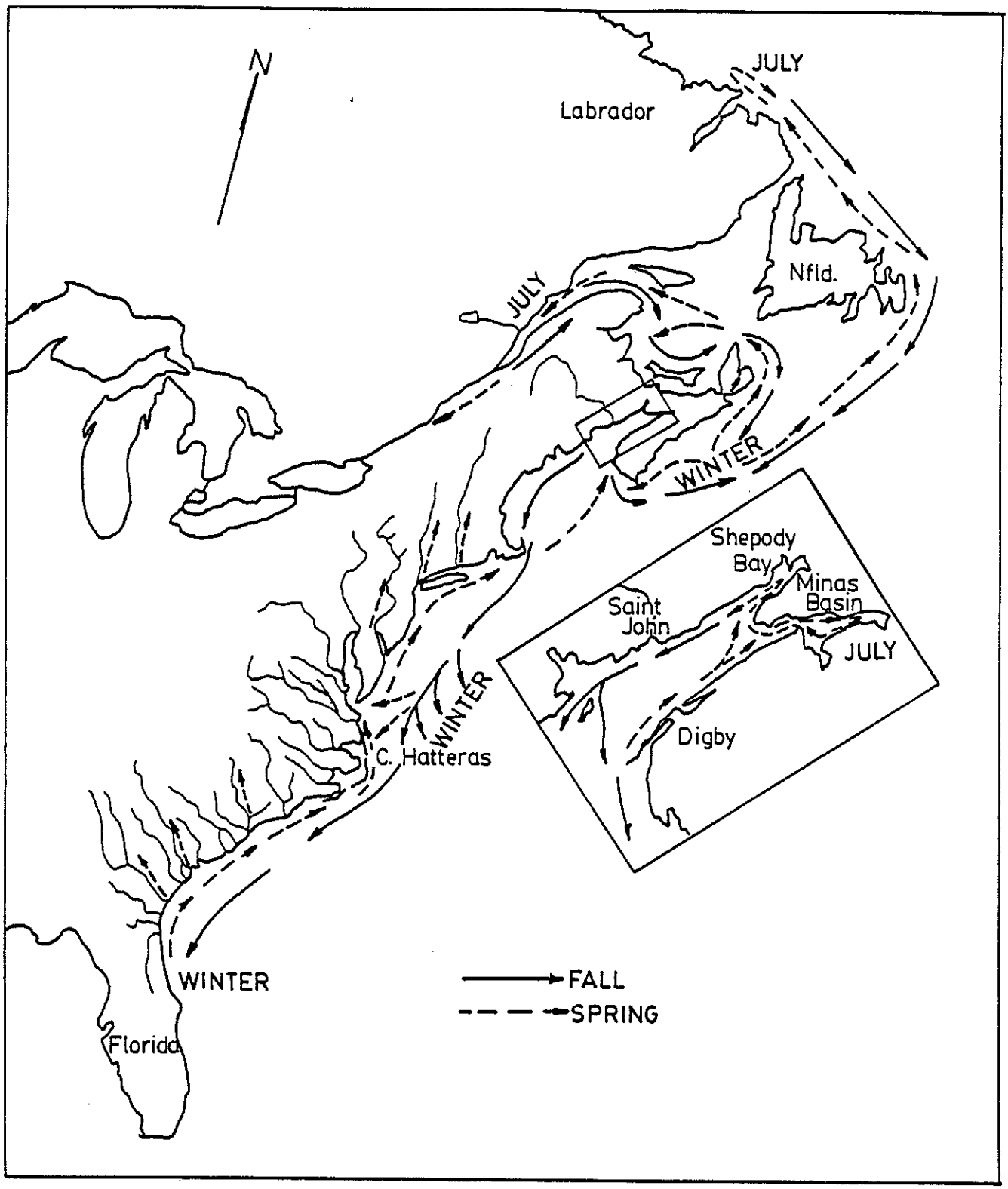

Figure 1. Seasonal migration patterns and overwintering areas of American shad (*Alosa sapidissima*) along the eastern seaboard of North America (from Dadswell et al. 1987).

fisheries (a fishery in a state that harvests natal stocks of another state), and the role they may play in the ongoing attempts to restore shad stocks that are currently in a state of collapse.

River Herring

River herring is the term commonly used to describe the two alosids *A. pseudoharengus* (alewife) and *A. aestivalis* (blueback herring). Both anadromous species are native to the eastern seaboard of North America. These species often intermingle both in fresh waters and ocean environments, but their distributions are slightly different. Alewife is a more northern species than blueback herring, ranging from North Carolina to Paquet, in northeastern Newfoundland (Scott and Scott, 1988). Bluebacks have been recorded in the Gulf of St. Lawrence, although they are more common in warmer southern waters. The southern limit of their range is northern Florida (Scott and Scott 1988).

Little is known about the migratory habits of river herring when in ocean waters. Rulifson et al. (1987) found large number of alewives and blueback in the Bay of Fundy during the summer months of 1983, 1985 and 1986. Based on tag returns from their study they hypothesized that the majority of the bluebacks in the Bay of Fundy were not of local origin, suggesting that they had migrated to the Bay in a pattern similar to that of American shad.

Tag returns have been recovered from Cape Cod for river herring tagged in the Cooper River, South Carolina (Curtis 1971) and Georges Bank for river herring tagged in inshore North Carolina (Johnson et al. 1977). Several river herring tagged in the St Johns River, New Brunswick, were recovered by trawler off Rhode Island (Rulifson et al. 1987). Thus, tag returns do indicate a migratory component within the life history of river herring. The mixture of alewife and blueback in the migratory stock is unknown at this stage. The duration of ocean migration, and the routes and distances covered have yet to be described.

The offshore harvest of river herring by foreign fleets was thought to be responsible for the collapse of the river herring fishery in North Carolina in the 1970s (Rulifson et al. 1987). More recently, ASMFC is concerned about the potential for by-catch of river herring in the offshore foreign/joint venture trawl fishery of Atlantic mackerel (ASMFC 1985). Currently, the mackerel fishery is allowed a maximum river herring by-catch of 220,000 pounds. If the migrations of river herring are as extensive as has been hypothesized, then the potential effects of offshore harvest on the stocks of the eastern seaboard could be considerable.

The objective of this study was therefore to identify trends in the territorial sea and offshore ocean harvest of river herring since 1978.

METHODS

Landings Data

Historical landings data for 1978 through 1988 were collected from two sources: individual states and the National Marine Fisheries Service (NMFS). A letter requesting landings data for both shad and river herring was sent to each state agency responsible for collecting and collating these data (see Appendix 1 for details of agencies and personnel contacted). Attached to the letter was a questionnaire requesting some details about the state's ocean shad fishery, including gear types used, season and fishing areas. The ocean and total landings data of shad and river herring for each state were also requested from NMFS, as was information about the by-catch of river herring by the offshore Atlantic mackerel fishery. Data for states from Maine to Virginia were provided by the Northeast Fisheries Center in Woods Hole, Mass. Data for the states from North Carolina to Florida were provided by the Southeast Fisheries Center in Beaufort, N.C.

Shad ocean catch data for each state as received from the state and NMFS were plotted separately, and regression lines were calculated to determine overall trends in landings data. In addition, NMFS total landings for shad were also plotted. For each state, the percentage of the total catch comprised of ocean-caught shad was calculated for each year of the study. Using the data provided by NMFS, the catch of shad landed in each state each year was broken down into catch by gear type. The overall East Coast ocean catch of shad was calculated for each year of the study period, and the percentage of the total East Coast catch that this constituted was determined. The same procedure was repeated for river herring.

On-site Fishery Investigations

Initially, several active commercial ocean shad fisheries in New Jersey, Delaware, Maryland and Virginia were to be visited and characterized. The visits were designed to garner more details as to the operation of ocean shad fisheries by conducting interviews with fishermen who were participants in the fishery. We sought information about gear used, number of people in the fishery, season, catches etc. The field trip was scheduled for early spring, but particularly bad weather delayed on-site visitation until the first two weeks of April, which was reasonably late in the fishing season.

RESULTS

American Shad

Harvest Trends

Owing to differences between landings data for some states as provided by the state and NMFS, state data were used in the analysis of trends in lieu of NMFS data. Generally, the data

set used depended on the recommendation of the particular state agency, where we used the data set that the agency felt was most complete for its state (Table 1). Where no recommendation was received from an agency, NMFS data was used. NMFS landings data for 1988 were incomplete for several states; therefore, general trend analyses for the east coast excluded the year 1988. However, when available the information was presented for each state and discussed.

Ocean harvest of American shad along the eastern seaboard of the U.S. has steadily increased since 1978 (Table 2). The increase in ocean landings followed a trend in increased total landings until 1984, when largest ocean harvest and total harvest of shad occurred during the ten-year study period. From 1985 to 1987, total landings dropped below 4 million pounds while the ocean harvested continued to increase. In 1987, ocean harvest constituted just over 38 percent of total shad harvest on the eastern seaboard (Table 2). Preliminary data for 1988 indicates that the ocean harvest constituted 65 percent of the total east coast shad harvest; however, we feel that these numbers might reflect incomplete catch data.

Table 1. A listing of Atlantic coastal States with American shad landings and the data base type for each state used in the analyses.

State	Database
Maine	NMFS
New Hampshire	NMFS
Massachusetts	NMFS
Connecticut	NMFS
Rhode Island	NMFS
New York	NMFS
New Jersey	STATE
Delaware	NMFS
Maryland	STATE
Virginia	STATE
North Carolina	STATE
South Carolina	STATE
Georgia	NMFS
Florida	STATE

Since 1978, the bulk of the ocean harvest of American shad has been from five states (in descending order): Virginia, South Carolina, Florida, New Jersey, and Maryland (Table 3). During the ten-year study period, landings by these five states comprise over 75 percent of all

Table 2. Commercial landings (thousands of pounds) of American shad along the USA east coast, 1978-1987.

Year	Total ocean landings	Total shad landings	Percent ocean landings
1978	265	2,418	10.9
1979	417	2,047	20.4
1980	618	3,829	16.1
1981	998	3,207	31.1
1982	1,125	3,139	35.8
1983	829	3,124	26.5
1984	1,526	4,788	31.9
1985	1,341	3,673	36.5
1986	1,357	3,529	38.5
1987	1,637	3,806	43.0

Table 3. Commercial ocean landings (thousands of pounds) of American shad by state, 1978-1987.

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total ocean landings
1978	24.5	0.0	0.8	1.2	0.3	2.0	67.4	0.3	20.3	13.2	5.0	0.0	0.0	129.5	264.5
1979	18.6	0.0	3.1	1.4	0.0	8.1	65.9	0.0	26.0	75.8	25.1	83.5	0.0	109.4	416.9
1980	28.0	0.0	8.4	2.1	0.0	113.5	76.6	0.0	2.8	95.9	3.9	153.3	0.0	133.1	617.7
1981	90.6	5.6	16.7	33.4	0.1	58.3	93.7	0.0	0.0	275.7	107.4	121.7	0.0	195.2	998.3
1982	25.8	2.7	29.4	79.3	0.1	73.6	141.6	12.4	19.2	277.0	64.0	245.1	0.0	154.7	1,124.8
1983	38.7	3.4	13.5	23.5	1.6	33.0	135.4	7.1	76.7	209.7	3.8	205.5	0.0	76.8	828.6
1984	33.3	5.1	29.7	36.6	0.1	33.6	148.0	12.7	86.9	644.4	13.5	331.5	0.0	150.3	1,525.7
1985	16.0	7.3	22.3	90.8	0.0	93.8	166.1	33.3	339.1	332.2	3.2	137.5	0.0	99.6	1,341.1
1986	23.1	16.9	60.1	52.4	0.0	72.9	133.8	53.6	257.2	355.6	63.1	220.7	0.0	47.7	1,357.0
1987	26.4	33.8	40.8	103.9	0.0	11.6	106.3	75.9	301.1	395.8	41.2	359.7	1.3	139.2	1,636.9
10-yr avg.	32.5	7.5	22.5	42.5	0.2	50.0	113.5	19.5	112.9	267.5	33.0	185.9	0.1	123.5	1011.2

shad harvested from ocean waters (Table 4). During the same period, the average ocean harvest for each of the remaining states (except New York) was less than five percent (Table 4). On a year by year basis, the average harvest rates do not always reflect any one states' actual proportion of the catch. However, states that averaged less than five percent of the 10-year catch rarely caught more than 10 percent of the total ocean harvest for any one year. In contrast, South Carolina and Virginia commonly landed more than 20 percent of the total east coast ocean harvest (Table 4).

Since 1978, total shad landings on the eastern seaboard have come principally from two states: Virginia and New York (Table 5). Together, these two states represented about 43 percent of all shad landed during the ten-year period (Table 6). However, of these two states, only Virginia has the ocean shad harvest contributing an important segment of total eastern seaboard landings (Table 4).

Even though several states dominate ocean harvest and total harvest of shad, the ocean fishery for the species is an important component of the fishery for many of the states. In fact, the ocean shad fishery represents the entire reported landings for the species in three states: Maine, Massachusetts and Rhode Island, and most of the reported landings for New Hampshire (Table 7). In addition, since 1980 the ocean shad harvest has been an important segment of total landings for Maryland, South Carolina, and Virginia (Table 7). All aspects considered, the ocean shad harvest in states of Virginia, South Carolina, Florida, New Jersey, and Maryland contributed nearly 24 percent of all shad landed on the eastern seaboard since 1978 (Table 8).

Maine

American shad ocean landings in Maine are exclusively from a by-catch fishery; no directed fishery for shad exists at the present time.

Gear: Most shad are taken in groundfish gill nets with mesh sizes ranging from 5.5" to 6.5" stretch mesh (Table 9). Other gear types harvesting shad through the last ten years are bottom otter trawls, and to a lesser degree, long-lines. However, the catch from these gear types is generally small compared to the catch taken in groundfish nets (Table 9).

Season: As this is a by-catch fishery, shad are taken year round, with greatest landings during April through June and October through December.

Location: All shad landed in Maine are harvested from the ocean (Figure 3). Shad landed are harvested from areas 511, 512, 513 and 515 (Figure 2), although the most commonly fished area is Jeffreys Ledge, which is approximately 25 miles due east and parallel to the Maine coast line. There are no specific landing sites for American shad, and the total number of sites at which fish are landed is unknown. The principal landing areas for finfish are Kennebunkport, Ogunquit, Portland, Bath and Rockland.

Table 4. Percent of yearly ocean landings of American shad by state, 1978-1987. Total ocean shad landings are represented in thousands of pounds.

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total ocean landings
1978	9.3	0.0	0.3	0.5	0.1	0.8	25.5	0.1	7.7	5.0	1.9	0.0	0.0	49.0	265
1979	4.5	0.0	0.7	0.3	0.0	1.9	15.8	0.0	6.2	18.2	6.0	20.0	0.0	26.2	417
1980	4.5	0.0	1.4	0.3	0.0	18.4	12.4	0.0	0.4	15.5	0.6	24.8	0.0	21.6	618
1981	9.1	0.6	1.7	3.3	0.0	5.8	9.4	0.0	0.0	27.6	10.8	12.2	0.0	19.5	998
1982	2.3	0.2	2.6	7.0	0.0	6.5	12.6	1.1	1.7	24.6	5.7	21.8	0.0	13.7	1,125
1983	4.7	0.4	1.6	2.8	0.2	4.0	16.3	0.9	9.3	25.3	0.5	24.8	0.0	9.3	829
1984	2.2	0.3	1.9	2.4	0.0	2.2	9.7	0.8	5.7	42.2	0.9	21.7	0.0	9.9	1,526
1985	1.2	0.5	1.7	6.8	0.0	7.0	12.4	2.5	25.3	24.8	0.2	10.3	0.0	7.4	1,341
1986	1.7	1.2	4.4	3.9	0.0	5.4	9.9	3.9	19.0	26.2	4.6	16.3	0.0	3.5	1,357
1987	1.6	2.1	2.5	6.3	0.0	0.7	6.5	4.6	18.4	24.2	2.5	22.0	0.1	8.5	1,637
10-yr avg.	4.1	0.5	1.9	3.4	0.0	5.3	13.0	1.4	9.4	23.4	3.2	19.2	0.0	11.7	1011.2

Table 5. Total commercial landings (thousands of pounds) of American shad by state, 1978-1987 (NMFS data).

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total shad landings
1978	24.5	7.8	0.8	1.2	306.3	308.5	242.1	69.9	92.6	1,234.7	-	-	-	130.0	2,418.4
1979	18.6	7.3	3.1	1.4	206.8	438.4	248.6	94.9	46.2	967.3	-	-	-	114.8	2,047.4
1980	28.0	6.9	8.4	2.1	310.5	1,248.8	291.7	96.0	23.8	973.9	199.2	270.6	188.5	180.8	3,829.1
1981	90.6	5.6	16.7	33.4	324.7	541.1	263.2	197.3	0.6	498.8	351.5	446.4	195.8	241.0	3,206.8
1982	25.8	2.7	29.4	79.3	283.0	383.2	349.9	350.0	16.1	585.3	411.9	242.7	198.5	181.0	3,138.7
1983	38.7	3.4	13.5	23.5	426.0	448.4	228.5	232.8	62.0	564.1	445.9	335.1	225.4	76.9	3,124.1
1984	33.3	5.1	29.7	36.6	398.8	601.5	293.2	220.0	70.3	1,270.1	584.8	536.4	221.1	487.5	4,788.4
1985	16.0	7.3	22.3	90.8	402.0	773.9	291.7	203.4	189.4	632.7	329.6	369.5	248.6	95.7	3,673.0
1986	23.1	16.9	60.1	52.4	322.0	688.7	335.1	242.3	134.6	573.1	373.8	481.7	163.4	62.1	3,529.2
1987	26.4	41.3	40.8	103.9	333.9	619.1	267.8	259.1	189.3	632.8	327.6	486.5	294.1	183.0	3,805.6
10-yr avg.	32.5	10.4	22.5	42.5	331.4	605.2	271.2	196.6	82.5	793.3	302.4	316.9	173.5	175.3	3356.1

Table 6. Percent of yearly total commercial landings of American shad by state, 1978-1987. Total shad landings are represented in thousands of pounds.

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total shad landings
1978	1.0	0.3	0.0	0.0	12.7	12.8	10.0	2.9	3.8	51.1	ERR	ERR	ERR	5.4	2,418
1979	0.9	0.4	0.2	0.1	10.1	21.4	7.3	4.6	2.3	47.2	ERR	ERR	ERR	5.6	2,047
1980	0.7	0.2	0.2	0.1	8.1	32.6	7.6	2.5	0.6	25.4	5.2	7.1	4.9	4.7	3,829
1981	2.8	0.2	0.5	1.0	10.1	16.9	8.2	6.2	0.0	15.6	11.0	13.9	6.1	7.5	3,207
1982	0.8	0.1	0.9	2.5	9.0	12.2	11.1	11.2	0.5	18.6	13.1	7.7	6.3	5.8	3,139
1983	1.2	0.1	0.4	0.8	13.6	14.4	7.3	7.5	2.0	18.1	14.3	10.7	7.2	2.5	3,124
1984	0.7	0.1	0.6	0.8	8.3	12.6	6.1	4.6	1.5	26.5	12.2	11.2	4.6	10.2	4,788
1985	0.4	0.2	0.6	2.5	10.9	21.1	7.9	5.5	5.2	17.2	9.0	10.1	6.8	2.6	3,673
1986	0.7	0.5	1.7	1.5	9.1	19.5	9.5	6.9	3.8	16.2	10.6	13.6	4.6	1.8	3,529
1987	0.7	1.1	1.1	2.7	8.8	16.3	7.0	6.8	5.0	16.6	8.6	12.8	7.7	4.8	3,806
10-yr avg.	1.0	0.3	0.6	1.2	10.1	18.0	8.2	5.9	2.5	25.3	10.5	10.9	6.0	5.0	3356.1

Table 7. Percent contribution of the state ocean catch (State or NMFS data) of American shad to total state shad catch, 1978-1987. Values over 100% are a result of discrepancies between state and federal databases.

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL
1978	100	0	100	100	0	1	28	0	22	1	-	-	-	0
1979	100	0	100	100	0	2	44	0	56	8	-	-	-	0
1980	100	0	100	100	0	9	26	0	12	10	2	57	0	0
1981	100	100	100	100	0	11	36	0	1	55	31	27	0	0
1982	100	100	100	100	0	19	40	4	119	47	16	101	0	0
1983	100	100	100	100	0	7	59	3	124	37	1	61	0	0
1984	100	100	100	100	0	6	50	6	124	51	2	62	0	0
1985	100	100	100	100	0	12	57	16	179	52	1	37	0	0
1986	100	100	100	100	0	11	40	22	191	62	17	46	0	0
1987	100	82	100	100	0	2	40	29	159	63	13	74	0	0

Table 8. Percent contribution of the state ocean catch of American shad to total east coast commercial shad landings (thousands of pounds), 1978-1987.

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total shad landings	Percent ocean catch
1978	1.0	0.0	0.0	0.0	0.0	0.1	2.8	0.0	0.8	0.5	0.2	0.0	0.0	5.4	2,418	10.9
1979	0.9	0.0	0.2	0.1	0.0	0.4	3.2	0.0	1.3	3.7	1.2	4.1	0.0	5.3	2,047	20.4
1980	0.7	0.0	0.2	0.1	0.0	3.0	2.0	0.0	0.1	2.5	0.1	4.0	0.0	3.5	3,829	16.1
1981	2.8	0.2	0.5	1.0	0.0	1.8	2.9	0.0	0.0	8.6	3.3	3.8	0.0	6.1	3,207	31.1
1982	0.8	0.1	0.9	2.5	0.0	2.3	4.5	0.4	0.6	8.8	2.0	7.8	0.0	4.9	3,139	35.8
1983	1.2	0.1	0.4	0.8	0.1	1.1	4.3	0.2	2.5	6.7	0.1	6.6	0.0	2.5	3,124	26.5
1984	0.7	0.1	0.6	0.8	0.0	0.7	3.1	0.3	1.8	13.5	0.3	6.9	0.0	3.1	4,788	31.9
1985	0.4	0.2	0.6	2.5	0.0	2.6	4.5	0.9	9.2	9.0	0.1	3.7	0.0	2.7	3,673	36.5
1986	0.7	0.5	1.7	1.5	0.0	2.1	3.8	1.5	7.3	10.1	1.8	6.3	0.0	1.4	3,529	38.5
1987	0.7	0.9	1.1	2.7	0.0	0.3	2.8	2.0	7.9	10.4	1.1	9.5	0.0	3.7	3,806	43.0
10-yr avg.	1.0	0.2	0.6	1.2	0.0	1.4	3.4	0.5	3.1	7.4	1.1	6.1	0.0	3.5	3356.1	29.1

Table 9. Commercial ocean landings (pounds) of American shad for Maine, 1978-1988.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Long-line	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978		24,300			200				24,511	24,500	24,500	100.00
1979		18,100			300			200	18,509	18,600	18,600	100.00
1980		27,500			500				27,958	28,000	28,000	100.00
1981		88,900			1,700				90,579	90,600	90,600	100.00
1982		25,100			400			300	25,883	25,800	25,800	100.00
1983		36,500			2,200				38,876	38,700	38,700	100.00
1984		31,000			2,200			100	33,414	33,300	33,300	100.00
1985		13,400			2,600				16,145	16,000	16,000	100.00
1986		21,500			1,600				23,012	23,100	23,100	100.00
1987		21,100			5,300				26,652	26,400	26,400	100.00
1988		29,000			2,600				31,681	31,600	31,600	100.00

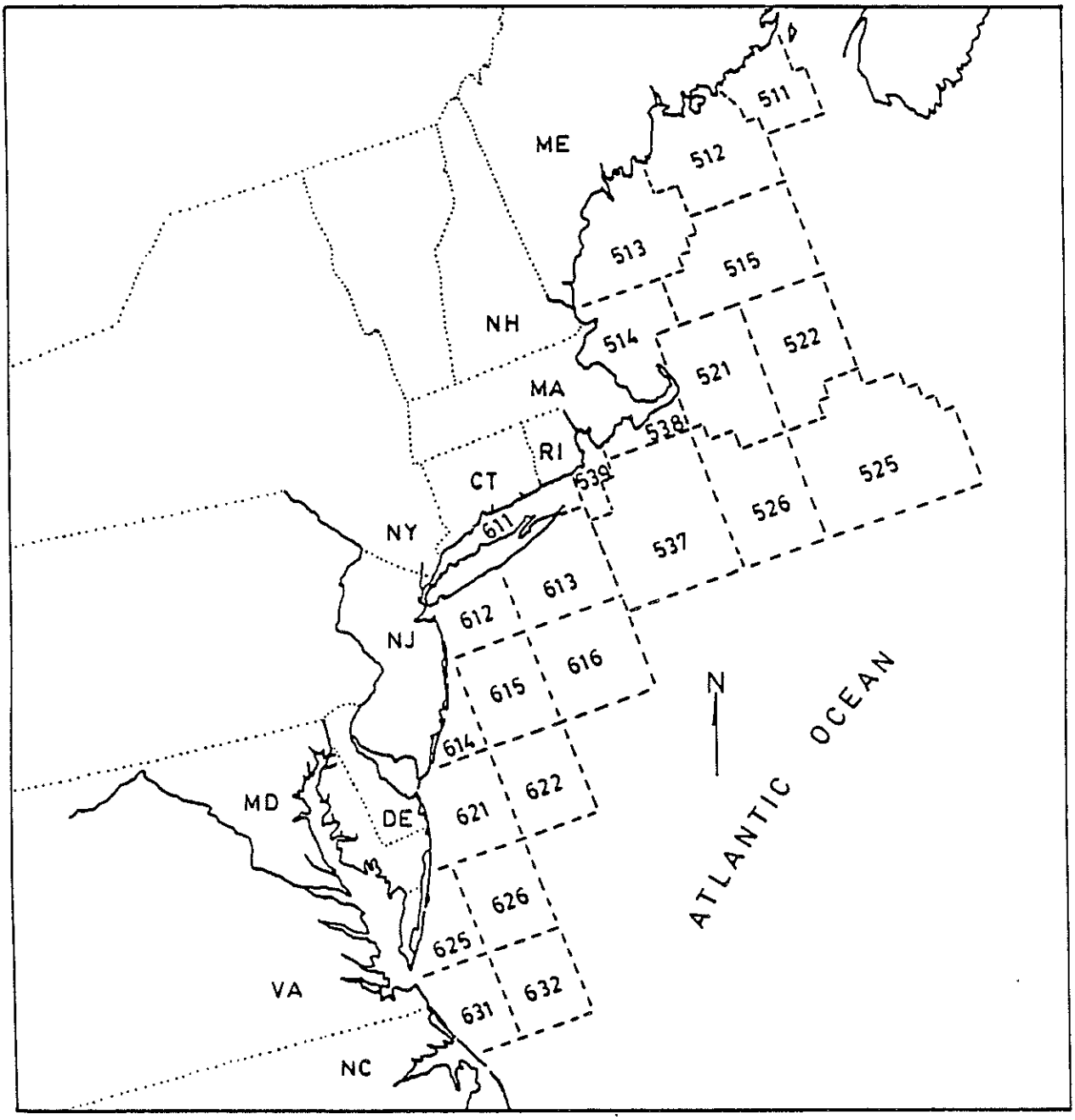

Figure 2. NMFS fishery sectors off New England and Mid-Atlantic states for which ocean harvests of American shad and/or river herring were reported since 1978.

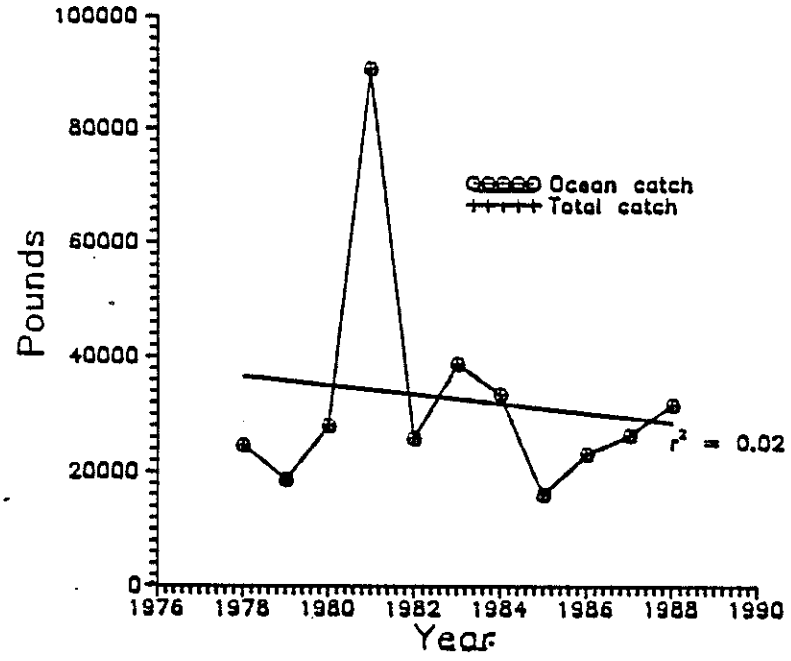

Figure 3. Ocean landings and total landings of American shad (pounds) by commercial fishermen for Maine, 1978-1988 (NMFS data).

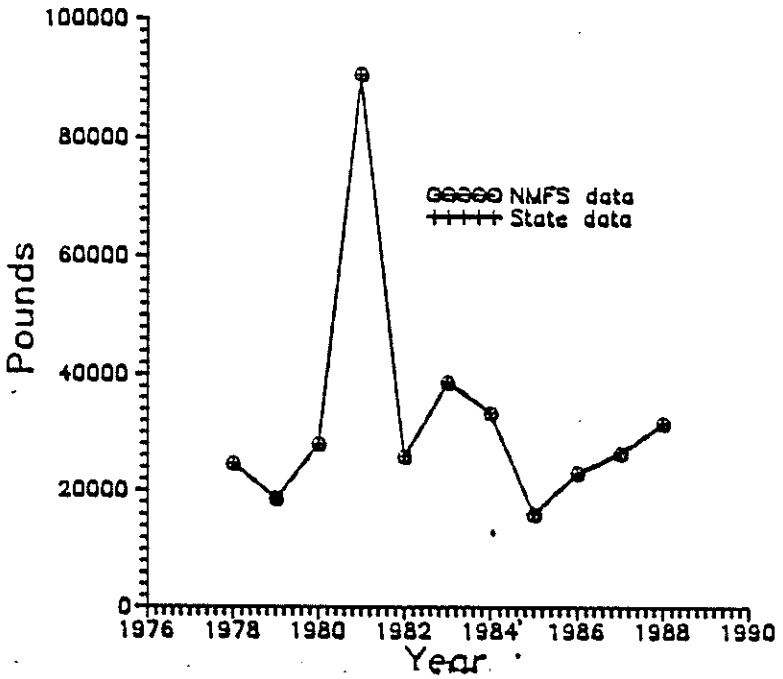

Figure 4. Commercial ocean landings of American shad (pounds) for Maine, 1978-1988, as reported by NMFS and by the Maine Department of Marine Resources.

Catch reporting: Fishery statistics are collected by Maine Department of Marine Resources in collaboration with NMFS (Table 10). Thus the data provided by the state and NMFS are virtually identical (Figure 4).

Catch analysis: In general, catches have declined slightly since 1978 (Figure 3, Figure 5). However, the catch is tremendously variable from year to year. Variation in the annual catch data probably reflects either changes in effort of the fisheries for which shad is a by-catch, or changes in the size of the stock. However, since Maine shad landings are incidental, the catch data probably contributes little to the understanding in trends of the stock in the region (ASMFC, 1985).

The Maine fishery is one of several along the East Coast that lands shad all year, with peak catches occurring during April through July, and October through December. These peaks in landings correspond well with the north-south/spring-fall ocean migratory patterns of shad as described by Dadswell et al. (1987). Thus, it is likely that the Maine shad fishery is an intercept fishery, catching shad as they move northwards into the Gulf of Maine and Canadian waters during post-spawning migrations, and again as they move south to ocean overwintering grounds in fall. The Maine winter fishery may be exploiting the stock that overwinters on the Scotian shelf (Dadswell et al. 1987). The gear types involved, the harvest areas, the time of year during which most landings occur, and the small population sizes of Maine riverine stocks suggest that a significant proportion of the Maine landings is not from local populations.

New Hampshire

The New Hampshire shad fishery is exclusively a by-catch fishery.

Gear: The bulk of the harvest is by gill nets (mesh size unknown), with small landings contributed from bottom otter trawls (Table 11).

Season: Shad are landed year round, with the largest landings during spring and summer.

Location: All shad landed in New Hampshire during the study period were caught at sea except for 7,500 pounds taken from Great Bay in 1987. Most shad are caught in area 513, with some harvest reported for area 514 (Figure 2). Very few, if any, shad are caught within three miles of the New Hampshire coast. Fish are landed at Portsmouth, Hampton and Rye Harbor.

Catch reporting: Catch reports are mandatory, and enforced by state law and regulation (Table 10). Commercial catch data are collected monthly through surveys, but the source of information (buyer, fishermen) is unclear. No ocean catches were reported for 1978, 1979 and 1980. At the time of writing, no catch data had been received directly from New Hampshire Fish and Game Department. Therefore only NMFS data were in the analysis. According to NMFS Northeast Fisheries Center (NEFC), the state data and the NMFS would be one and the

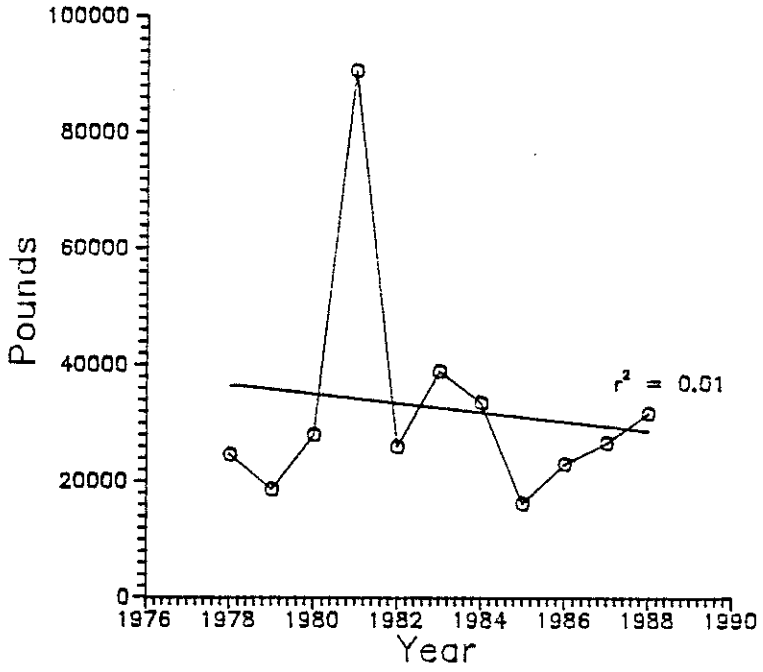

Figure 5. Commercial ocean landings of American shad (pounds) for Maine, 1978-1988 (state data).

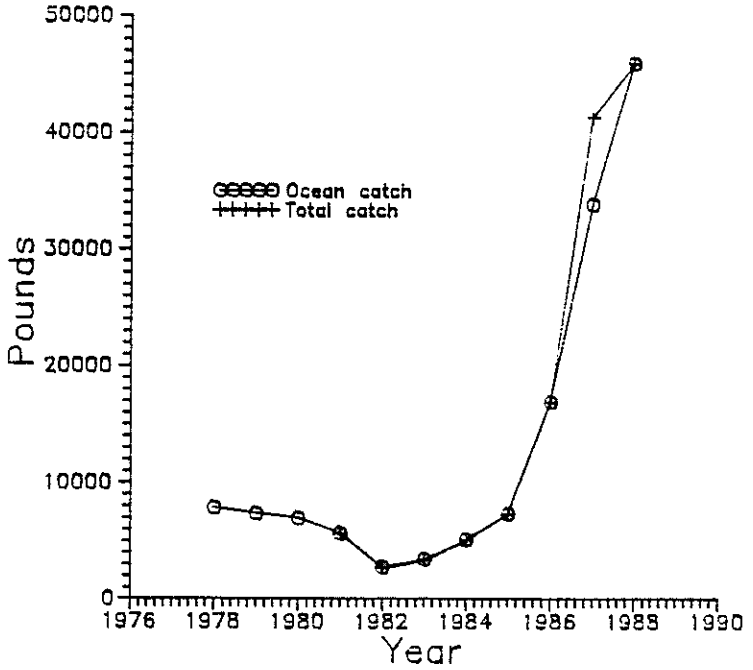

Figure 6. Ocean landings and total landings of American shad (pounds) by commercial fishermen for New Hampshire, 1978-1988 (NMFS data).

Table 10. Requirements of commercial finfish harvest reporting for Atlantic coast states for 1986 (from VMRC 1988).

State	Reporting Requirements	Required by Law or Regulation	Need for Data	Data Collection Interval	Data Source	Data Collection Areas	Number of Gear Types	Number of Field Technicians
NH	Mandatory	Both	Useful	Monthly	Unclear	3	5	1
MA	Mandatory	Both	Useful, essential	Monthly, annually	Unknown	70	10	17
RI	Voluntary	Neither	Essential	Daily	Unclear	10	15	None
CT	Mandatory	Law	Essential	Daily	Harvester catch reports	9	6	5
NJ	Voluntary	Neither	Essential	Weekly	Mainly NMFS port agents	Unknown	Unknown	10
DE	Mandatory	Law	Useful	Daily	Daily fishermen logs	4	4	2
MD	Mandatory	Law	Essential	Daily, monthly	Monthly census of license holders	30	15	22
VA	Voluntary	Neither	Essential	Monthly	Dealer reports	83	35	3
NC	Voluntary	Neither	Essential	Monthly	Dealer surveys	20	50	30
SC	Mandatory	Law	Essential	Monthly	Dealer and buyer surveys	Unknown	Unknown	Unknown
GA	Mainly voluntary	Law	Essential	Weekly, monthly	Dealer trans-action tickets	48	25	9
FL	Mandatory	Both	Essential	Daily	Dealer trip tickets	17	30	Not provided

*Although these requirements are no longer current in some states, they provide an indication of the reporting requirements during the study period.

Table 11. Commercial ocean landings (pounds)of American shad for New Hampshire, 1978-1988.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Weirs	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978	No ocean catch reported								No	0	7,800	0.00
1979	No ocean catch reported								data	0	7,300	0.00
1980	No ocean catch reported								provided	0	6,900	0.00
1981		5,500			100					5,600	5,600	100.00
1982		2,700								2,700	2,700	100.00
1983		3,400								3,400	3,400	100.00
1984		5,100								5,100	5,100	100.00
1985		7,300								7,300	7,300	100.00
1986		16,800			100					16,900	16,900	100.00
1987		33,400			400					33,800	41,300	81.84
1988		45,100			800					45,900	45,900	100.00

same (personnel communication, G. Sheperd, NEFC, Woods Hole Laboratory, Woods Hole, MA.).

Catch analysis: A marked increase in New Hampshire shad landings has occurred over the last eleven years (Figure 6). However, since this is a by-catch fishery, problems in data interpretation similar to those for Maine exist. Specifically, the increase in landings does not necessarily indicate increased stock size or provide any information as to the status of the eastern seaboard shad stock. More likely it reflects increased effort in those fisheries which are taking shad as a by-catch.

New Hampshire's shad fishery is similar to that of Maine, in that most of the shad harvested are probably from ocean migratory stocks. Peak landings occur during spring and summer, corresponding with the northward post-spawning migration. Territorial Sea landings (0 - 3 miles) are insignificant, suggesting that offshore (and presumably migratory) stocks are being harvested. Therefore, the New Hampshire shad fishery is most likely a by-catch intercept fishery.

Massachusetts

The Massachusetts shad harvest is a primarily a directed fishery.

Gear: Massachusetts shad landings are principally from gill nets (mesh size unknown). This is the only gear type for which catches were recorded for each year of the study. Other harvest methods include pound nets, otter trawls, long-lines, floating traps and beach haul seines (Table 12).

Season: Unknown.

Location: All NMFS landings reported for the study period were from the Atlantic Ocean (Figure 7). The major areas of harvest were sectors 513, 514, and 538 (Figure 2). Shad were also taken in areas 515, 521, and 522. Principal landing sites for shad are unknown at this time.

Catch reporting: Catch reports are mandatory, and required by state law and regulation (Table 10). Catch data are collected monthly and annually, but the source of the data (e.g., buyer, fishermen) is unknown.

Shad landings information for Massachusetts provided by NMFS was markedly different from the information provided by the state (Figure 8). Massachusetts Department of Marine Fisheries recorded small ocean catches of shad for 1979 - 1983 and 1987, while NMFS data indicated relatively large catches for all years. One reason for the discrepancy might be that landings reported by NMFS for territorial seas include by definition all fish harvested from inland waters. Therefore, the landings for territorial seas reported by NMFS, although reported as

Table 12. Commercial ocean landings (pounds) of American shad for Massachusetts, 1978-1988.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Long-line	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978		700		100						800	800	100.00
1979		500		2,600					526	3,100	3,100	100.00
1980		5,100		1,800				1,500	739	8,400	8,400	100.00
1981		10,100		6,100	300			200	1,520	16,700	16,700	100.00
1982		17,400		11,500	500				5,390	29,400	29,400	100.00
1983		12,100		1,100	300				35	13,500	13,500	100.00
1984		29,600		100					0	29,700	29,700	100.00
1985		22,000			100			200	0	22,300	22,300	100.00
1986		58,800			900			400	0	60,100	60,100	100.00
1987		40,400			100		100	200	0	40,800	40,800	100.00
1988		50,300	200	100	200				57	50,800	50,800	100.00

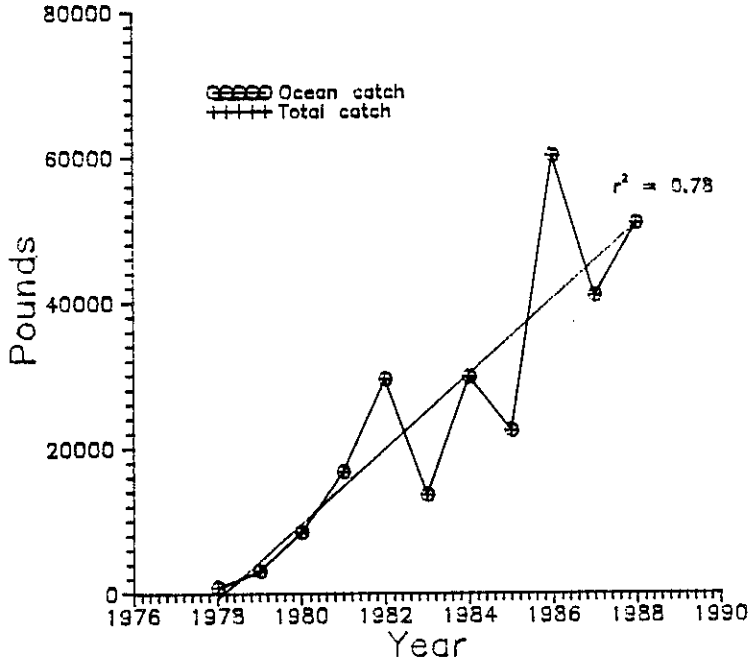

Figure 7. Ocean landings and total landings of American shad (pounds) by commercial fishermen for Massachusetts, 1978-1988 (NMFS data).

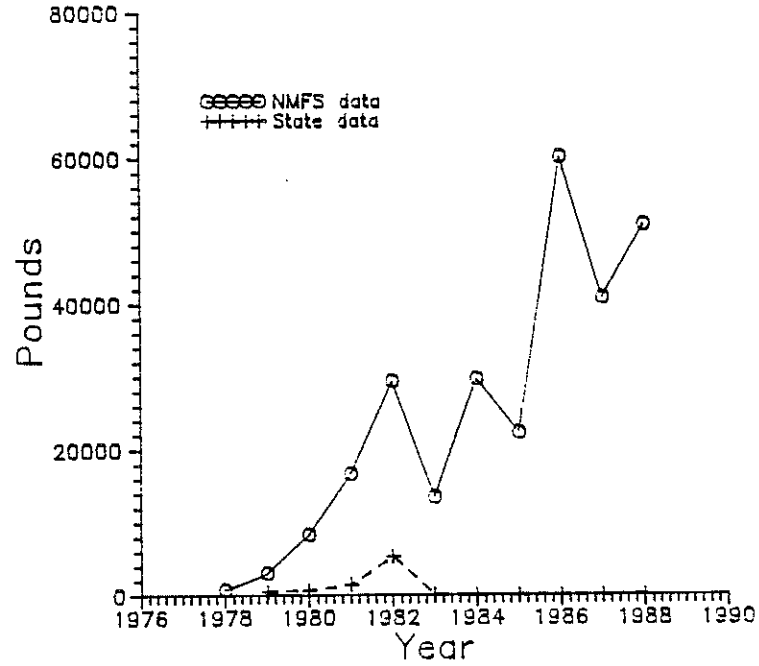

Figure 8. Commercial ocean landings of American shad (pounds) for Massachusetts, 1978-1988, as reported by NMFS and by the Massachusetts Division of Marine Fisheries.

harvested from the Atlantic Ocean, may includ shad harvested from inland waters, thus potentially representing an overestimate of ocean shad landings.

Catch analysis: Owing to the differences between the data sets, only the NMFS information was analyzed, which NEFC considers to be the only complete data for the state (G. Shepard, personnel communication). State data are depicted graphically (Figure 9).

Over the eleven-year period, there has been a definite trend toward increased shad landings (Figure 7). Since all shad landed are caught at sea, the Massachusetts shad harvest probably represents primarily an intercept fishery. The lack of details concerning seasonal harvest and nature of the fishery preclude further analysis.

Rhode Island

The Rhode Island shad fishery is another by-catch fishery, where shad are taken incidental to other species.

Gear: Floating trap is the principal gear type involved in the Rhode Island ocean shad fishery. Otter trawls and gill nets are also minor contributors to the shad harvest (Table 13).

Season: Shad are harvested throughout the year, although largest landings usually occur from May through July.

Location: All reported shad landings for Rhode Island since 1978 were from the Atlantic Ocean (Figure 10). The majority of the harvest is from area 539, with smaller catches occasionally reported from areas 511, 514, 525, 526, 537, 538, 611 and 616 (Figure 2). The two reported landing sites are Pt. Judith and Newport.

Catch reporting: Rhode Island catch reports are voluntary i.e., they are not required by state law or regulation (Table 10). Data are collected daily, and although reporting is voluntary, state personnel (Mark Gibson, Rhode Island Fish and Wildlife) believe that the data are a reasonable representation of the true catch. Commercial fisheries data are collected through a joint state/NMFS project, therefore the data provided to us by the state and NMFS is virtually identical (Figure 11).

Catch analysis: Shad landings for Rhode Island have increased sharply over the last eleven years (Figures 10, 12). There is some variability in the annual harvest; however, it is extremely difficult to ascertain the reason for the increase because the shad fishery is incidental. It probably represents an increase in effort for other species; thus, the increasing by-catch of shad is probably incidental and not related to an increase in stock size. Ocean shad harvest in Rhode Island waters is reasonably large, with a maximum of 121,600 pounds in 1988. Similarly to Maine, New Hampshire and Massachusetts, Rhode Island probably represents an intercept fishery, harvesting shad during pre- and post-spawning ocean migrations.

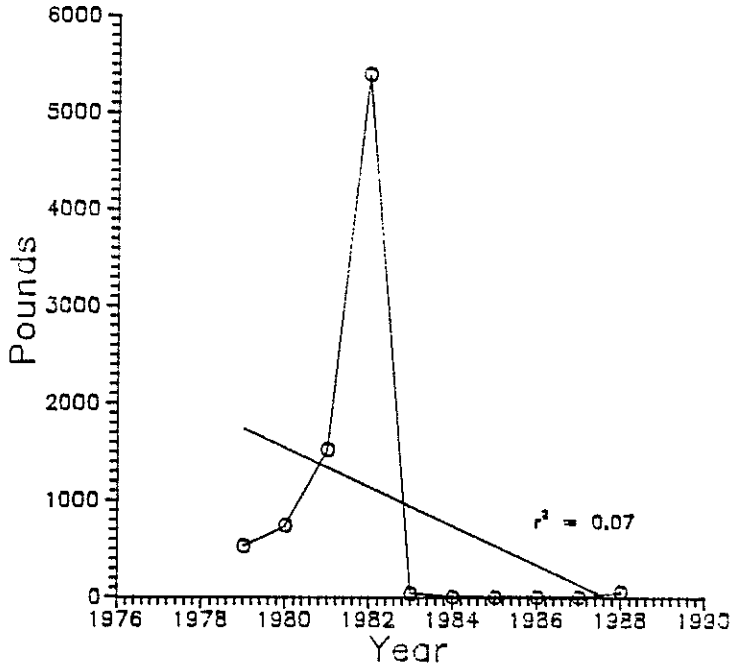

Figure 9. Commercial ocean landings of American shad (pounds) for Massachusetts, 1978-1988 (state data).

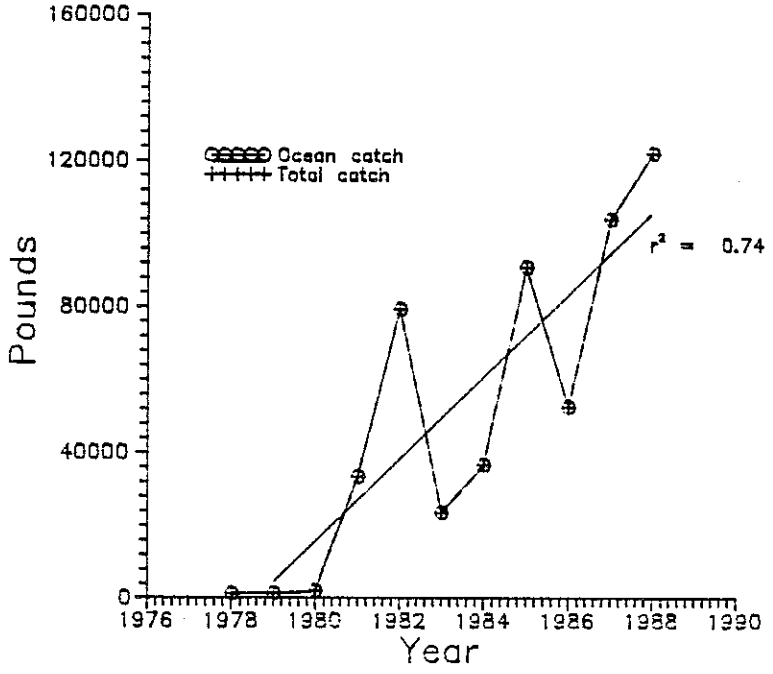

Figure 10. Ocean landings and total landings of American shad (pounds) by commercial fishermen for Rhode Island, 1978-1988 (NMFS data).

Table 13. Commercial ocean landings (pounds) of American shad for Rhode Island, 1978-1988.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Long-line	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Percent ocean
1978							1,200		1,000	1,200	1,200	100.00
1979		100					1,300		1,000	1,400	1,400	100.00
1980							2,100		2,000	2,100	2,100	100.00
1981		200					33,200		33,000	33,400	33,400	100.00
1982		2,300			300		76,700		79,000	79,300	79,300	100.00
1983		5,600			1,400		16,400	100	23,000	23,500	23,500	100.00
1984		20,300			10,800		5,500		36,000	36,600	36,600	100.00
1985		25,100			29,200	300	36,200		91,000	90,800	90,800	100.00
1986		5,700			9,600		37,100		52,500	52,400	52,400	100.00
1987		7,300			34,900		61,700		104,000	103,900	103,900	100.00
1988		3,800			12,200		106,000		121,600	122,000	122,000	100.00

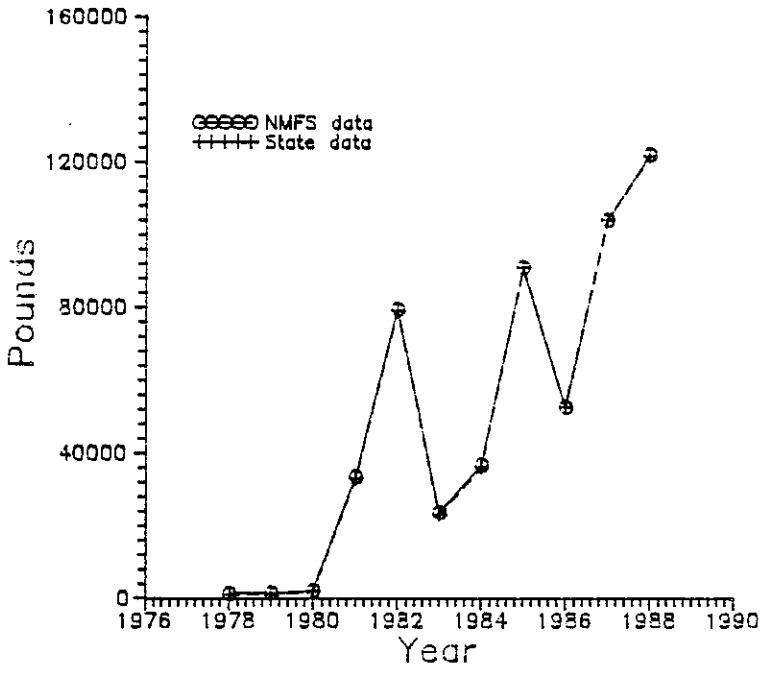

Figure 11. Commercial ocean landings of American shad (pounds) for Rhode Island, 1978-1988, as reported by NMFS and by the Rhode Island Department of Fish and Wildlife.

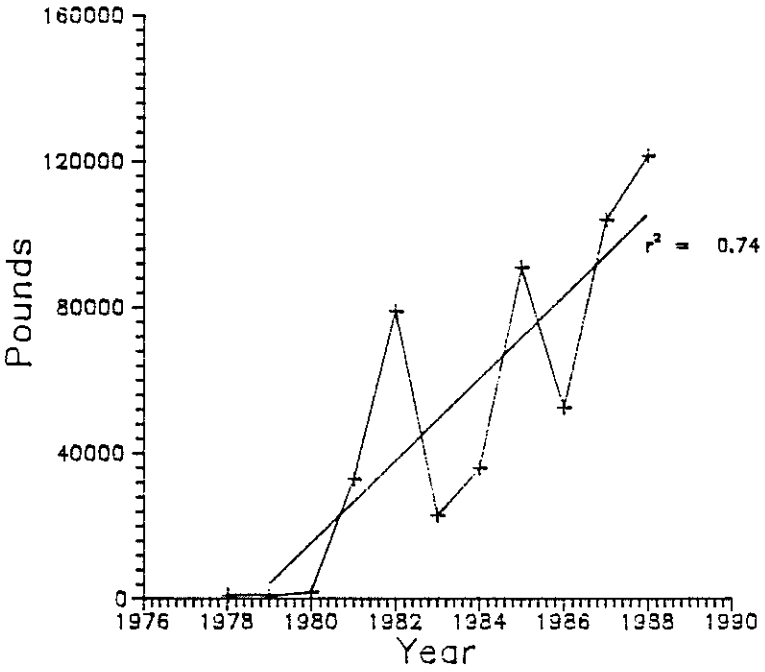

Figure 12. Commercial ocean landings of American shad (pounds) for Rhode Island, 1978-1988 (state data).

Connecticut

We have no information about whether the ocean shad fishery in Connecticut is a by-catch or directed fishery, but indirect evidence suggests that it is primarily bycatch in nature.

Gear: Ocean catches of shad in Connecticut are by two gear types: otter trawl and gill net (Table 14). However, shad harvest in these gear types is sporadic.

Season: Unknown.

Location: An extremely low percentage of the overall shad catch in Connecticut during the study period was caught at sea (Table 14, Figure 13). For each of the eleven years of the study, ocean-caught fish constituted less than one percent of the total shad landings for the state. Most of the shad landed, particularly since 1982, were caught in area 611 (Long Island Sound) (Figure 2). No information was available as to where shad are landed.

Catch reporting: Catch reports for Connecticut are mandatory and required by state law and regulation (Table 10). Data are collected from harvester catch reports which are completed daily and submitted annually. For this study, the Connecticut Department of Environmental Protection reported that shad were harvested in three of the eleven study years - 1984, 1986, and 1988. In contrast, NMFS reported catches for five of the study years - 1978 and 1981 through 1984 (Figure 14). As NMFS obtains the data directly from the Connecticut DEP (G. Shepard, personnel communication), the discrepancies might be due to differences in defining ocean landings.

Catch analysis: The paucity of catch data from the state and NMFS made any meaningful analysis of the shad landings in Connecticut difficult. Ocean harvest is extremely low compared to the total landings for Connecticut and to ocean landings for other eastern seaboard states. A slight increase in landings is apparent over the last eleven years (Figures 13, 15), but owing to the few data available, this trend cannot be confirmed. Similarly, the lack of information about seasonality of the harvest confounds attempts to identify whether the fishery exploits local or migratory stocks; the close proximity of the fishery to the Hudson River population may result in exploitation of fish of Hudson origin.

New York

The ocean shad fishery of New York is primarily a by-catch fishery.

Gear: During the study period, most shad were harvested by ocean pound net (Table 15). The second most important gear was beach haul seines, but harvest by this method was variable for each year of the study. Gill nets and bottom otter trawls are minor gear types for ocean shad harvest in New York.

Table 14. Commercial ocean landings (pounds) of American shad for Connecticut, 1978-1988.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Long-line	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978					300					300	306,300	0.10
1979	No ocean catch									0	206,800	0.00
1980	No ocean catch									0	310,500	0.00
1981					100					100	324,700	0.03
1982		100								100	283,000	0.04
1983					1,600					1,600	426,000	0.38
1984					100				80	100	398,800	0.03
1985	No ocean catch								0	0	402,000	0.00
1986	No ocean catch								500	0	322,000	0.00
1987	No ocean catch								0	0	333,900	0.00
1988	No catch reported								400			

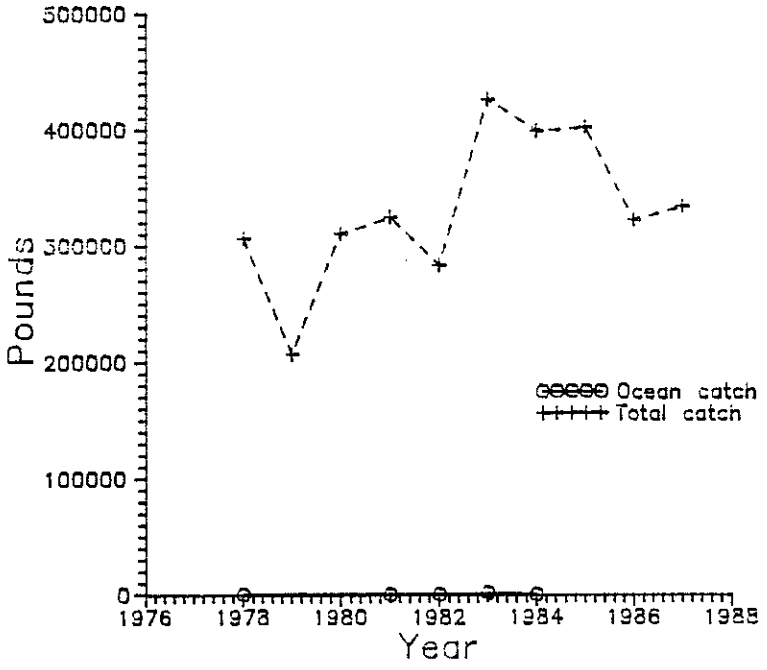

Figure 13. Ocean landings and total landings of American shad (pounds) by commercial fishermen for Connecticut, 1978-1988 (NMFS data).

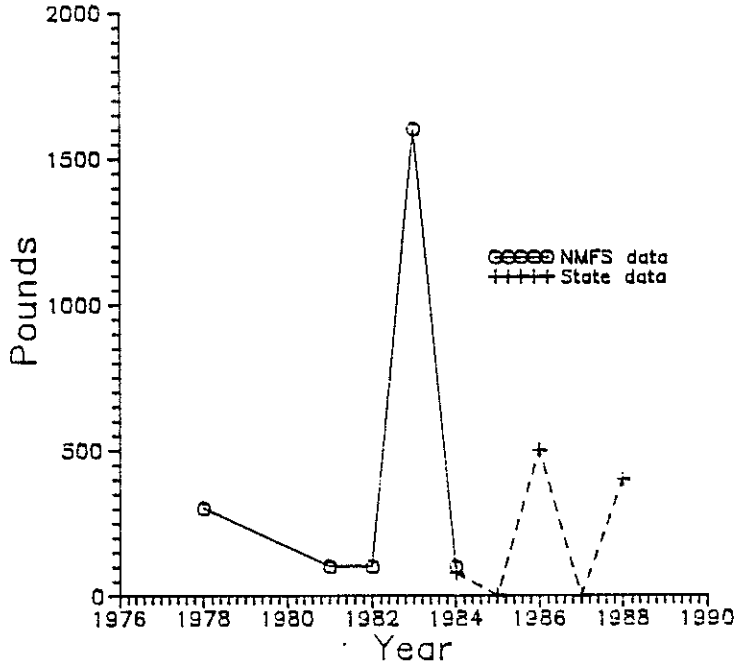

Figure 14. Commercial ocean landings of American shad (pounds) for Connecticut, 1978-1988, as reported by NMFS and by the Connecticut Department of Environmental Protection.

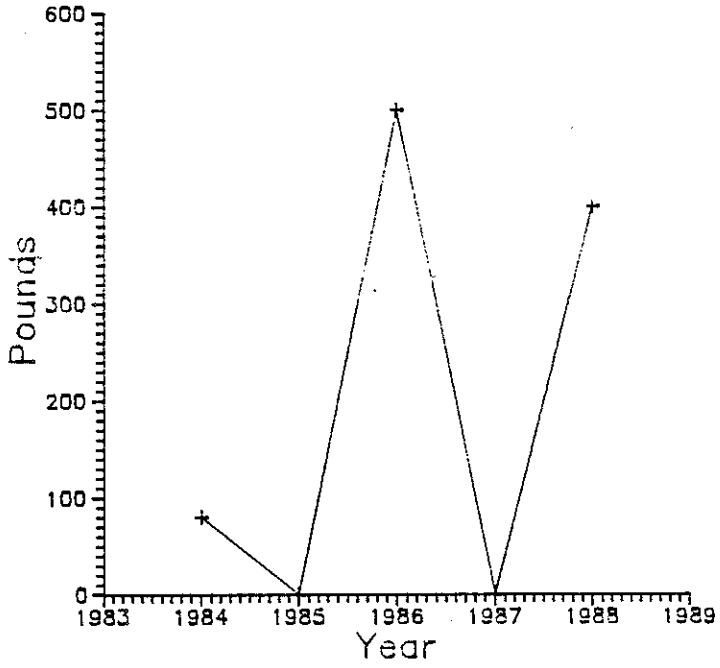

Figure 15. Commercial ocean landings of American shad (pounds) for Connecticut, 1978-1988 (state data).

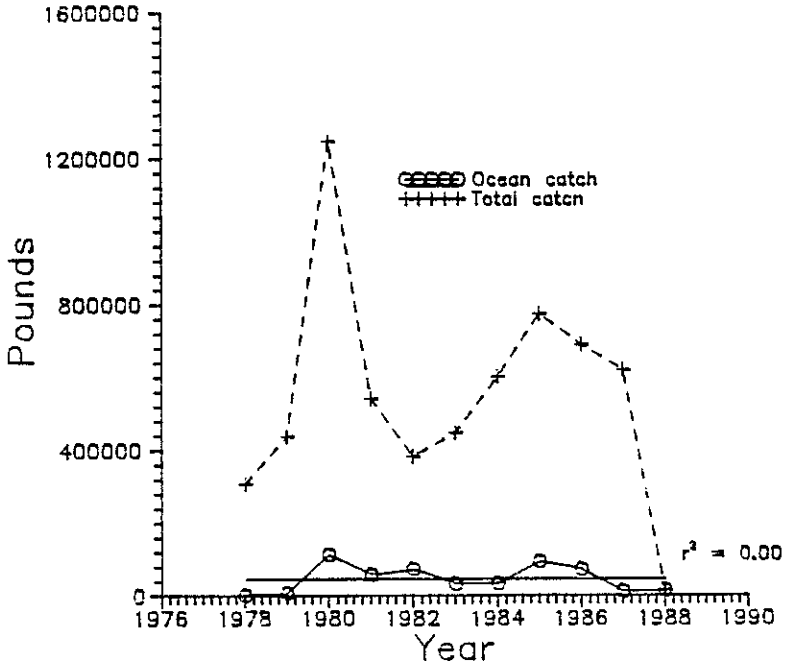

Figure 16. Ocean landings and total landings of American shad (pounds) by commercial fishermen for New York, 1978-1988 (NMFS data).

Table 15. Commercial ocean landings (pounds) of American shad for New York, 1978-1988.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Long-line	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978		100	1,400	400	100				2,000	2,000	308,500	0.65
1979		100	1,400	5,400	1,200				8,000	8,100	438,400	1.85
1980		200	14,600	96,000	2,700				112,900	113,500	1,248,800	9.09
1981		1,200	600	55,700	800				58,300	58,300	541,100	10.77
1982		300	11,300	61,700	300				73,600	73,600	383,200	19.21
1983		1,000	14,100	17,600	300				33,000	33,000	448,400	7.36
1984		700	6,500	26,300	100				33,600	33,600	601,500	5.59
1985		200	26,500	62,500	4,600				89,200	93,800	773,864	12.12
1986		18,100		54,700	100				72,900	72,900	688,668	10.59
1987		4,000	1,000	6,600					11,600	11,600	619,082	1.87
1988		8,500		2,500	4,500				15,500	15,500	15,500	100.00

Season: Shad are caught in the New York ocean fishery primarily during May and June. It is uncertain whether shad are landed during the remainder of the year.

Location: A very low percentage of total shad landings for New York are from ocean waters (Table 15, Figure 16). The only exception to this was in 1988, when 100 percent of the reported landings were of ocean origin, although this may be due to incomplete data reports. Most of the ocean shad are taken within three miles of the shore. Fishing areas include the south shore of Long Island and Eastern Long Island Sound (Area 611), and sectors 612 and 613 (Figure 2). Shad are landed at approximately 12 sites, the most important of which are Long Island South Shore, Eastern Long Island and the area from Freeport to Port Jefferson.

Catch reporting: Details of the catch reporting requirements in New York are unknown. The catch data provided to us by the state were obtained by the state from NMFS, and are therefore identical to the landings data we recieved from NMFS (Figure 17). The details of NEFC fisheries statistics methodology are discussed by Schulz (1989).

Catch analysis: There is no trend in ocean landings of shad in New York waters since 1978. However, annual landings were extremely variable such that any overall trend is obscured (Figure 16 and 18).

The seasonality of shad harvest suggests that the New York fishery is primarily an intercept fishery catching shad during the northward migration after spawning. The New York ocean harvest for shad should include fish of Hudson River origin; however, the ratio of Hudson River shad harvested in the ocean fishery relative to non-local migratory stocks is unknown.

New Jersey

New Jersey is the northern-most state to have a directed ocean shad fishery.

Gear: Greatest ocean landings of shad in New Jersey are by gill net with a minimum mesh size of 5" bar (Table 16). Other gear types used in the ocean fishery (in decreasing order of importance) are pound nets, beach haul seines, bottom otter trawls, and occasionally paired midwater trawls (Table 16).

Season: The season extends from 1 February to 15 May.

Location: All shad landed in New Jersey are of ocean harvest (Table 15, Figure 19). Areas of harvest include sectors 611 through 615, 621, 622, and 626 (Figure 2). Harvest is fairly evenly distributed among these areas; larger catches tend to be in areas 611 through 615 and 621. Discussions with state personnel indicate that all state landings are not harvested from the ocean. This is supported by the discrepancies for catch data obtained from the state and NMFS. Most fishing effort occurs within three miles of the coast. Although specific landing sites are not known, most landings are reported in Atlantic County, Ocean County, Monmouth

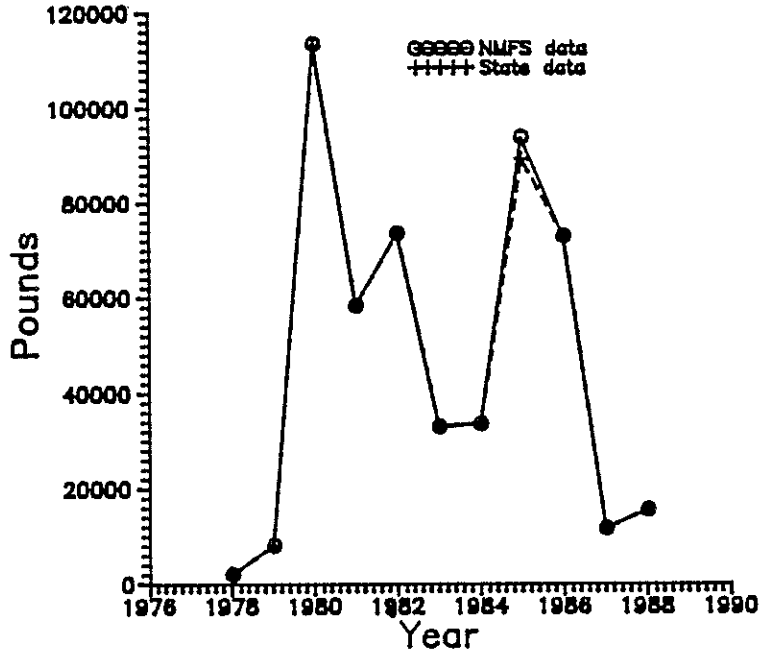

Figure 17. Commercial ocean landings of American shad (pounds) for New York, 1978-1988, as reported by NMFS and by the New York State Department of Environmental Conservation.

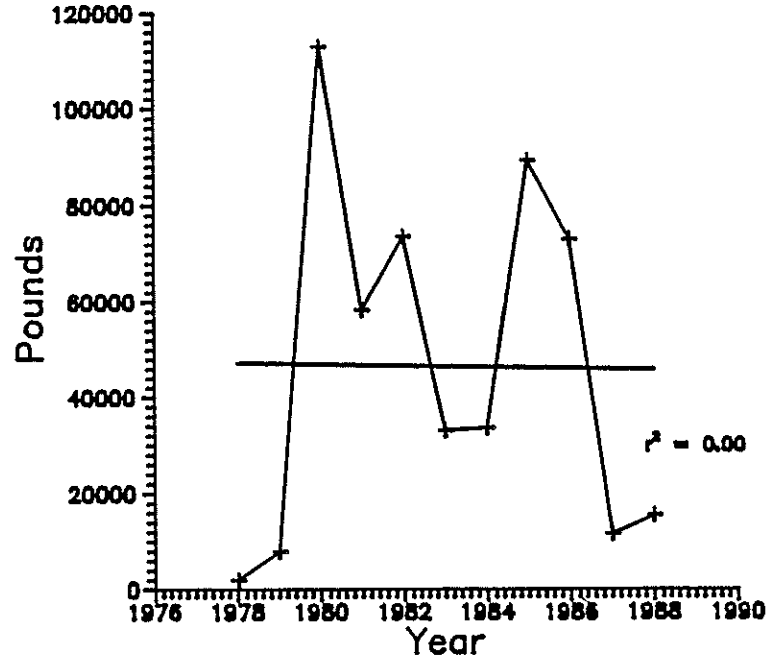

Figure 18. Commercial ocean landings of American shad (pounds) for New York, 1978-1988 (state data).

Table 16. Commercial ocean landings (pounds) of American shad for New Jersey, 1978-1988.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Long-line	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978		198,100		35,300	8,700				67,400	242,100	242,100	27.84
1979		121,800		10,400	16,400				65,930	148,600	148,600	44.37
1980		253,500		10,400	27,800				76,600	291,700	291,700	26.26
1981		226,400		30,800	5,700	200			93,720	263,100	263,200	35.61
1982		323,600	1,100	20,100	4,800				141,640	349,600	349,900	40.48
1983		195,200	2,100	20,400	10,700	100			135,380	228,500	228,500	59.25
1984		224,200	6,400	54,900	7,700				147,980	293,200	293,200	50.47
1985		258,700	8,100	20,700	4,200				166,140	291,700	291,700	56.96
1986		258,700	5,700	41,500	29,200				133,780	335,100	335,100	39.92
1987		223,200	8,200	31,300	5,100				106,300	267,800	267,800	39.69
1988		341,600	9,300	72,000	11,700				193,780	434,600	434,600	44.59

County, and Cape May County.

Catch reporting: Catch reports are submitted on a voluntary basis and are not required by New Jersey law or regulation (Table 10). Even though the state obtains its fisheries statistics directly from NMFS, there is a noticeable difference in catch reports by the state and by NMFS for the period 1978 through 1988 (Figure 20). The differences might be due to NMFS including fish harvested from inland waters with fish harvested from the Territorial Seas. Therefore, in reporting Territorial Seas landings for New Jersey, NMFS includes fish harvested from Delaware Bay, in spite of providing a distinct water body code for Delaware Bay.

Catch analysis: The New Jersey catch increased sharply over the last eleven years (Figures 19, 21). The majority of the ocean shad catch is by gill net. Since this is the only species specific gear used in the ocean fishery, it may be the only gear type used in the directed fishery for ocean shad. Catches from the other gear types would then be considered incidental.

The ocean gill net catch for shad alone has increased over the study period (Table 15), confirming the trend toward larger ocean shad catches in New Jersey. Since the season for ocean shad harvest extends from 1 February to 15 April, the gill net effort may represent a fishery that is exploiting shad moving from ocean overwintering grounds toward natal streams. A small portion of the ocean catch might be of shad migrating north, after spawning in rivers to the south of New Jersey. It is unclear at this stage whether the shad caught in haul seines, pound nets and otter trawls are landed during this season.

Delaware

The Delaware ocean shad fishery is also a directed fishery.

Gear: Only gill nets are used in the Delaware ocean shad fishery. Gear deployment is primarily anchored gill nets, although some drift gill nets are used. Both gear types have a mesh size of 5.5" stretch.

Season: No legislated season is in effect. Fishing generally begins in the last week of February or the first week of March, and continues until the end of April. The Delaware ocean shad fishery has been in existence since at least 1980, when it was finally noted by the Delaware Division of Fish and Wildlife (DFW).

Location: The ocean catch of shad in Delaware comprises a small percentage of the total state landings, although this percentage has increased over the last eleven years (Table 17, Figure 22). Offshore effort is concentrated in area 621 between 0.5 and two miles of the coast (Figure 2). The primary landing site is the Delaware Seashore State Park Marina at Indian River Inlet. Part of the catch may be landed at South Shores Marina.

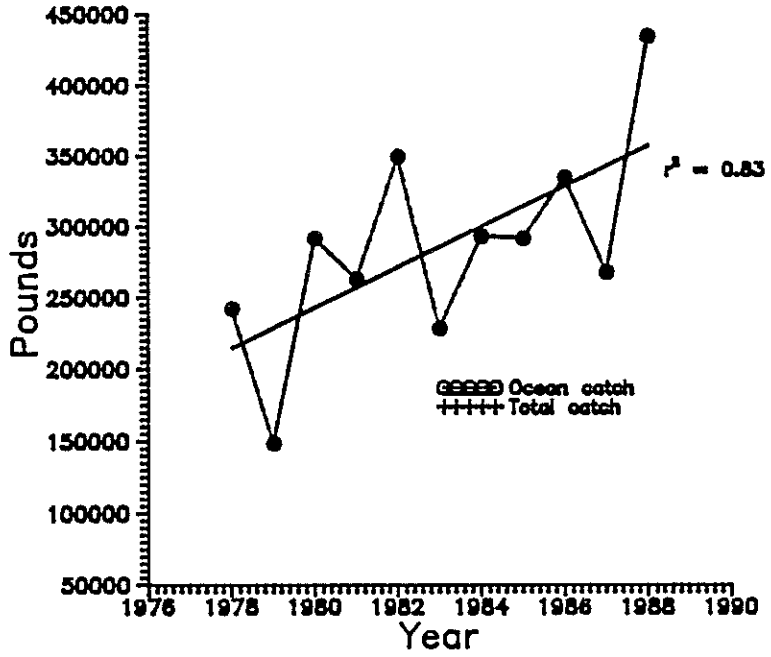

Figure 19. Ocean landings and total landings of American shad (pounds) by commercial fishermen for New Jersey, 1978-1988 (NMFS data).

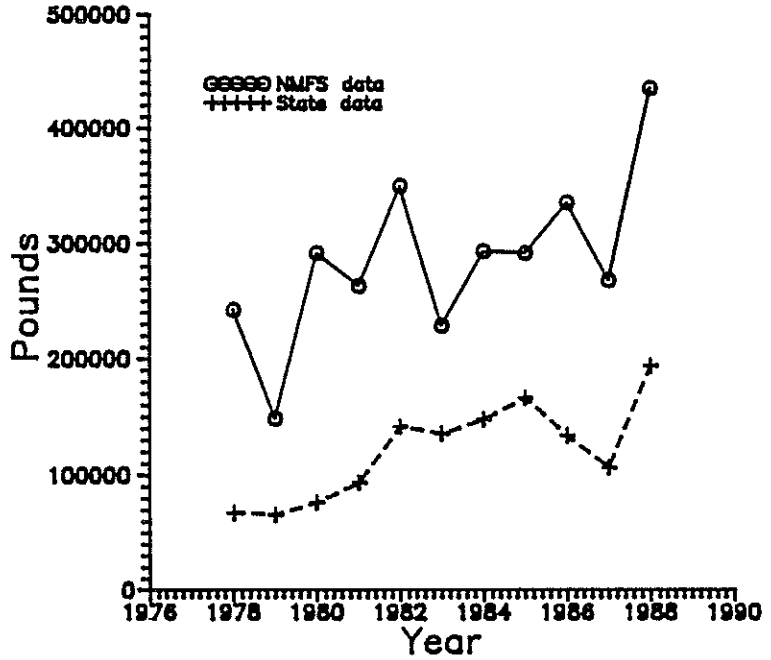

Figure 20. Commercial ocean landings of American shad (pounds) for New Jersey, 1978-1988, as reported by NMFS and by the New Jersey Division of Fish, Game and Wildlife.

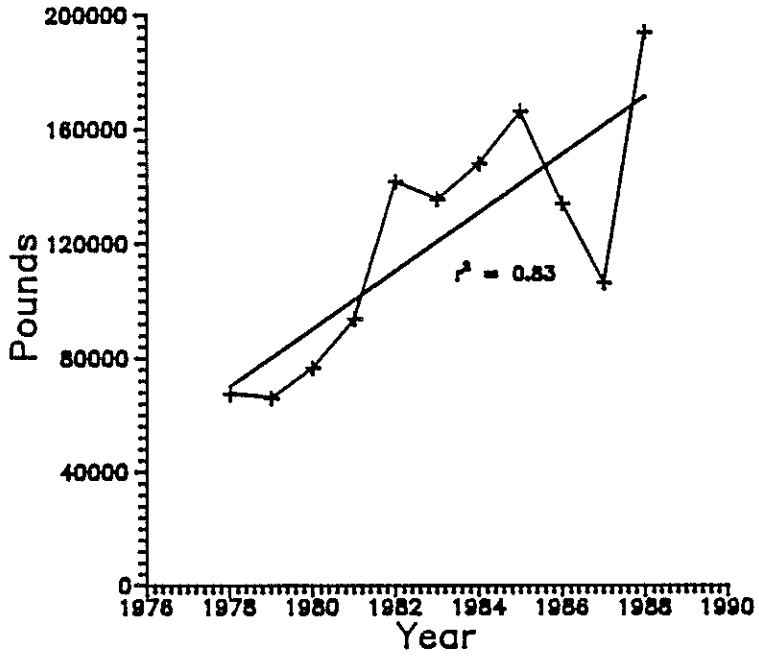

Figure 21. Commercial ocean landings of American shad (pounds) for New Jersey, 1978-1988 (state data).

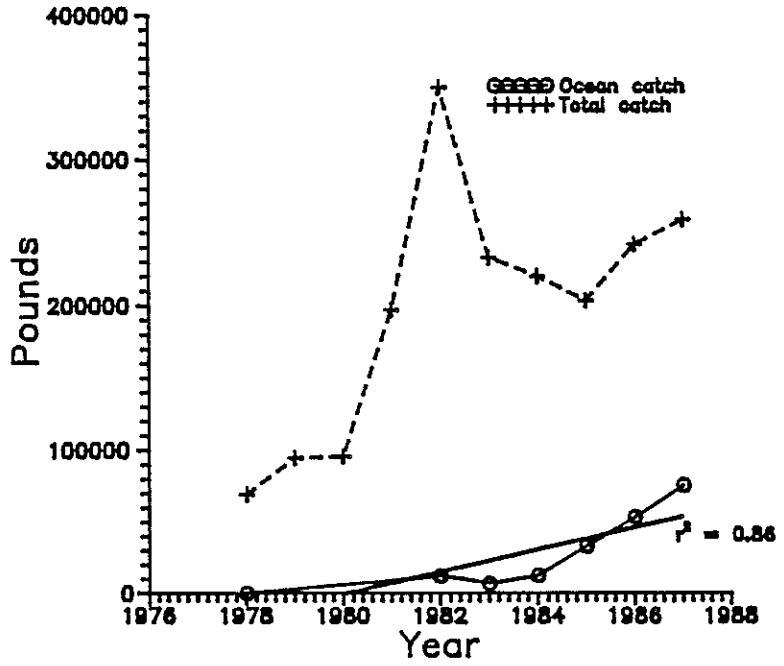

Figure 22. Ocean landings and total landings of American shad (pounds) by commercial fishermen for Delaware, 1978-1988 (NMFS data).

Table 17. Commercial ocean landings (pounds) of American shad for Delaware, 1978-1988.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Long-line	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978		300								300	69,900	0.43
1979	No ocean catch reported									0	94,900	0.00
1980	No ocean catch reported									0	96,000	0.00
1981	No ocean catch reported									0	197,300	0.00
1982		12,400								12,400	350,000	3.54
1983		7,100								7,100	232,800	3.05
1984		12,700								12,700	220,000	5.77
1985		33,300							33,270	33,300	203,400	16.37
1986		53,600							53,691	53,600	242,300	22.12
1987		75,900							75,851	75,900	259,100	29.29
1988	No ocean catch reported								86,129			

Catch reporting: Catch reports are mandatory and required by state law (Table 10). Commercial catch data are entered into daily log sheets by fishermen, which in turn are mailed monthly to Delaware DFW. The reporting program has been in existence only since 1985, and no state ocean catch data are available prior to that time. NMFS obtains the data directly from Delaware DFW; therefore, the state data are virtually identical to the NMFS data (Figure 23).

Catch analysis: Ocean landings of shad in Delaware have gradually increased over the study period. The coefficient of variation describes 86 percent and 98 percent of the variation in the NMFS and state data, respectively (Figures 22, 24). The percentage of the total state landings constituted from the ocean catch also increased, from 0.43 percent in 1978 to 29.29 percent in 1987 (Table 17).

The Delaware fishery is generally in operation by the first week of March, and usually closes by mid-April. It is therefore similar to the gill net fishery of New Jersey in that it is probably harvesting shad in the ocean prior to spawning; e.g., those fish that overwinter in the mid-Atlantic Bight, with a negligible portion of the catch harvested from the early post-spawning migrations.

Maryland

The Maryland ocean shad fishery is a directed fishery.

Gear: The large majority of the Maryland ocean shad catch is taken in gill nets. Only drift gill nets are used, with mesh sizes ranging between 5" and 6" stretch; mesh sizes of 5.5" to 6" are most common. Bottom otter trawl is the only other gear type harvesting shad in ocean waters, but catches in this gear are probably incidental.

Season: There is no legislated season for the ocean shad fishery in Maryland. Fishing usually begins in early February, and continues until late April.

Location: State ocean landings data were used in the analysis, whereas the total landings data used were provided by NMFS. The portion of the total Maryland landings of shad comprised of ocean caught fish ranges from a low of one percent in 1981 to a high of 4.7 times the total harvest in 1988 (Table 18, Figure 25). On average, however, the ocean catch has been approximately 1.45 times higher than the total state shad landings. Most of the ocean catch is harvested from area 621 (Figure 2). The Maryland Department of Natural Resources estimates that approximately 70 percent of the fishing effort is within three miles of the coast. Shad are also harvested from Assawoman and Chincoteague Bays, and area 622. All fish are landed at Ocean City.

Catch reporting: Catch reporting is mandatory, and required by Maryland law. Catch data are collected from monthly reports submitted by license holders. However, NMFS consistently underreports the ocean landings for Maryland (Figure 26). Possible reasons for the

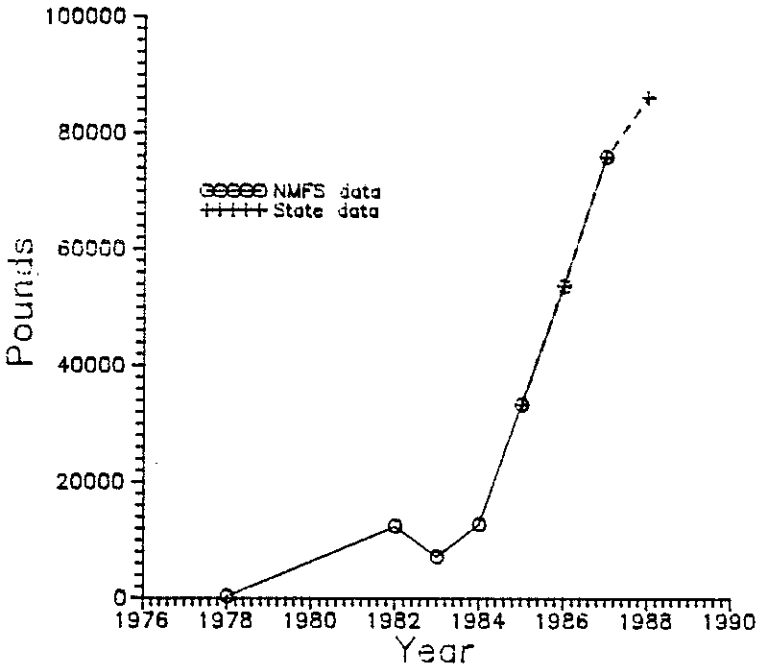

Figure 23. Commercial ocean landings of American shad (pounds) for Delaware, 1978-1988, as reported by NMFS and by the Delaware Division of Fish and Wildlife.

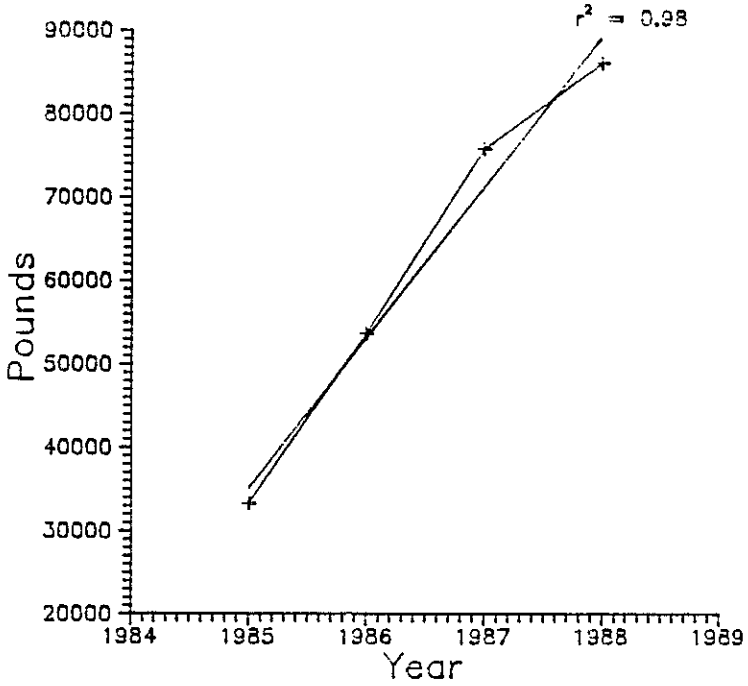

Figure 24. Commercial ocean landings of American shad (pounds) for Delaware, 1978-1988 (state data).

Table 18. Commercial ocean landings (pounds) of American shad for Maryland, 1978-1988.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Long-line	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978		13,300							20,342	13,300	92,600	21.97
1979		13,200							25,992	13,200	46,200	56.26
1980		2,200			200				2,779	2,400	23,800	11.68
1981	No ocean catch reported								7	0	600	1.17
1982		13,800			100				19,184	13,900	16,100	119.16
1983		56,400							76,669	56,400	62,000	123.66
1984		59,300							86,909	59,300	70,300	123.63
1985		39,000							339,054	39,000	189,400	179.01
1986		4,000							257,170	4,000	134,600	191.06
1987		185,000							301,051	185,000	189,300	159.03
1988		143,300							676,759	143,300	144,000	469.97

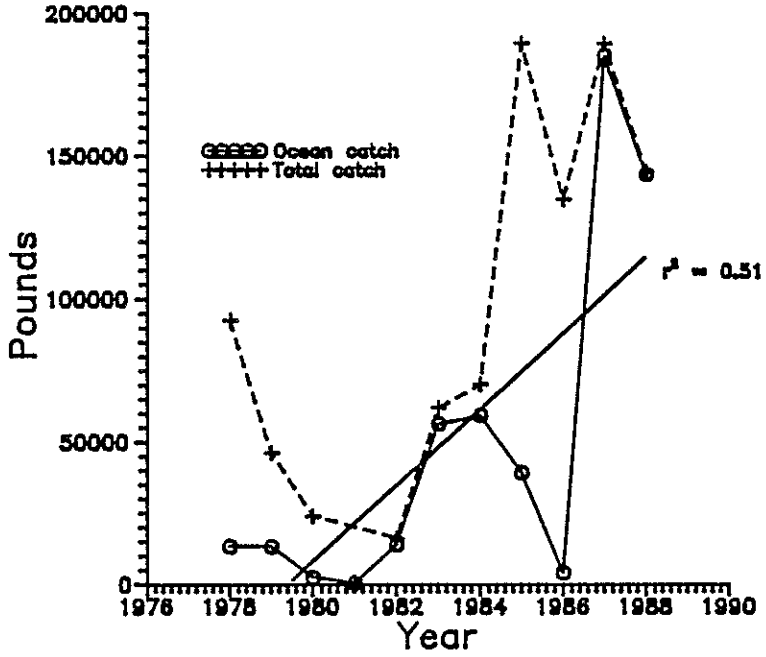

Figure 25. Ocean landings and total landings of American shad (pounds) by commercial fishermen for Maryland, 1978-1988 (NMFS data).

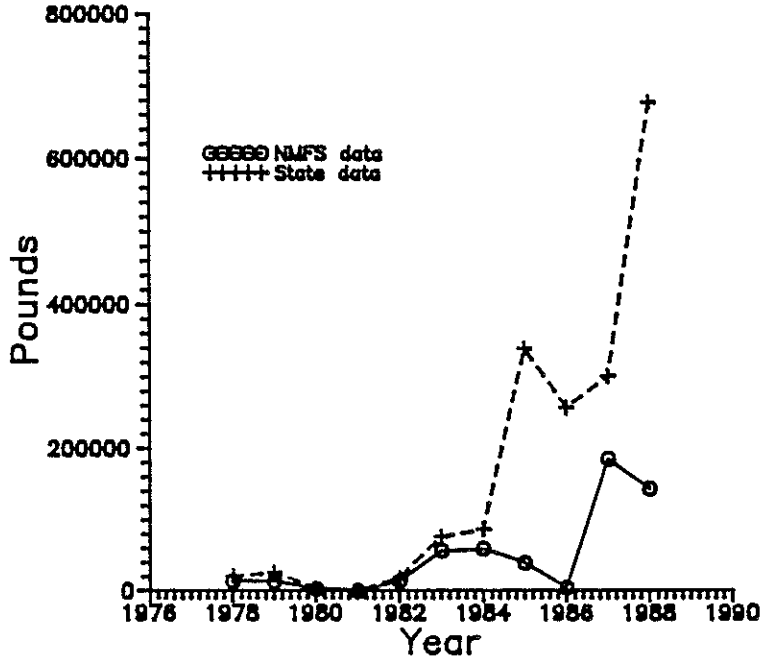

Figure 26. Commercial ocean landings of American shad (pounds) for Maryland, 1978-1988, as reported by NMFS and by the Maryland Department of Natural Resources.

trend might be in the definition of ocean landings and/or a lag in the time that the state takes to pass on annual data to NEFC, and the subsequent failure of NMFS to add deliquent data to the national database. The reasons for these discrepancies need to be clarified.

Catch analysis: The ocean catch of American shad in Maryland has increased since 1981, when essentially no shad were landed (Figures 25 and 27). The Chesapeake Bay shad fishery was closed in 1980, and fishing pressure may have shifted from the Bay to the ocean. The fishery in Maryland is similar to that of Delaware, with a directed gill net fishery harvesting all or most of the reported catch. Similar to Delaware, the seasonality of the Maryland fishery suggests that it is exploiting shad moving from overwintering grounds to coastlines adjacent to natal streams just prior to spawning.

Virginia

Virginia has a directed fishery for ocean harvest of shad.

Gear: The primary gear for ocean shad harvest in Virginia is gill nets, principally staked and drift gill nets. Mesh sizes are unknown. Bottom otter trawls represented the second largest landings during the study period (Table 19). Shad were also caught by beach haul seines, pound nets, and paired midwater trawls.

Season: No season for an ocean shad fishery is legislated by Virginia. Fishing usually starts in mid-February, and continues into early April.

Location: An increasing percentage of the total landings of shad in Virginia are being caught at sea. The percentage had increased from one percent in 1978 to 41 percent in 1988 (Table 18, Figure 28). Most shad are caught in areas 625 and 631, with additional reports from area 621 (Figure 2). Fishing occurs along the entire Virginia coastline, with most of the catch harvested within three miles of the coast. No specific landing sites are known; rather, shad are landed at a variety of small ports.

Catch reporting: Catch reports are voluntary, obtained from buyers by state technicians on a monthly basis. Although the NMFS database and the state database are identical, we included shad harvest from the seaside bays in the state data (Figure 29, Table 19), because it incorporated ocean catch information not provided to us by NMFS.

Catch analysis: Since 1978, ocean landings of shad in Virginia have increased while total state landings have decreased (Figures 28, 30). This suggests that fishing pressure may be shifting from inshore fisheries to the relatively untapped ocean fishery.

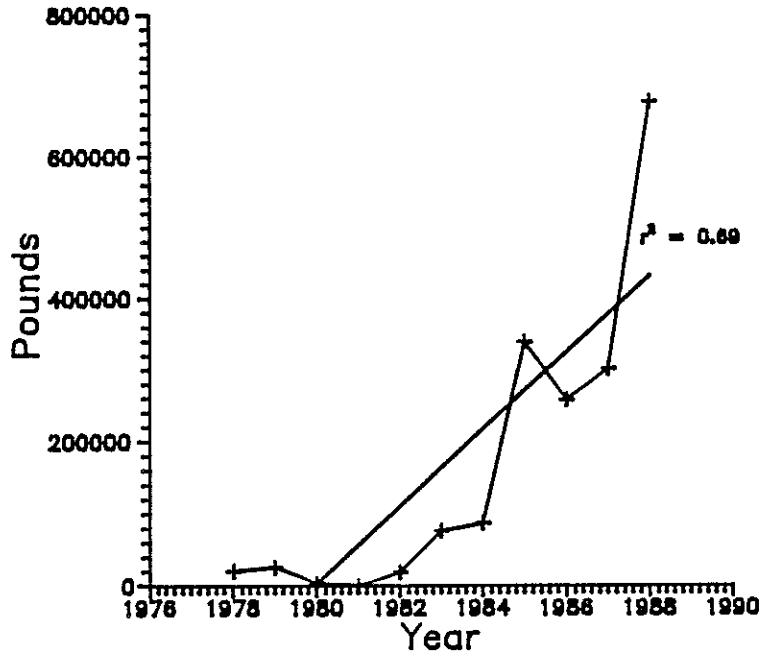

Figure 27. Commercial ocean landings of American shad (pounds) for Maryland, 1978-1988 (state data).

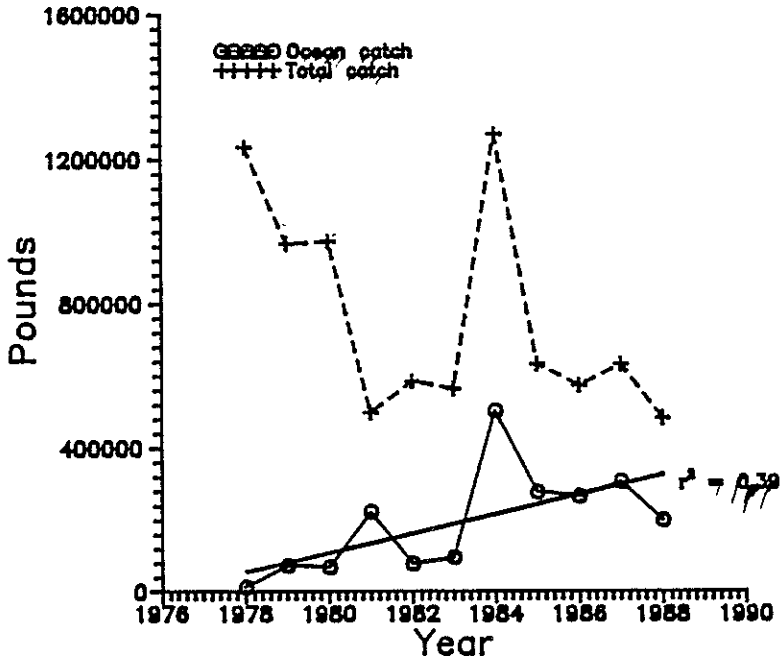

Figure 28. Ocean landings and total landings of American shad (pounds) by commercial fishermen for Virginia, 1978-1988 (NMFS data).

Table 19. Commercial ocean landings (pounds) of American shad for Virginia, 1978-1988. State-reported catch data include seaside bays.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Long-line	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978		12,000	1,200						13,161	13,200	1,234,700	1.07
1979		74,400	100						75,806	74,500	967,300	7.84
1980		66,300	1,800		1,300				95,914	69,400	973,900	9.85
1981		224,500							275,679	224,500	498,800	55.27
1982		57,800			21,400				276,995	79,200	585,300	47.33
1983		88,100		9,300					209,697	97,400	564,100	37.17
1984		489,500			5,400	8,500			644,397	503,400	1,270,100	50.74
1985		252,300	3,300		22,500				332,157	278,100	632,710	52.50
1986		262,200	1,000		3,400				355,588	266,600	573,100	62.05
1987		306,000	600		1,200				395,834	307,800	632,800	62.55
1988		200,800								200,800	483,000	

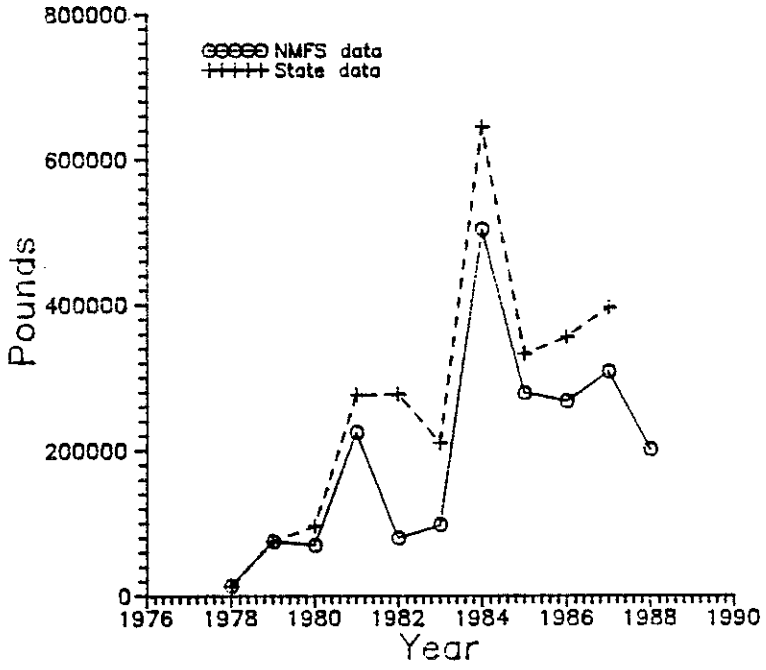

Figure 29. Commercial ocean landings of American shad (pounds) for Virginia, 1978-1988, as reported by NMFS and by the Virginia Marine Resources Commission.

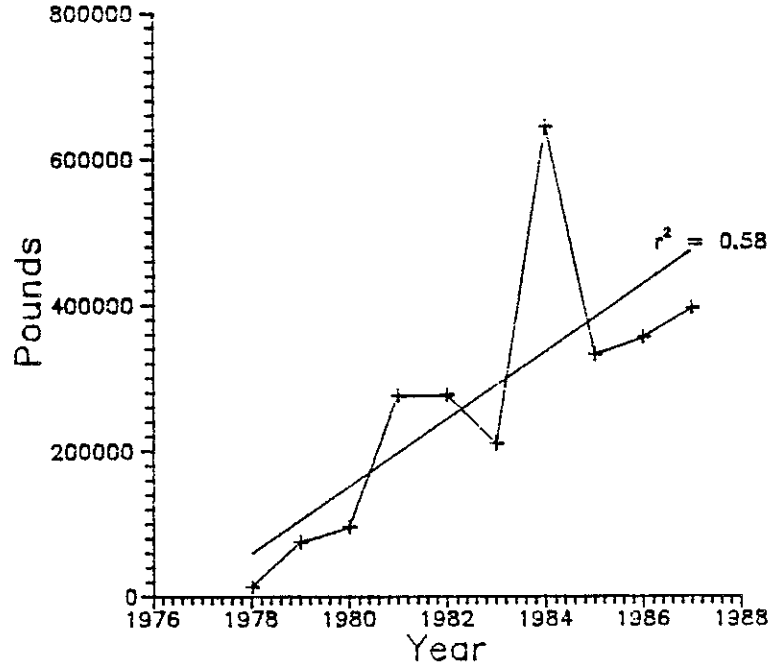

Figure 30. Commercial ocean landings of American shad (pounds) for Virginia, 1978-1988 (state data).

The ocean shad fishery of Virginia is similar to that of New Jersey, Delaware and Maryland. Again, gill net is the primary gear type and the season extends from February to early April. These fisheries may exploit shad stocks overwintering in the mid-Atlantic Bight during the pre-spawning migration.

North Carolina

Gear: Greatest ocean shad landings are by gill net, which is the only gear type consistently harvesting shad in North Carolina ocean waters (Table 20). Beach haul seines were used at one time but have declined in importance in recent years. Otter trawls land consistently small catches of shad; troll lines harvested shad only in 1984.

Season: Ocean harvest of shad in offshore North Carolina waters extends from early February to early April; there is no legislated season.

Location: A relatively small percentage of the total landings in North Carolina are from the ocean catch (Table 20, Figure 31). Specific locations of harvest and landing sites are unknown.

Catch reporting: Catch reports are voluntary, and collected monthly through dealer surveys conducted by North Carolina Division of Marine Fisheries. The data reported to us by NMFS and by the state are identical (Figure 32, Table 19).

Catch analysis: Ocean landings of shad in North Carolina are extremely variable on a yearly basis (Figures 31, 33), but a slight increase in landings is apparent for the study period. Ocean catches closely follow the pattern of total landings.

However, the state of North Carolina is unique because it potentially exploits shad migrating from overwintering areas to both northern and southern spawning areas. Dadswell et al. (1987) hypothesized that some portions of the mid-Atlantic shad stock move northward from the mid-Atlantic Bight overwintering ground, while others move south. Cape Hatteras is considered to be the rough dividing line separating the two migratory groups. Therefore, depending on where in North Carolina fishing occurs, the shad fishery could potentially harvest stocks migrating both north and south to natal streams.

South Carolina

Gear: Prior to 1985, stationary or anchored gill nets of 5.5" stretched mesh were the gear of choice. Beginning in 1985, South Carolina legislation barred the use of any gear other than drift gill nets. The mesh size has remained unchanged. A single catch of eight pounds was recorded in 1984 for otter trawls, which is the only other gear type reporting ocean shad landings in South Carolina.

Table 20. Commercial ocean landings (pounds) of American shad for North Carolina, 1980-1988.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Troll-line	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978	No reports available								5,000			-
1979	No reports available								25,064			-
1980		2,524	1,419						3,943	3,943	199,206	1.98
1981		26,571	79,599		1,245				107,415	107,415	351,500	30.56
1982		20,291	43,672		16				63,979	63,979	411,852	15.53
1983		3,647			141				3,788	3,788	445,879	0.85
1984		982	6,771		3,738			2,020	13,511	13,511	584,843	2.31
1985		2,810			349				3,159	3,159	329,639	0.96
1986		63,052			34				63,086	63,086	373,794	16.88
1987		40,807	26		329				41,162	41,162	327,646	12.56
1988		28,817			42				28,859	28,859	261,821	11.02

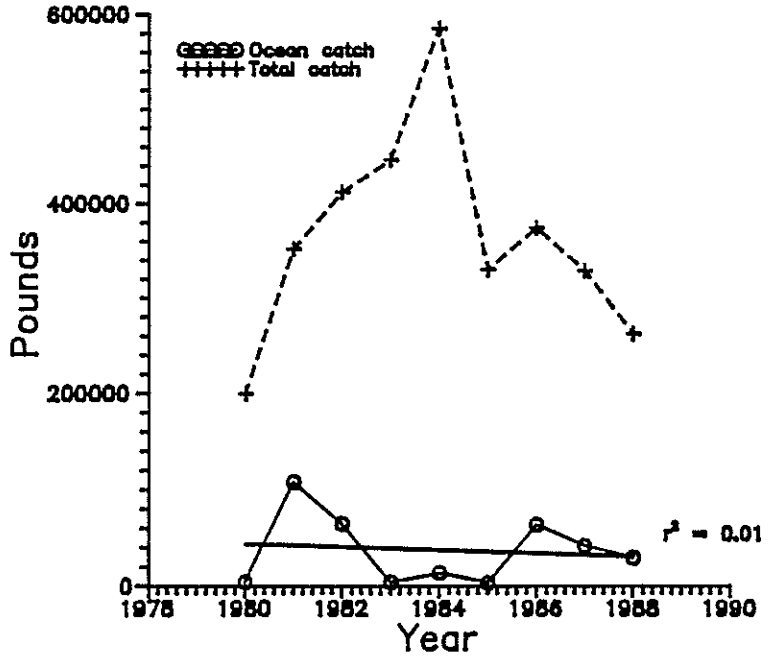

Figure 31. Ocean landings and total landings of American shad (pounds) by commercial fishermen for North Carolina, 1978-1988 (NMFS data).

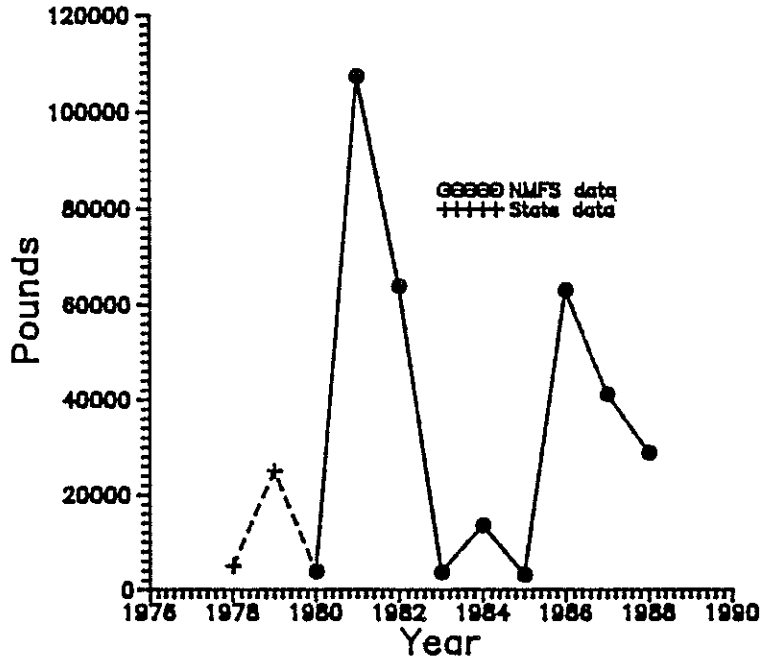

Figure 32. Commercial ocean landings of American shad (pounds) for North Carolina, 1978-1988, as reported by NMFS and by the North Carolina Division of Marine Fisheries.

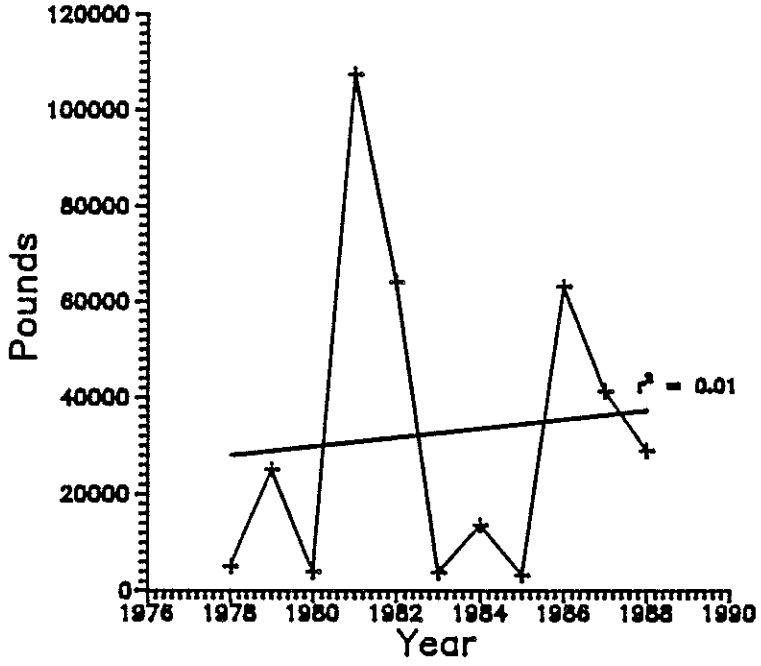

Figure 33. Commercial ocean landings of American shad (pounds) for North Carolina, 1978-1988 (state data).

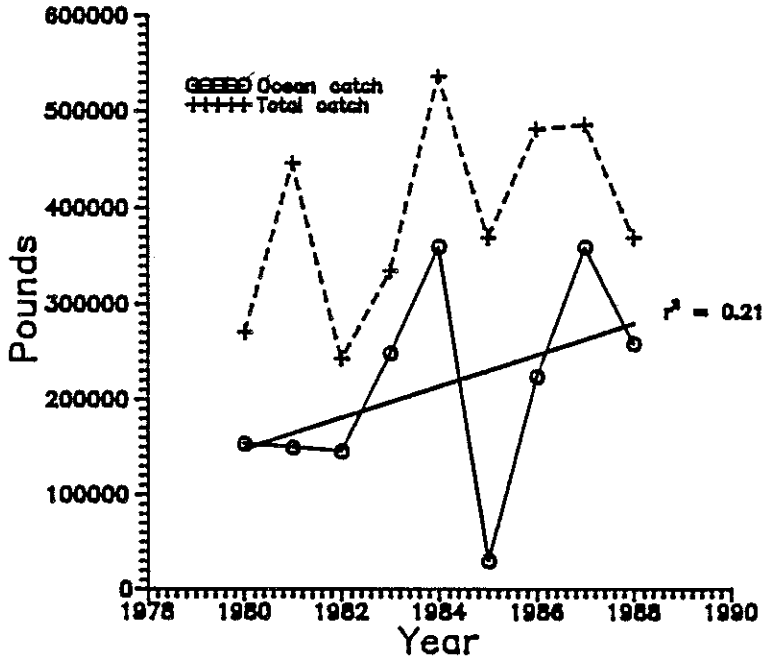

Figure 34. Ocean landings and total landings of American shad (pounds) by commercial fishermen for South Carolina, 1978-1988 (NMFS data).

Season: The South Carolina ocean shad fishery operates from 1 February to the Saturday before Easter each year (usually falls sometime in mid-April).

Location: For the eleven-year period, the ocean catch has constituted an average of 66.7 percent of the total South Carolina shad harvest, with a range from 27.2 percent in 1981 to 100 percent in 1982 (Table 21). Trends and patterns for the total harvest and ocean catch are similar (Figure 34). Most shad are harvested within three miles of the coastline. The area fished most heavily (approximately 80 percent of the catch) lies between Pawleys Island and Cape Romain. The bulk of the catch is landed at Georgetown, with some landings at Murrel's Inlet and Myrtle Beach.

Catch reporting: Details of the catch reporting system in South Carolina are few. Monthly reports from dealers and buyers are collected by the South Carolina Wildlife and Marine Resources Department. The NMFS data occasionally reflected different landings than the state data, particularly for 1985 (Figure 35). These reasons for these differences should be identified.

Catch analysis: The South Carolina ocean shad catch has increased steadily over the last ten years (Figures 34, 36), although there is considerable variation over the years.

Once again, as for all states from New Jersey south, the seasonality of the fishery suggests that migrating shad are probably being harvested as they migrate from overwintering grounds to natal spawning streams.

Georgia

No ocean catches of shad were reported by NMFS for Georgia waters during the study period except for a catch of 1,258 pounds in 1987 (Table 22). The Georgia Department of Natural Resources reported no catches at all.

Florida

No ocean catches of shad were reported for Florida by NMFS. The state did, however, report considerable landings.

Gear: Anchored gill nets are most commonly used. State personnel had no information on mesh sizes.

Season: No legislated season exists. The Florida ocean shad fishery operates mainly from December to March, with minor landings being reported from May to October.

Location: Apparently, all ocean fishing for shad occurs in Duvall County at the mouth of the St. Johns River. Duvall County is the primary area for which landings have been reported,

Table 21. Commercial ocean landings (pounds) of American shad for South Carolina, 1980-1988.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Long-line	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978	No reports available											-
1979	No reports available								83,508			-
1980		153348							153,348	153,348	270,553	56.68
1981		149,552							121,659	149,552	446,412	27.25
1982		145,303							245,086	145,303	242,741	100.97
1983		248,426							205,522	248,426	335,080	61.34
1984		360,199			4				331,510	360,203	536,362	61.81
1985		30,204							137,510	30,204	369,532	37.21
1986		224,020							220,728	224,020	481,655	45.83
1987		359,612							359,739	359,612	486,501	73.94
1988		258,397							258,397	258,397	369,542	69.92

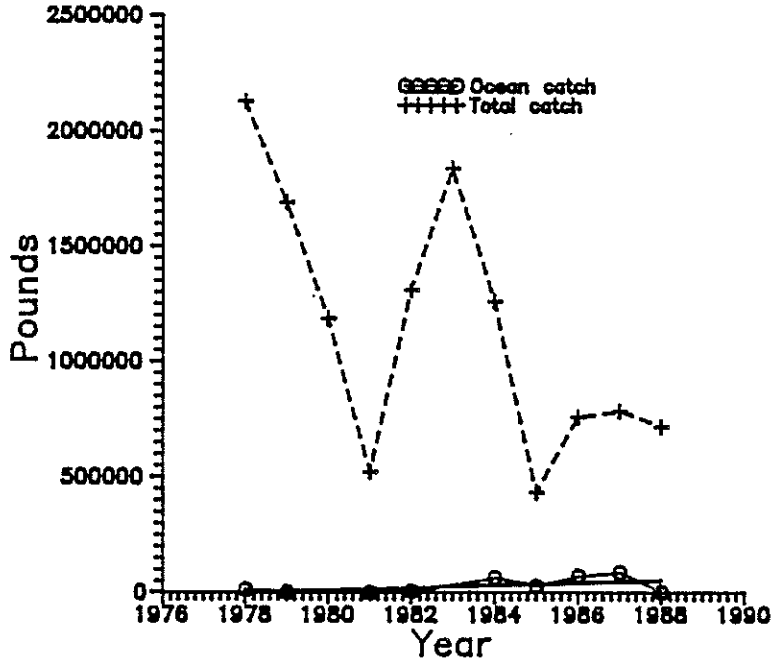

Figure 35. Commercial ocean landings of American shad (pounds) for South Carolina, 1978-1988, as reported by NMFS and by the South Carolina Wildlife and Marine Resources Department.

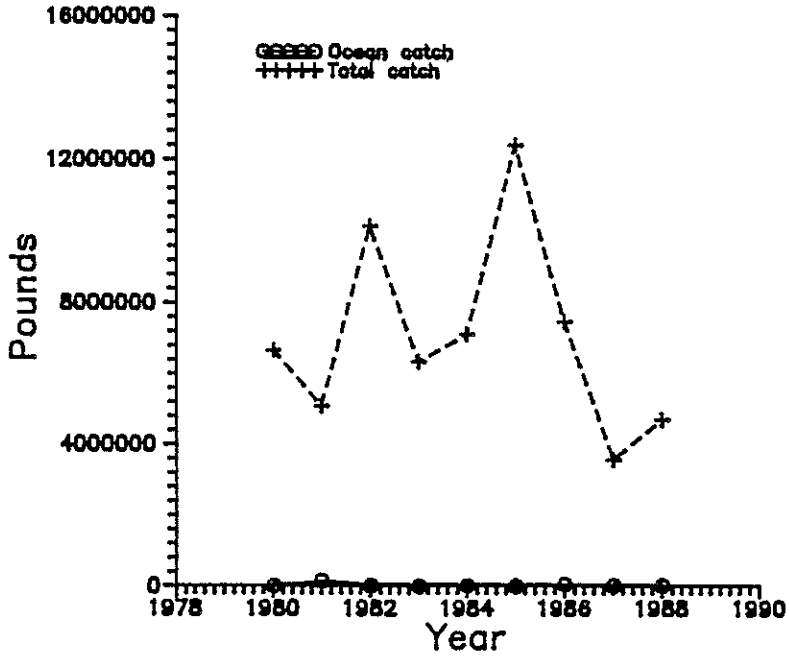

Figure 36. Commercial ocean landings of American shad (pounds) for South Carolina, 1978-1988 (state data).

Table 22. Commercial ocean landings (pounds) of American shad for Georgia, 1978-1988.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Long-line	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978	No reports available								0			-
1979	No reports available								0			-
1980									0	0	188,489	0.00
1981									0	0	195,823	0.00
1982									0	0	198,465	0.00
1983									0	0	225,409	0.00
1984									0	0	221,083	0.00
1985									0	0	248,612	0.00
1986									0	0	163,448	0.00
1987		1,258							0	1,258	294,097	0.43
1988	No catch reported											

although the reporting system is such that catches are reported where they are landed, not where they were actually caught. Thus, some uncertainty exists as to the exact location of the Florida ocean shad fishery.

Catch reporting: Catch reporting is mandatory, and required by Florida law and regulation. Data are collected daily through transaction level marine trip tickets completed by the dealers. The reporting program has been in effect since 1985.

It is apparent that there is a great difference between the catch data from the state and from NMFS. For the eleven-year study period, the state reported reasonably large annual landings (smallest landing of 47,661 lbs in 1986), while NMFS reported zero landings (Figure 37). In discussions with Florida state personnel by telephone, it was mentioned that data prior to 1985 were obtained by them from NMFS. Therefore, NMFS should have records of ocean shad landings in Florida for the study period. Obviously, this is a problem that needs to be addressed. Discussions with NMFS personnel indicate that one problem may involve the manner in which Florida codes catch areas and gear types. The Florida coding system is not consistent with the Federal system, which makes information retrieval more difficult by NMFS personnel.

Catch analysis: A tremendous annual variation is evident in the ocean catch of shad in Florida (Figure 37, Table 23). Nevertheless, the regression line does show a slight increase in the landings over the study period. At this stage it is unknown whether the fishery is directed for shad or is incidental, although the times of year during which shad are landed suggests that it is partly a by-catch fishery.

Greatest landings occur from December to March, again an indicator that stocks migrating from overwintering grounds to natal streams are being exploited. In this case, however, the fishery probably exploits the overwintering aggregation that occurs off Florida (Dadswell et al. 1987), rather than the mid-Atlantic stock, and because it is the most southern state, it is probably exploiting only shad that spawn in Florida rivers.

River Herring

Harvest Trends

For this section, only data provided by NMFS were used to compare harvest trends of river herring among states.

River herring harvested from ocean fisheries constitute a small percentage of total eastern seaboard landings each year. The ocean harvest of river herring on the eastern seaboard has increased slightly since 1979, although the total harvest appears to have remained relatively steady (Table 24). North Carolina, Maine and Virginia were the states that reported the bulk of the pounds caught over the study period (Table 25). North Carolina had the highest total landings, harvesting an average of approximately 53 percent of the total annual river herring along the

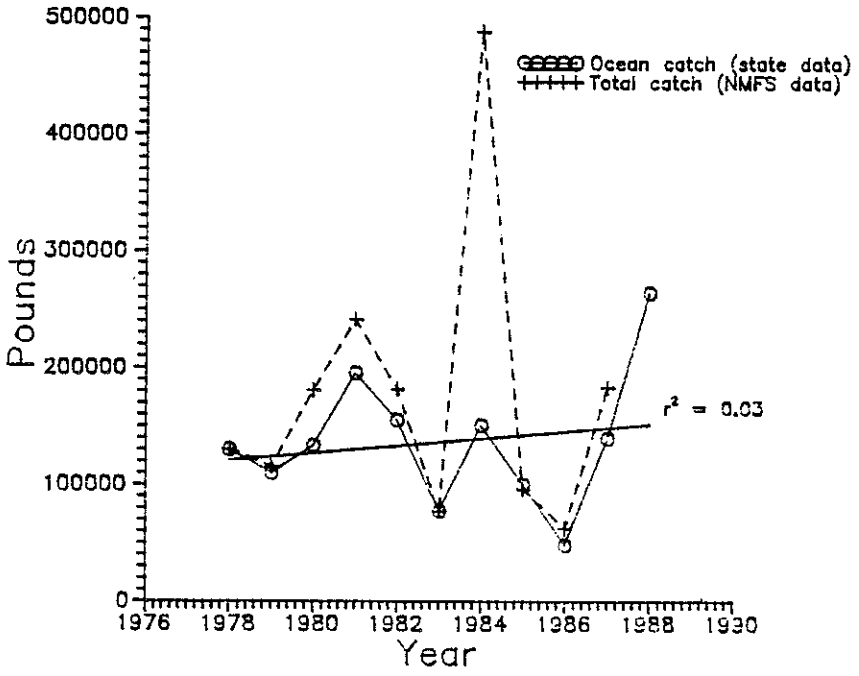

Figure 37. Commercial ocean landings of American shad (pounds) for Florida, 1978-1988 (state data).

Table 23. Commercial ocean landings (pounds) of American shad for Florida, 1978-1988.

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Long-line	Landings State-reported catch	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978									129,529	0	130,000	0.00
1979									109,419	0	114,800	0.00
1980									133,129	0	180,763	0.00
1981									195,150	0	241,032	0.00
1982									154,653	0	180,991	0.00
1983									76,788	0	76,863	0.00
1984									150,312	0	487,527	0.00
1985									99,623	0	95,745	0.00
1986									47,661	0	62,059	0.00
1987									139,198	0	183,000	0.00
1988	No reports available								263,898			

Table 24. Commercial landings (pounds) of river herring along the USA eastern seaboard, 1978-1987 (NMFS data).

Year	Total ocean landings*	Total river herring landings*	Percent ocean landings
1978	688,400	6,045,700	11.4
1979	52,100	4,619,800	1.1
1980	92,060	11,119,589	0.8
1981	238,830	8,331,537	2.9
1982	274,480	13,011,751	2.1
1983	114,050	9,825,401	1.2
1984	244,500	9,694,306	2.5
1985	66,360	14,020,677	0.5
1986	137,470	8,945,280	1.5
1987	135,380	5,614,596	2.4

* Total river herring landings show river herring landed in the U.S.A., does not include river herring taken as a by-catch in the joint venture Atlantic mackerel fishery.

Table 25. Total commercial landings (thousands of pounds) of river herring by state, 1978-1987 (NMFS data).

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total river herring landings
1978	2,780.8	165.0	701.3	26.2	39.8	0.7	2.4	1.4	200.0	2,128.1	0.0	0.0	0.0	0.0	6,045.7
1979	2,647.6	0.0	52.3	11.7	62.7	1.0	6.6	5.6	143.4	1,688.9	0.0	0.0	0.0	0.0	4,619.8
1980	2,644.3	0.0	144.0	7.4	55.1	0.9	18.6	0.6	185.0	1,184.3	6,218.5	660.9	0.0	0.0	11,119.6
1981	2,327.0	0.0	84.0	0.0	52.7	64.9	13.8	0.0	82.1	519.7	4,753.7	433.6	0.0	0.0	8,331.5
1982	1,390.2	114.5	53.5	4.8	41.8	229.2	13.6	0.0	109.9	1,307.6	9,437.7	308.9	0.0	0.0	13,011.8
1983	1,035.4	115.2	93.1	6.1	37.5	24.7	2.2	0.8	158.3	1,837.5	5,868.3	646.3	0.0	0.0	9,825.4
1984	817.5	90.0	194.1	0.9	32.4	4.2	3.1	10.5	134.4	1,257.3	6,516.1	633.8	0.0	0.0	9,694.3
1985	1,344.9	61.3	46.6	0.4	38.9	0.2	4.8	7.6	183.9	432.0	11,874.8	25.1	0.0	0.3	14,020.7
1986	1,010.0	27.0	32.4	0.0	40.1	2.9	4.2	5.5	250.8	758.0	6,814.3	0.0	0.0	0.1	8,945.3
1987	791.7	19.6	32.5	2.6	21.4	2.8	5.2	5.4	755.3	783.0	3,195.0	0.0	0.0	0.2	5,614.6
10-yr avg.	1,679	59	143	6	42	33	7	4	220	1,190	5,468	271	0	0	9,123

eastern seaboard from 1978 through 1987 (Table 26).

Even though Massachusetts fisheries constituted the bulk of the ocean river herring catch, on average the figures are biased by a catch of 670,300 pounds in 1978 (Table 27). The Massachusetts ocean catch constituted an average of only 1.6 percent of the total ocean harvest of river herring for the ten years of the study (Table 28). The ocean harvest from each of the other states seldom represented more than 0.5 percent of the total eastern seaboard river herring harvest for any one year (Table 28).

Similarly, Massachusetts ocean landings since 1978 have averaged approximately 44 percent of the annual ocean landings of river herring for the eastern seaboard (Table 29), and along with Virginia and North Carolina comprise an average of almost 74 percent of the annual ocean landings of river herring. During the study period , only New Jersey exhibited ocean landings comprised solely of ocean origin (Table 30). Delaware, Georgia and Florida reported no ocean harvest of herring at all (Table 30).

Maine

Extreme differences in the landings information for ocean-harvested river herring provided to us by NMFS and Maine Department of Marine Resources were evident. According to state personnel, no ocean-harvested river herring are landed in Maine. In contrast, NMFS reported an average catch of over 1,500,000 pounds of ocean-caught herring for the eleven-year study period (Table 31), which was reported as being harvested from pound nets. State personnel reported, however, that all river herring landed in the state are taken in river weirs, which are fished at the head of tide in many of the Maine rivers supporting spawning populations of river herring (Lewis N. Flagg, Maine Department of Marine Resources, Anadromous Fish Division, Augusta, Maine). This discrepancy is a result of inland or riverine harvest being incorporated into the 0-3 mile category by NMFS. As riverine harvest is not included in our definition of ocean harvest, we utilized the data provided by the Maine DMR for the analyses of this report.

New Hampshire

New Hampshire reported no landings of ocean-harvested river herring during the study period. According to NMFS data, all river herring landed in the state were harvested from Great Bay. Total landings for the state appear to have declined since 1978 from 165,000 pounds to 19,550 pounds in 1987 (NMFS data, Table 32).

Massachusetts

Gear: Beach haul seine was the only gear type in which river herring were landed in Massachusetts each year (Table 33). Beach haul seines also caught the most fish, although catches have steadily declined over the years. Other gear types include dip nets, bottom otter trawls, fyke and hoop nets, and menhaden purse seines (Table 33).

Table 26. Percent of yearly total commercial landings of river herring by state, 1978-1987 (NMFS data).

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total commercial landings (pounds)
1978	46.0	2.7	11.6	0.4	0.7	0.0	0.0	0.0	3.3	35.2	0.0	0.0	0.0	0.0	6,045,700
1979	57.3	0.0	1.1	0.3	1.4	0.0	0.1	0.1	3.1	36.6	0.0	0.0	0.0	0.0	4,619,800
1980	23.8	0.0	1.3	0.1	0.5	0.0	0.2	0.0	1.7	10.7	55.9	5.9	0.0	0.0	11,119,589
1981	27.9	0.0	1.0	0.0	0.6	0.8	0.2	0.0	1.0	6.2	57.1	5.2	0.0	0.0	8,331,537
1982	10.7	0.9	0.4	0.0	0.3	1.8	0.1	0.0	0.8	10.0	72.5	2.4	0.0	0.0	13,011,751
1983	10.5	1.2	0.9	0.1	0.4	0.3	0.0	0.0	1.6	18.7	59.7	6.6	0.0	0.0	9,825,401
1984	8.4	0.9	2.0	0.0	0.3	0.0	0.0	0.1	1.4	13.0	67.2	6.5	0.0	0.0	9,694,306
1985	9.6	0.4	0.3	0.0	0.3	0.0	0.0	0.1	1.3	3.1	84.7	0.2	0.0	0.0	14,020,677
1986	11.3	0.3	0.4	0.0	0.4	0.0	0.0	0.1	2.8	8.5	76.2	0.0	0.0	0.0	8,945,280
1987	14.1	0.3	0.6	0.0	0.4	0.0	0.1	0.1	13.5	13.9	56.9	0.0	0.0	0.0	5,614,596
10-yr avg.	22.0	0.7	2.0	0.1	0.5	0.3	0.1	0.0	3.0	15.6	53.0	2.7	0.0	0.0	9,122,864

Table 27. Commercial ocean landings (thousands of pounds) of river herring by state, 1978-1987 (NMFS data).

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total ocean landings
1978	0.0	0.0	670.3	2.2	1.9	0.0	2.4	0.0	0.4	11.2	0.0	0.0	0.0	0.0	688.4
1979	0.0	0.0	40.3	6.2	2.2	0.0	6.6	0.0	0.1	0.7	0.0	0.0	0.0	0.0	56.1
1980	0.0	0.0	62.0	7.4	2.4	0.1	18.6	0.0	0.2	0.0	1.4	0.0	0.0	0.0	92.1
1981	0.0	0.0	16.7	0.0	0.3	64.6	13.8	0.0	0.0	0.2	143.2	0.0	0.0	0.0	238.8
1982	0.0	0.0	15.5	4.8	0.2	229.0	13.6	0.0	0.1	3.6	7.7	0.0	0.0	0.0	274.5
1983	0.0	0.0	82.1	6.1	0.4	22.8	2.2	0.0	0.3	0.0	0.0	0.1	0.0	0.0	114.0
1984	0.0	0.0	161.9	0.9	0.5	4.0	3.1	0.0	1.8	62.8	9.5	0.0	0.0	0.0	244.5
1985	0.0	0.0	20.0	0.4	15.3	0.0	4.8	0.0	0.1	25.7	0.1	0.0	0.0	0.0	6.4
1986	0.0	0.0	17.8	0.0	0.1	2.9	4.2	0.0	1.9	70.3	40.3	0.0	0.0	0.0	137.2
1987	0.0	0.0	17.2	2.6	0.8	2.7	5.2	0.0	2.2	85.4	19.3	0.0	0.0	0.0	135.4
10-yr avg.	0.0	0.0	110.4	3.1	2.4	32.6	7.5	0.0	0.7	26.0	22.1	0.0	0.0	0.0	204.8

Table 28. Percent contribution of the state ocean river herring landings to total commercial landings or river herring along the USA eastern seaboard, 1978-1987 (NMFS data).

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total commercial landings (pounds)	Percent ocean catch
1978	0.0	0.0	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	6,045,700	11.4
1979	0.0	0.0	0.9	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,619,800	1.2
1980	0.0	0.0	0.6	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11,119,589	0.8
1981	0.0	0.0	0.2	0.0	0.0	0.8	0.2	0.0	0.0	0.0	1.7	0.0	0.0	0.0	8,331,537	2.9
1982	0.0	0.0	0.1	0.0	0.0	1.8	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	13,011,751	2.1
1983	0.0	0.0	0.8	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9,825,401	1.2
1984	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.1	0.0	0.0	0.0	9,694,306	2.5
1985	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	14,020,677	0.5
1986	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.5	0.0	0.0	0.0	8,945,280	1.5
1987	0.0	0.0	0.3	0.0	0.0	0.0	0.1	0.0	0.0	1.5	0.3	0.0	0.0	0.0	5,614,596	2.4
10-yr avg.	0.0	0.0	1.6	0.0	0.0	0.3	0.1	0.0	0.0	0.3	0.3	0.0	0.0	0.0	9,122,864	2.7

Table 29. Percent of yearly ocean landings of river herring by state, 1978-1987 (NMFS data).

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total ocean landings (pounds)
1978	0.0	0.0	97.4	0.3	0.3	0.0	0.3	0.0	0.1	1.6	0.0	0.0	0.0	0.0	688,400
1979	0.0	0.0	71.8	11.1	3.9	0.0	11.8	0.0	0.2	1.2	0.0	0.0	0.0	0.0	52,100
1980	0.0	0.0	67.3	8.0	2.6	0.1	20.2	0.0	0.2	0.0	1.5	0.0	0.0	0.0	92,060
1981	0.0	0.0	7.0	0.0	0.1	27.0	5.8	0.0	0.0	0.1	60.0	0.0	0.0	0.0	238,830
1982	0.0	0.0	5.6	1.7	0.1	83.4	5.0	0.0	0.0	1.3	2.8	0.0	0.0	0.0	274,480
1983	0.0	0.0	72.0	5.3	0.4	20.0	1.9	0.0	0.3	0.0	0.0	0.1	0.0	0.0	114,050
1984	0.0	0.0	66.2	0.4	0.2	1.6	1.3	0.0	0.7	25.7	3.9	0.0	0.0	0.0	244,500
1985	0.0	0.0	30.1	0.6	23.1	0.0	7.2	0.0	0.2	38.7	0.1	0.0	0.0	0.0	66,360
1986	0.0	0.0	12.9	0.0	0.1	2.1	3.1	0.0	1.4	51.1	29.3	0.0	0.0	0.0	137,470
1987	0.0	0.0	12.7	1.9	0.6	2.0	3.8	0.0	1.6	63.1	14.2	0.0	0.0	0.0	135,380
10-yr avg.	0.0	0.0	44.6	3.5	3.2	14.7	6.6	0.0	0.8	18.4	11.3	0.0	0.0	0.0	204,363

Table 30. Percent contribution of the state ocean catch of river herring to total state commercial river herring catch, 1978-1987 (NMFS data).

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL
1978	0	0	96	8	5	0	100	0	0	1	-	-	-	0
1979	0	0	77	53	4	0	100	0	0	0	-	-	-	0
1980	0	0	43	100	4	11	100	0	0	0	0	0	0	0
1981	0	0	20	0	1	100	100	0	0	0	3	0	0	0
1982	0	0	29	100	0	100	100	0	0	0	0	0	0	0
1983	0	0	88	100	1	92	100	0	0	0	0	0	0	0
1984	0	0	83	100	2	95	100	0	1	5	0	0	0	0
1985	0	0	43	100	39	0	100	0	0	6	0	0	0	0
1986	0	0	55	0	0	100	100	0	1	9	1	0	0	0
1987	0	0	53	100	4	98	100	0	0	11	1	0	0	0
10-yr avg.	0	0	59	66	6	60	100	0	0	3	0	0	0	0

Table 31. Commercial ocean landings (pounds) of river herring for Maine, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Eel pots & traps	Landings State-reported ocean	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978				2,780,800					0	2,780,800	2,780,800	100.0
1979		100		2,647,500					0	2,647,600	2,647,600	100.0
1980				2,644,300					0	2,644,300	2,644,300	100.0
1981				2,317,000				10,000	0	2,327,000	2,327,000	100.0
1982				1,390,200					0	1,390,200	1,390,200	100.0
1983				1,035,400					0	1,035,400	1,035,400	100.0
1984		77,000		740,500					0	817,500	817,500	100.0
1985				1,344,900					0	1,344,900	1,344,900	100.0
1986				1,010,000					0	1,010,000	1,010,000	100.0
1987				791,700					0	791,700	791,700	100.0
1988	No catch reported											

Table 32. Commercial ocean landings (pounds) of river herring for New Hampshire, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Weirs	Landings State-reported ocean	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978	No ocean catch reported								No	0	165,000	0.00
1979	No catch reported								data	0	0	-
1980	No catch reported								provided	0	0	-
1981	No catch reported									0	0	-
1982										0	114,500	0.00
1983	No ocean catch reported									0	115,216	0.00
1984	No ocean catch reported									0	90,000	0.00
1985	No ocean catch reported									0	61,300	0.00
1986	No ocean catch reported									0	26,990	0.00
1987	No ocean catch reported									0	19,550	0.00
1988	No catch reported											

Table 33. Commercial ocean landings (pounds) of river herring for Massachusetts, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Fyke and Hoop nets	Menhaden purse seines	Landings State-reported ocean	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978			50,000		600			619,700	No	670,300	701,300	95.58
1979			40,000		300				data	40,300	52,300	77.06
1980			62,000						provided	62,000	144,000	43.06
1981			16,700							16,700	84,000	19.88
1982			15,500							15,500	53,500	28.97
1983	8,000		74,000		100					82,100	93,100	88.18
1984	6,000		45,000		100			110,800		161,900	194,100	83.41
1985	15,000		5,000							20,000	46,600	42.92
1986	12,800		5,000							17,800	32,400	54.94
1987	12,200		5,000							17,200	32,500	52.92
1988		No catch reported										

Season: Unknown.

Location: On average, ocean landings have made up 56.3 percent of the total catch for river herring landed in Massachusetts. However, the annual percentage over the last eleven years has varied from a low of 18.3 percent to a high of 100 percent (Table 33). Catches were taken from a variety of areas, including Buzzards Bay, areas 513 and 514, and area 521 (Figure 2). Principal landing sites of catches remain unidentified.

Catch reporting: Catch reports are mandatory, and required by Massachusetts law and regulation (Table 10). Catch data are collected monthly and annually, but we have no information as to the source of the data. No catch figures were provided by the state. However, NMFS data and state data should be one and the same (similar to shad landings).

Catch analysis: Massachusetts landings of river herring have declined substantially during the study period (Figure 38), particularly between 1978 and 1979. After this "crash," landings have remained reasonably consistent. River herring ocean landings have followed a similar pattern to total landings, except for 1983 when ocean landings declined as total landings increased (Figure 38).

Rhode Island

Gear: Floating traps are responsible for the largest and most consistent ocean landings of river herring in Rhode Island. Gill net is the only other gear type in which river herring are caught (Table 34).

Season: Unknown.

Location: Since 1980, all reported river herring landings for Rhode Island were harvested from the Atlantic Ocean (Table 34, Figure 39). All ocean landings were reported from area 539. The two reported landing sites are Pt. Judith and Newport.

Catch reporting: Catch reports are voluntary; i.e., they are not required by state law or regulation. Data are collected daily and, although reporting is voluntary, state personnel (Mark Gibson, RI Fish and Wildlife) feel that the information reasonably reflects the true catch. Commercial fisheries data are collected through a joint state/NMFS project, and are therefore virtually identical.

Catch analysis: Ocean landings of river herring have declined slightly over the last eleven years, but more significantly, ocean landings have represented all Rhode Island landings since 1980. In considering catches of such small size, any trend analysis becomes controversial, as the direction and scope of the trend can be easily changed by a single large catch of fish during any one year. Originally, our study was to address only fisheries that landed more than

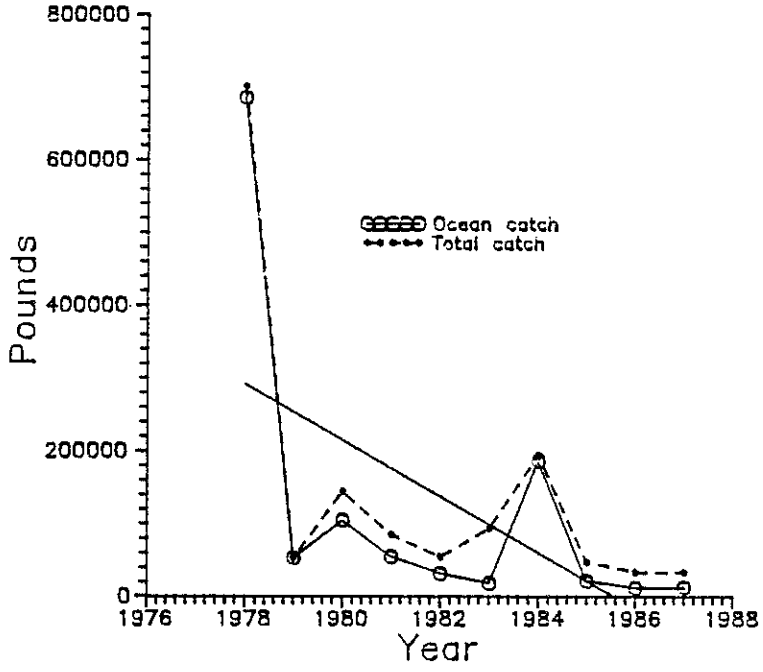

Figure 38. Ocean landings and total landings of river herring (pounds) by commercial fishermen for Massachusetts, 1978-1988 (NMFS data).

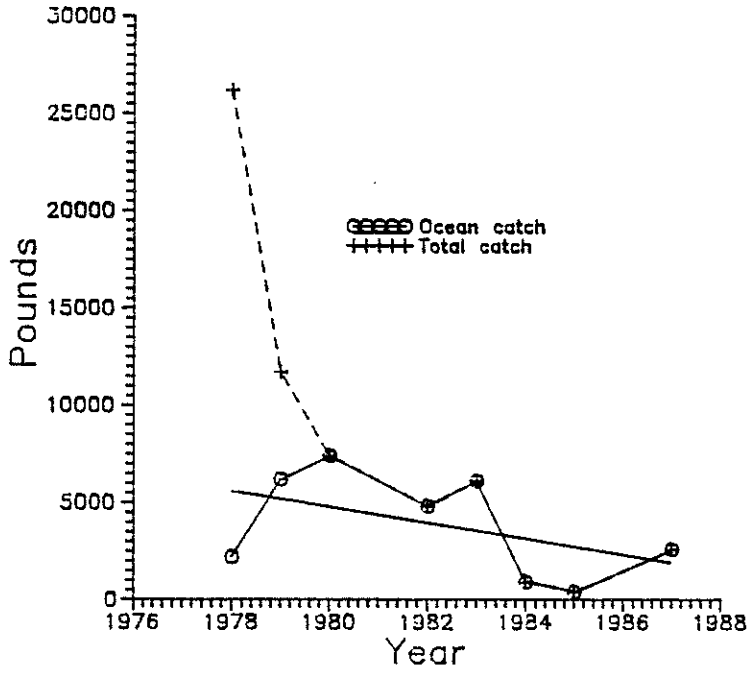

Figure 39. Ocean landings and total landings of river herring (pounds) by commercial fishermen for Rhode Island, 1978-1988 (NMFS data).

Table 34. Commercial ocean landings (pounds) of river herring for Rhode Island, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Weirs	Landings State-reported ocean	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978							2,200		2,000	2,200	26,200	8.40
1979							6,200		6,000	6,200	11,700	52.99
1980			5,000				2,400		2,000	7,400	7,400	100.00
1981		No catch reported					0		0	0	0	-
1982							4,800		5,000	4,800	4,800	100.00
1983							6,100		6,000	6,100	6,100	100.00
1984							900		1,000	900	900	100.00
1985							400		404	400	400	100.00
1986		No catch reported					0		0	0	0	-
1987							2,600		2,550	2,600	2,600	100.00
1988		No catch reported										

10,000 pounds per year, however, we feel that this information, although not highly significant, is useful. Even so, with no information as to when the most herring are landed, and so little knowledge about the ocean migration patterns of river herring, further assessment of the catch data is impractical.

Connecticut

Gear: Gill nets are the principal gear for river herring landed in Connecticut (Table 35). Other gear types are (in order of importance): otter trawls, hand-lines and beach haul seines.

Season: Unknown.

Location: An extremely low percentage of the overall catch of river herring landed in Connecticut during the study period was caught at sea (Table 35, Figure 40). For each of the eleven years of the study except 1985, ocean caught fish represented less than five percent of the total river herring landings for the state. During the period 1978 - 1987, all river herring were caught in area 611 (Long Island Sound) (Figure 2). No information about landing sites of the catch was available.

Catch reporting: Catch reports in Connecticut are mandatory and required by state law and regulation (Table 10). Data are collected from fishermen catch reports which are completed daily and submitted annually. For this study, no catch reports were received from the state. Therefore, analyses were performed on NMFS data only.

Catch analysis: Ocean landings of river herring appear to be of relatively little importance to the total state landings. The trend line indicates that the catch has remained reasonably steady during the last eleven years (Figure 40). However, ocean landings have never been very large; the largest reported catch (15,300 pounds) was in 1985.

New York

Gear: Pound nets were the primary gear for river herring harvest in New York during the study period (Table 36). Sporadic catches were taken in gill nets, beach haul seines, fyke and hoop nets, and beach haul seines.

Season: Unknown.

Location: Except for 1980, over 90 percent of river herring landed in New York since 1978 were taken in the ocean (Table 36). Fish were caught in Moriches Bay, Shinnecock Bay, Gardiners Bay, Peconic Bay in areas 611 and 612 (Figure 2). The unusually large river herring catch in 1982 was taken in area 612. Landing sites for the catches are undetermined.

Table 35. Commercial ocean landings (pounds) of river herring for Connecticut, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Hand-line	Landings State-reported ocean	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978		1,000						900		1,900	39,800	4.77
1979		1,500	200					500		2,200	62,700	3.51
1980		900	1,500							2,400	55,100	4.36
1981		300								300	52,700	0.57
1982		100			100					200	41,800	0.48
1983		200			200					400	37,500	1.07
1984					500				1,300	500	32,400	1.54
1985		1,100	10,000		800			3,400	11,100	15,300	38,900	39.33
1986		100							21,300	100	40,100	0.25
1987		700			100				1,100	800	21,400	3.74
1988		No catch reported							700			

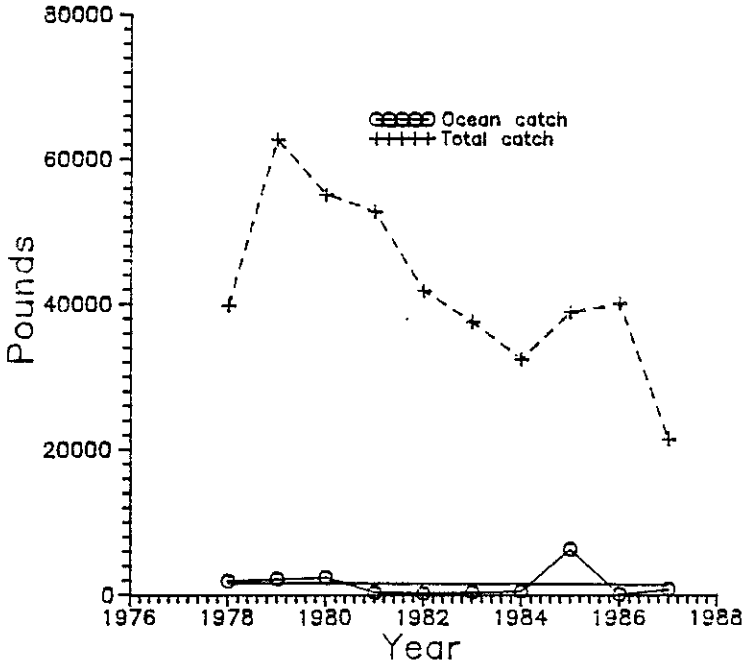

Figure 40. Ocean landings and total landings of river herring (pounds) by commercial fishermen for Connecticut, 1978-1988 (NMFS data).

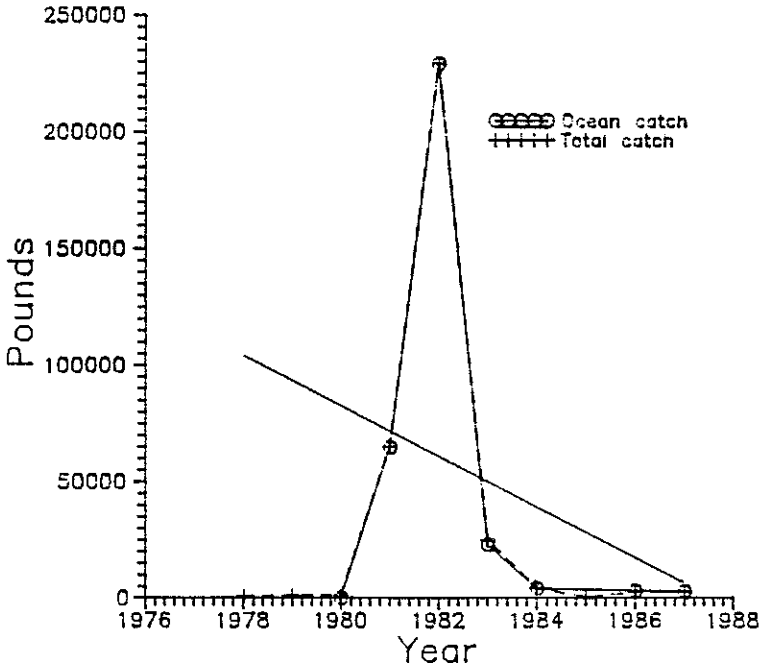

Figure 41. Ocean landings and total landings of river herring (pounds) by commercial fishermen for New York, 1978-1988 (NMFS data).

Table 36. Commercial ocean landings (pounds) of river herring for New York, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Fyke & hoop nets	Landings State-reported ocean	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978	No ocean catch reported								No	0	700	0.00
1979	No ocean catch reported								data	0	1,000	0.00
1980				100					provided	100	900	11.11
1981				64,600						64,600	64,900	99.54
1982				220,000				9,000		229,000	229,200	99.91
1983				22,800						22,800	24,700	92.31
1984				4,000						4,000	4,200	95.24
1985	No ocean catch reported									0	150	0.00
1986			400	300	2,200					2,900	2,900	100.00
1987		1,800	300	600						2,700	2,765	97.65
1988	No catch reported											

Catch reporting: Details of the catch reporting requirements in New York are unknown. State catch reports were unavailable.

Catch analysis: The trend in landings of river herring in New York appears to be towards smaller catches (Figure 41). However, this trend line is strongly influenced by a large pound net catch in 1982 (Table 36). Additional years of data would be needed to determine whether the trend line is an accurate reflection of the status of the fishery. It should be noted that other than the landings of 1981 - 1983, the ocean catch of river herring in New York does not exceed 4,000 pounds. The data suggest that some abnormal event may have occurred during these three years, resulting in artificially high catches. Investigation of the catch data for the previous 30+ years is required to establish whether the high or low catches are more representative of historical river herring harvests in New York.

New Jersey

Gear: The largest landings of river herring in New Jersey are taken by gill net. Other gear used in the fishery (in decreasing order of importance) include pound nets, beach haul seines, bottom otter trawls, paired midwater trawls, and fyke and hoop nets (Table 36).

Season: Unknown.

Location: All river herring landed in New Jersey are caught in the ocean (Table 37, Figure 42). River herring are harvested from areas 611 - 614, and 621 (Figure 2). Catches are fairly evenly distributed among these areas, with slightly larger catches in areas 612 and 621. Most fishing occurs within three miles of the coast. Although specific landing sites are not known, most river herring landings are reported in Atlantic County, Ocean County, Cape May County, and Monmouth County.

Catch reporting: Catch reports are submitted on a voluntary basis and are not required by New Jersey law or regulation. No catch reports were received from the state; NMFS data were used in analyses.

Catch analysis: The New Jersey ocean river herring catch has decreased since 1978. The trend line is again based on small catches, most of which are below 10,000 pounds, and could therefore be prone to error. It is interesting to note that the years of greatest landings were 1980 - 1982, the same years during which high catches were recorded in New York. At this stage it cannot be ascertained whether there is any connection between the fisheries of the two states.

Delaware

There are no reported ocean landings of river herring for Delaware. The total catch since 1978 has ranged between no catch at all in 1982, 1983 and 1988 to 10,500 pounds in 1985

Table 37. Commercial ocean landings (pounds) of river herring for New Jersey, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Fyke & hoop nets	Landings State-reported ocean	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978			2,400						No	2,400	2,400	100.00
1979		4,100	2,500						data	6,600	6,600	100.00
1980		15,400	3,200						provided	18,600	18,600	100.00
1981		13,800								13,800	13,800	100.00
1982		13,600								13,600	13,600	100.00
1983		1,700		500						2,200	2,200	100.00
1984		2,500		400				200		3,100	3,100	100.00
1985		4,400		400						4,800	4,800	100.00
1986				2,100	2,100					4,200	4,200	100.00
1987		4,300		700	200					5,200	5,200	100.00
1988		400		200	100					700	700	100.00

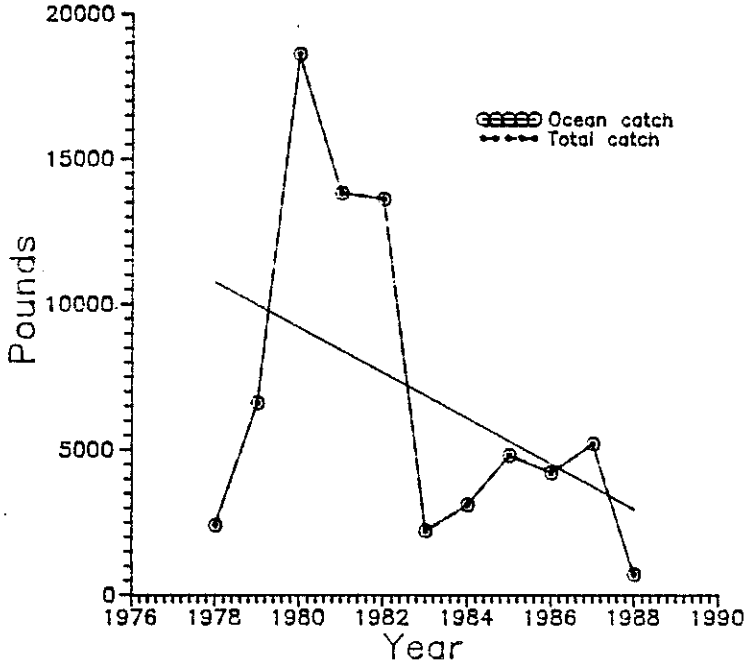

Figure 42. Ocean landings and total landings of river herring (pounds) by commercial fishermen for New Jersey, 1978-1988 (NMFS data).

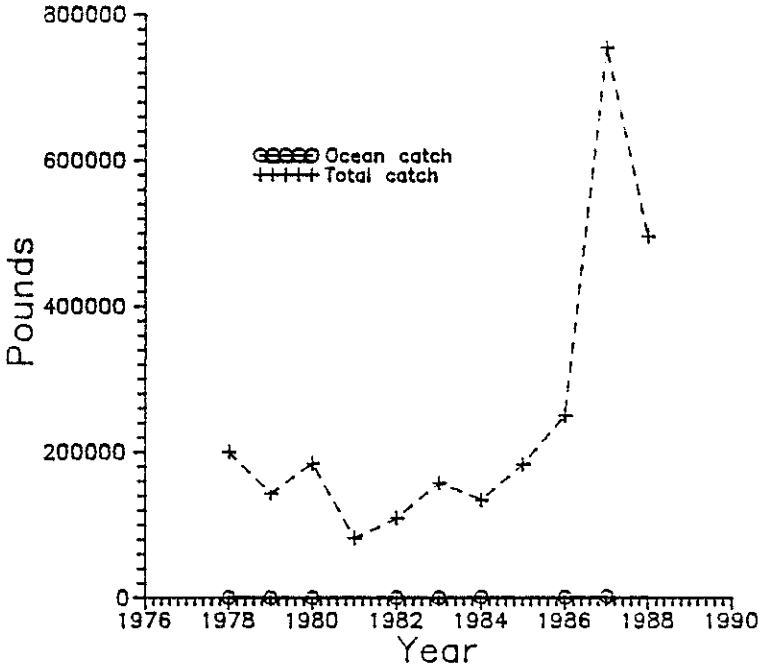

Figure 43. Ocean landings and total landings of river herring (pounds) by commercial fishermen for Maryland, 1978-1988 (NMFS data).

Table 38. Commercial ocean landings (pounds) of river herring for Delaware, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Weirs	Landings State-reported ocean	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978	No ocean catch reported								No	0	1,400	0.00
1979	No ocean catch reported								data	0	5,600	0.00
1980	No ocean catch reported								provided	0	600	0.00
1981	No ocean catch reported									0	0	-
1982	No catch reported									0	0	-
1983	No catch reported									0	800	0.00
1984	No ocean catch reported									0	10,500	0.00
1985	No ocean catch reported									0	7,600	0.00
1986	No ocean catch reported									0	5,500	0.00
1987	No ocean catch reported									0	5,400	0.00
1988	No catch reported											

Table 39. Commercial ocean landings (pounds) of river herring for Maryland, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Weirs	Landings State-reported ocean	Landings NMFS Total ocean	Landings Tota state	Landings Percent ocean
1978		400							No	400	200,000	0.20
1979		100							data	100	143,400	0.07
1980		200							provided	200	185,000	0.11
1981	No ocean catch reported									0	82,100	0.00
1982		100								100	109,900	0.09
1983		300								300	158,300	0.19
1984		1,800								1,800	134,400	1.34
1985		100								100	183,900	0.05
1986		900			1,000					1,900	250,800	0.76
1987		2,200								2,200	755,300	0.29
1988	No ocean catch reported									0	496,100	0.00

(Table 38). Total landings of river herring in Delaware seem to have increased slightly over the previous eleven years.

Maryland

Gear: All river herring landed during the study period were harvested by gill net (Table 39).

Season: Unknown.

Location: The percentage of total Maryland landings of river herring represented by ocean-caught fish was never greater than one percent (Table 39, Figure 43). All ocean-caught river herring were harvested from various seaside bays and area 621 (Figure 2). Landing sites for catches are unknown.

Catch reporting: Catch reporting is mandatory and required by state law. Catch data are collected in monthly reports from license holders. State catch reports were unavailable.

Catch analysis: Ocean catches of river herring in Maryland have increased slightly over the last eleven years. However, catches on which this analysis is based are so small that analysis of the data is not valid.

Virginia

Gear: Ocean gill net is the most consistent gear type for Virginia river herring catches, although otter trawls constitute the bulk of river herring landings (Table 40). Occasional catches have been taken in pound nets and beach haul seines.

Season: Unknown.

Location: Very little of the total Virginia river herring landings are caught at sea. Ocean-caught river herring are taken from various seaside bays and areas 626 and 631 (Figure 22). No specific landing sites are known; apparently river herring catches are landed at a variety of small ports.

Catch reporting: Catch reports are voluntary in Virginia, and are usually obtained from buyers by state technicians on a monthly basis. No catch reports were received from the state.

Catch analysis: Ocean landings of river herring appear to have increased slightly over the study period. This increase seems so coincide with a decrease in total catch (Figure 44). Nevertheless, the ocean catch makes up a very small percentage of the total Virginia river herring landings.

Table 40. Commercial ocean landings (pounds) of river herring for Virginia, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Weirs	Landings State-reported ocean	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978				11,200					No	11,200	2,128,100	0.53
1979		700							data	700	1,688,900	0.04
1980		No ocean catch reported							provided	0	1,184,300	0.00
1981		200								200	519,700	0.04
1982		3,400			200					3,600	1,307,600	0.28
1983		No ocean catch reported								0	1,837,500	0.00
1984		600			62,200					62,800	1,257,300	4.99
1985		1,300			24,400					25,700	432,000	5.95
1986		600	400		69,300					70,300	758,000	9.27
1987		100	300		85,000					85,400	783,000	10.91
1988		200								200	714,700	0.03

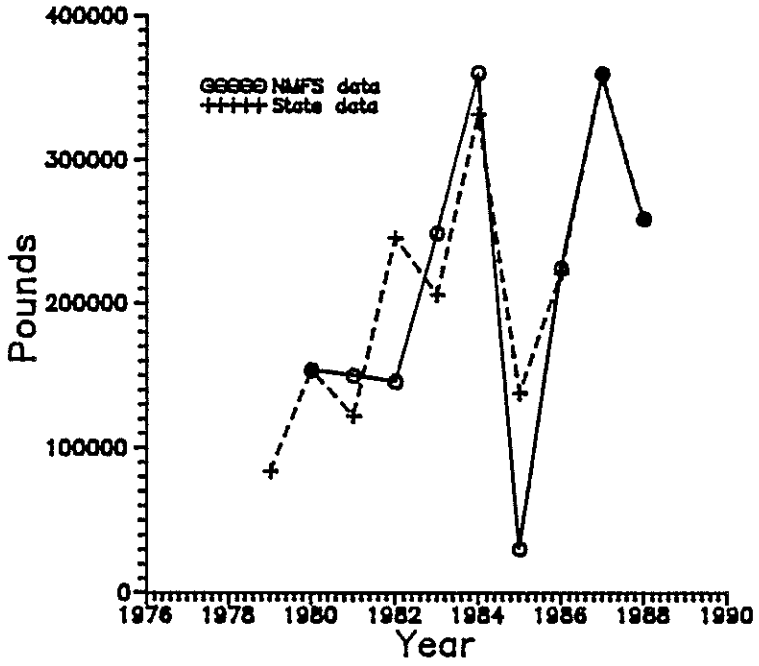

Figure 44. Ocean landings and total landings of river herring (pounds) by commercial fishermen for Virginia, 1978-1988 (NMFS data).

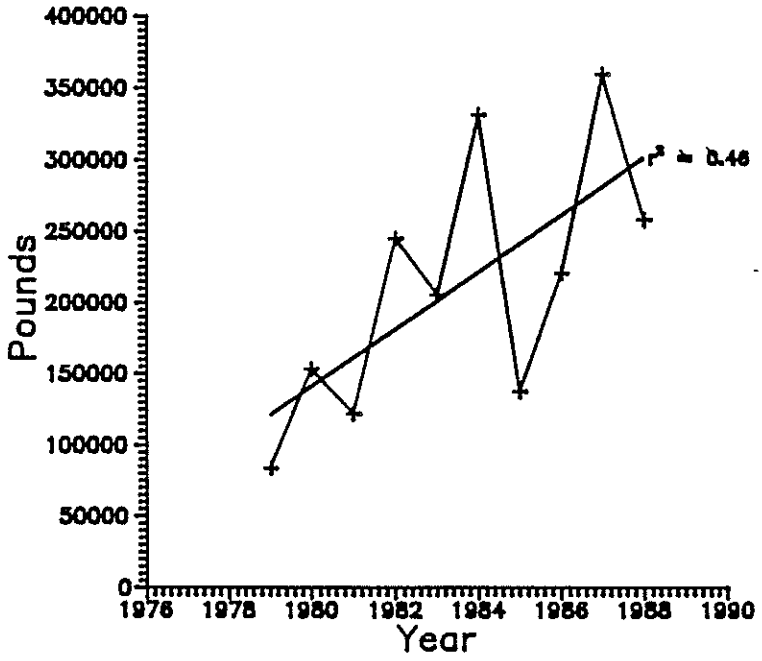

Figure 45. Ocean landings and total landings of river herring (pounds) by commercial fishermen for North Carolina, 1978-1988 (NMFS data).

Table 41. Commercial ocean landings (pounds) of river herring for North Carolina, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Weirs	Landings State-reported ocean	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978	No reports available											
1979	No reports available								19,388			
1980					1,360				1,360	1,360	6,218,523	0.02
1981		2,000			141,232				143,232	143,232	4,753,723	3.01
1982					7,679				7,679	7,679	9,437,703	0.08
1983										0	5,868,332	0.00
1984					9,497				9,497	9,497	6,516,109	0.15
1985		55							55	55	11,874,758	0.00
1986		20			40,250				40,270	40,270	6,814,323	0.59
1987		716			18,563				19,279	19,279	3,194,975	0.60
1988					19,517				19,517	19,517	4,191,211	0.47

North Carolina

Gear: The greatest ocean landings of river herring are taken in otter trawls, with some fish being caught by gill nets (Table 41).

Season: Unknown.

Location: A very small percentage of the total landings in North Carolina is from the ocean (Table 41, Figure 45). The specific locations of the areas where the catches are taken, as well as the landing areas, are unknown.

Catch reporting: Catch reports are voluntary, and collected monthly through dealer surveys conducted by the North Carolina Division of Marine Fisheries.

Catch analysis: Ocean landings of river herring in North Carolina appear to decrease slightly; however, differences in catches over the period were extremely variable. During the study period, catches ranged from 0 to 143,232 pounds. We have no information about whether the fishery is directed or incidental.

South Carolina

No river herring were caught in the ocean and landed in South Carolina during the study period, except for a landing of 146 pounds caught by gill net in 1983. Total landings since 1978 have ranged from 0 pounds for 1986 through 1988 to 633,797 pounds in 1985, and have declined in recent years (Table 42).

Georgia

No catches of river herring were recorded in Georgia during the study period (Table 43).

Florida

No ocean catches of river herring were recorded in Florida during the study period. Total catches never exceeded 300 pounds (Table 44), and river herring landings in Florida were only recorded for three of the eleven years: 1985, 1986, and 1987.

River Herring By-catch in the Offshore Atlantic Mackerel Fishery

The by-catch of river herring by the offshore Atlantic mackerel fishery has been of concern to ASMFC for some time. The fishery is actually composed of a joint-venture fishery and a directed fishery by foreign vessels. The by-catch of river herring by this fishery is variable, but does seem to be increasing (Table 45). By-catch limitations are currently set at 220,000 pounds, which would seem to be adequate provided it can be effectively enforced.

Table 42. Commercial ocean landings (pounds) of river herring for South Carolina, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Weirs	Landings State-reported ocean	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978		No reports available							No data provided			
1979		No reports available										
1980										0	660,866	0.00
1981										0	433,614	0.00
1982										0	308,948	0.00
1983		146								146	646,253	0.02
1984										0	633,797	0.00
1985										0	25,085	0.00
1986										0	0	-
1987										0	0	-
1988										0	0	-

Table 43. Commercial ocean landings (pounds) of river herring for Georgia, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Weirs	Landings State-reported ocean	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978		No reports available							No data provided			
1979		No reports available										
1980										0	0	-
1981										0	0	-
1982										0	0	-
1983										0	0	-
1984										0	0	-
1985										0	0	-
1986										0	0	-
1987										0	0	-
1988		No catch reported										

Table 44. Commercial ocean landings (pounds) of river herring for Florida, 1978-1988 (NMFS data).

Year	Dip nets	Gill nets	Beach haul seine	Pound nets	Bottom otter trawl	Paired midwater trawl	Floating traps	Weirs	Landings State-reported ocean	Landings NMFS Total ocean	Landings Total state	Landings Percent ocean
1978									0	0	0	-
1979									0	0	0	-
1980									0	0	0	-
1981									0	0	0	-
1982									0	0	0	-
1983									0	0	0	-
1984									0	0	0	-
1985									0	0	284	0.00
1986									0	0	67	0.00
1987									0	0	206	0.00
1988	No catch reported											

No domestic landings occur in the directed foreign fishery, therefore these data are not included in the landings records. In the joint-venture fishery, American vessels transfer the cod-ends to foreign vessels, by-catch and all. The size of the by-catch is then recorded aboard the foreign vessel by the observer present. By-catch data are not recorded as landings in the U.S.A., so figures presented in this report as river herring landings do not include this by-catch. Landings by American vessels into U.S.A. ports occur if the vessel has a large catch of restricted species (thus retaining the catch rather than transferring the bag), or if the vessel makes a series of tows independent of the joint-venture operation. These landings would then be recorded as normal landings and should show in NMFS landings data for each state. Therefore, the total harvest of river herring from U.S.A. waters should actually include both the normal landings data, as recorded by the states and NMFS, added to the by-catch of river herring kept by foreign vessels participating in the joint-venture fishery.

Table 45. River herring by-catch (pounds) in the foreign and joint-venture Atlantic mackerelfishery along the eastern seaboard of the USA.

Year	By-catch
1981	24,250
1982	-
1983	16,214
1984	42,833
1985	220,656
1986	37,700
1987	179,674
1988	152,999
1989	166,888

On-site Fishery Investigations

Efforts were made to visit ocean shad fisheries in New Jersey, Delaware, Maryland and Virginia. A field trip throughout this region was conducted during the first two weeks of April, after being unavoidably delayed by bad weather and schedule conflicts. As a result of the delay, only one commercial fishery was successfully visited. However, during the field trip, visits were made to the state agencies responsible for fishery statistics collection of each of the four states. These visits were extremely informative, and aided us in collecting information we might otherwise not have received.

The one commercial fishery visited was operated out of Indian River inlet in southern Delaware. We were provided with the name of a fisherman who had cooperated with the Delaware Division of Fish and Wildlife in the past. He proved to be the only shad fisherman still operating, and closed down his fishery one day after the interview. The information

obtained by the interview was of little use for purposes of this document. However, he reported that the catches of ocean shad fishery were improving, and he believed that more fishermen would move to take advantage of it in the near future. As he operated a single boat with only one crew member, he felt the minimal capital investment required would not restrict entry into the fishery. Drift and stake gill nets were his gear of choice. He checked the staked nets every morning and set drift nets in fair weather. He fished for shad in the ocean from mid-February to mid-April, as did most of the fishermen involved in the fishery. He accepted regulation of the fishery, but seemed reluctant to favor any quota or catch limiting system.

DISCUSSION

The landings information provided by some states did not correspond well to that provided by NMFS, particularly pertaining to information about American shad. In the case of Florida, different codes used by the state and NMFS for the same water bodies and species may be one reason for differences. In Maine, the landings of river herring reported by NMFS were very different to that reported by the state. The primary reason for discrepancies might be the inclusion of fish harvested from inland waters in the Territorial Seas (0-3 miles) landings data. Owing to the difference in definition, we attempted to use state data whenever state personnel felt it was a more accurate reflection of the ocean landings (in terms of our definition of ocean), and sought to avoid the potential increase in landings figures that could result if the inland harvest was included as part of the ocean harvest. Where state data were not provided, or was identical to state data, we used the NMFS data. It should be recognized that in some instances these data might include a portion of the inland harvest, although in most instances where states did not record their own fisheries data, the agencies felt the NMFS was a realistic estimation of the ocean landings in their state.

Nevertheless, NMFS should attempt to avoid incorporating fish harvested from inland waters into the Territorial Seas landings data. Areas of confusion do exist in the data base; for example, although Delaware Bay is provided with a separate water body code, the fish harvested there are recorded with the landings of fish harvested from area 621. This could lead to the conclusion that no fish were harvested from Delaware Bay. The management of anadromous species would be less complex if inland harvest records could be kept separate from ocean harvest data.

The eastern seaboard landings of shad harvested from the ocean have increased steadily since 1978. Increased landings were reported for every state except Maine, North Carolina, and New York. This overall increase is concurrent with an apparent decline in total east coast shad landings since 1984; reduction in the total harvest has resulted in the ocean harvest representing an increasing portion of the total catch - from 10.9 percent in 1978 to 43 percent in 1987.

At this stage it is difficult to determine why the increase in ocean harvest of shad has occurred. Landings for states north of New Jersey are incidental by-catches of other, generally more lucrative, fisheries. The fisheries responsible for shad by-catches generally were not

identified to us by the states, but probably the by-catch effort in these fisheries is responsible for increased shad landings. This hypothesis is supported by the fact that stock sizes of eastern seaboard rivers have dwindled in recent years.

States from Florida to New Jersey all support a directed ocean shad fishery. Several states provided some information about the number of fishermen participating in the ocean shad fishery, but no catch-per-unit-effort information was provided. During the field trip, discussions with state personnel of New Jersey, Delaware, Maryland and Virginia revealed that the number of participants in the ocean fishery often provided a biased view of effort, as the greatest percentage of shad were landed by only a few fishermen (e.g., Maryland estimated that three of 11 license holders caught over 90 percent of the total ocean shad harvest). Nevertheless, the landings of the directed ocean fishery are increasing. As gill nets seem to be the only gear used in the directed fishery, the ocean landings of this portion of the fishery should be easy to monitor and control.

Multiple gear types contributed to the annual shad landings for New Jersey and Virginia, (where 28.9 percent of the ocean harvest since 1978 was landed), and several other states with a directed fishery. The Delaware fisherman interviewed during the field trip stated that, to his knowledge, all fishing for shad was by gill net. Therefore, ocean landings in New Jersey and Virginia by other gear types probably represent an incidental by-catch. The five states from New York to Maine, which only support a by-catch fishery, landed 15.3 percent of the total east coast ocean shad harvest. Thus, it is apparent that the by-catch of shad represents a potentially large portion of the annual east coast ocean shad harvest. Any regulation of the ocean shad fishery should therefore address the directed and incidental fisheries which harvest ocean shad.

Peak harvest for shad in the ocean fishery is between January and July, with peak landings recorded later in the season in the most northern states. This pattern of seasonal harvest corresponds to the migratory patterns of shad as they begin to migrate inshore from overwintering areas to spawn, and then return to ocean waters to migrate north for the summer. The correlation implies that the ocean shad fisheries of most states are intercept fisheries, exploiting the shad during their pre- and post-spawning migrations. If this is true, then the more northerly states support larger intercept fisheries than the southern states, and probably catch individuals representing spawning populations from every state to the south. Therefore, Florida is probably the one state which exploits only local populations.

The paucity of information about the ocean habits of river herring make the interpretation of the data more speculative. However, as far as is known, no directed at-sea fisheries exist for river herring; thus, all landings are incidental. The ocean harvest has increased slightly since 1978, and in 1987 made up 2.4 percent of the total river herring landings on the east coast. We are unsure about the reasons for the increase, although it probably reflects an increase in effort of the fisheries harvesting river herring as a by-catch. The potential impact of the river herring by-catch in the Atlantic mackerel fishery needs to be addressed; in 1987, 135,380 pounds of river herring were landed on the east coast, and 179,674 pounds were taken as a by-catch in the

joint-venture Atlantic mackerel fishery.

The ocean migration of river herring remains unclear. The few tagging studies conducted suggest that river herring follow a migration pattern similar to American shad, although probably to a lesser degree. No overwintering grounds have been identified for river herring. Nevertheless, tagging results do suggest that offshore harvest of river herring is by an intercept fishery. More information is needed about the seasonality of the ocean river herring fishery, and the ocean migration patterns of river herring, before this hypothesis can be tested.

The aspect of on-site fishery investigation is worth pursuing. Before additional interviews are conducted, however, locations and names of fishermen participating in the fishery must be obtained. Initially, several state agencies indicated that such information was available, but at the time of the field trip could not provide these data. An additional aspect helpful to future on-site investigations would be identifying specific buyers and landing sites to facilitate collection of biological data.

CONCLUSIONS AND RECOMMENDATIONS

American Shad

1. Total landings of American shad along the Atlantic seaboard increased from over two million pounds in 1978 to over four million pounds in 1984. Since 1985, landings have remained steady at approximately three and a half million pounds.

2. Virginia's fisheries contribute nearly 26 percent of total annual shad landings, followed by New York (18 percent), South Carolina (11 percent), North Carolina (10 percent), and Connecticut (10 percent).

3. Ocean landings of American shad have increased over 400 percent since 1978, comprising just 11 percent of the total harvest in 1978 but representing 43 percent of the total in 1987.

4. Ocean shad harvest increased in every Atlantic coastal state except Maine, North Carolina, and New York from 1978 to 1987.

5. Four states contribute over 66 percent of the ocean shad harvest: Virginia, South Carolina, Florida and New Jersey.

6. Georgia is the only state that does not harvest shad from ocean waters.

7. Three states rely exclusively on ocean fisheries for shad harvest, and these states comprise about 10 percent of the annual total ocean landings: Maine, Massachusetts, and Rhode Island.

8. Gill net is the primary gear type used in the ocean shad fishery. Exceptions are floating trap (Rhode Island), bottom otter trawl (Connecticut), and pound net (New York).

9. Landings in all states except Florida represent intercept fisheries. Florida is the only state that exploits only local populations.

10. Ocean harvest of shad by states north of New Jersey is primary the result of by-catch; from New Jersey south, ocean-harvested shad are landed primarily by directed fisheries.

11. NMFS should attempt to separate landings of fish harvested from inland waters from those harvested from Territorial Seas to facilitate the management of shared anadromous species.

River Herring

1. Total coast-wide landings of river herring rose from about six million pounds in 1978 to over nine million pounds during 1982-1985, then declined to slightly less than six million pounds by 1987.

2. The fisheries of North Carolina and Maine combined represent about 75 percent of all river herring landed annually along the Atlantic coast.

3. During the period 1979-1987, ocean harvest of river herring was a minor component of total harvest, averaging less than two percent.

4. The major portion of river herring ocean harvest is by Massachusetts (44 percent), followed by Virginia (18 percent), New York (14 percent), and North Carolina (11 percent).

5. Georgia has no river herring fishery, and two additional states do not harvest river herring from ocean waters: Delaware and Florida.

6. Ocean harvest of river herring is a result of by-catch in other fisheries of various gear types: dip net, gill net, pound net, hoop and fyke net, beach haul seine, menhaden purse seine, bottom otter trawl, and handline.

7. Little is known about the ocean migration patterns and overwintering areas of river herring, but limited data suggest that the ocean fisheries for river herring are probably intercept in nature.

8. The offshore foreign and joint venture fisheries for mackerel harvest river herring as by-catch. Although harvest quotas for river herring are currently set at 220,000 pounds, the

effects of a catch of this magnitude on river herring stocks needs to be further investigated.

9. The NMFS ocean landings information, combined with the offshore mackerel by-catch data, indicate that ocean harvest of river herring has increased over the past 10 years. These fisheries should be monitored closely for trends in river herring harvest.

10. We recommend that the various state agencies work closely with NMFS personnel to ascertain the causes in discrepancies between state landings data and the national data base. If American shad, blueback herring, and alewife are to be managed by trends in landings data, then the information must be accurate to ensure correct management options.

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