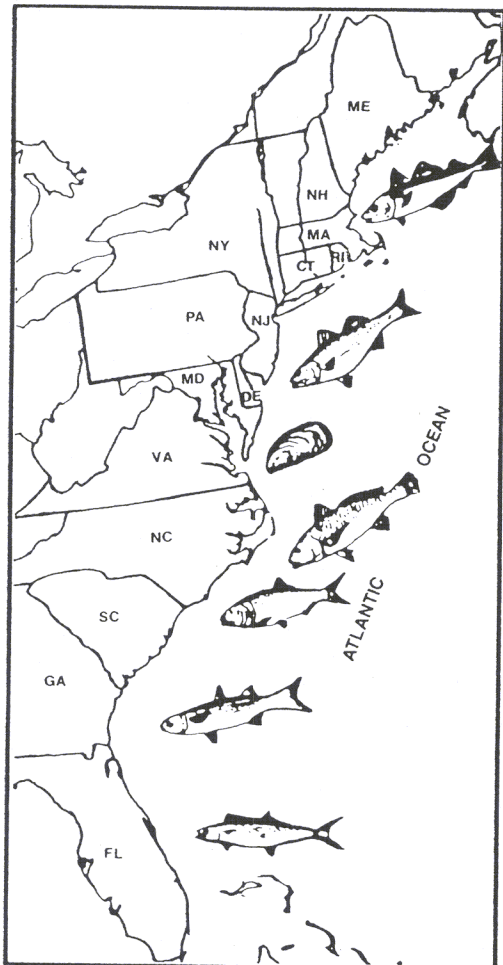


Fisheries Management Report No. 8
of the
ATLANTIC STATES MARINE
FISHERIES COMMISSION



1986
SUPPLEMENT TO
ATLANTIC MENHADEN
FISHERY
MANAGEMENT
PLAN

October 1986

1986 SUPPLEMENT TO ATLANTIC MENHADEN FISHERY MANAGEMENT PLAN

by

The Atlantic Menhaden Management Board

October 1986

Fisheries Management Report Number 8

Atlantic States Marine Fisheries Commission,
Washington, D.C.

This report has been prepared through a cooperative industry, state, and federal initiative for managing the Atlantic menhaden fishery as part of the Interstate Fisheries Management Program administered by the Atlantic States Marine Fisheries Commission. Funding, in part, was provided by the Northeast Region, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, under cooperative agreement # NA-80-FA-H-00017.

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INTRODUCTION

At the 10 October 1985 meeting of the Atlantic Menhaden Management Board (AMMB), the Atlantic Menhaden Advisory Committee (AMAC) was given several specific tasks:

1. Update the FMP database, including regulations and maps showing state-by-state closure areas
2. Evaluate the effects of various management actions
3. Prepare an RFP for a coastwide socioeconomic impact study (Appendix A)
4. Monitor the status of ulcerative mycosis (Appendix B)

This report concerns all of these items as well as a new stock assessment of Atlantic menhaden.

DATABASE UPDATE

The AMAC has reviewed and revised the data contained in the 1981 FMP through 1985 (some data available only through 1984). Major changes have occurred in the Atlantic menhaden industry since 1981. Considerable research has also been accomplished on the resource and the fishery during the 1981-1985 period. The cooperative interstate management program has aided in this work, especially through implementation of the Captains Daily Fishing Report system.

Comments on the revised tables and figures are followed by the tables and figures in the same order in which they appear in the 1981 FMP plan.

There have been numerous regulatory changes affecting the menhaden fishery, such as area closures and establishment of seasons. A tabular summary of current rules (December 1985) follows the revised tables and figures.

Since 1981 a number of areas have been closed to menhaden purse seine fishing along the Atlantic Coast. These closures were not recommended by the AMAC or the AMMB. A series of maps follows the regulatory summary. The maps show the areas in each state which were closed to menhaden fishing as of 31 December 1985.

Using the most recent data available, a complete stock assessment of Atlantic menhaden was conducted by NMFS in 1985. An executive summary of the assessment follows the maps.

Revisions to Tables and Figures in Fishery Management Plan for Atlantic Menhaden, *Brevoortia tyrannus* (Latrobe) by the Atlantic Menhaden Management Board, August 1981:

- Table 1.1 Landings (thousands of metric tons) by area and coastwide have been revised to include additional fishing seasons 1981-1985. The North Atlantic area was combined with the Middle Atlantic and Chesapeake Bay areas after 1981 to maintain confidentiality due to closure of the Port Monmouth, NJ, plant after the 1981 fishing season. The South Atlantic and North Carolina Fall fishery areas were combined in 1985 to maintain confidentiality due to the closure of Standard Products Inc.'s, Beaufort, NC, plant during the 1985 North Carolina Fall fishery.
- Figure 1.4 Locations and purse-seine landings by landing areas have been revised to reflect the period from 1980-1985 instead of 1975-1980.
- Table 1.2 The number of purse-seine vessels that landed Atlantic menhaden during the fishing season by area has been revised to include additional fishing seasons 1981-1985.
- Table 1.3 Atlantic menhaden nominal fishing effort (vessel weeks) by area has been revised to include additional fishing seasons 1981-1985.
- Table 1.4 Estimated numbers of Atlantic menhaden by age landed by purse-seine vessels and total weight landed have been revised for fishing seasons 1965-1980 and include additional fishing seasons 1981-1985.
- Table 1.5 Estimated number of Atlantic menhaden spawners, number of eggs produced, and number of fish recruited at age-1 have been re-estimated for the 1955-1976 year classes and estimated for the 1977-1981 year classes.
- Figure 1.5 Data from the revised Table 1.5 are used to estimate a new spawner-recruit relationship instead of data from the original Table 1.5.
- Figure 1.6 Atlantic menhaden mean weight at ages 1, 2, and 3 have been revised to include additional fishing seasons 1980-1984.
- Figure 1.7 Atlantic menhaden purse-seine landings and forecasts have been updated to include additional fishing seasons 1981-1985.
- Figure 1.8 Forecast of Atlantic menhaden purse-seine landings are presented for the 1986 fishing season instead of for the 1981 fishing season.

- Figure 1.9 In addition to extending the percent contribution of late age-2 spawners to the total spawning stock in numbers from 1976 to 1984, this figure also gives the percent contribution of eggs from late age-2 spawners to total egg production for years 1955-1984.
- Figure 1.10 In place of catchability coefficients calculated by averaging exploitation rates over ages 1-5+ and ages 2-3 for fishing years 1955-1976, annual catchability coefficients are calculated based on the starting population on March 1 and catches of ages 1-5+ for fishing years 1955-1982.
- Figure 1.11 Instead of presenting the overall yield-per-recruit for the 1974-1976 fishing seasons, this figure presents the overall yield-per-recruit for the 1981 fishing season.
- Table 1.6 In place of an array of yield-per-recruit (expressed as percent of current yield-per-recruit) for the 1974-1976 fishing seasons, this new table presents yields-per-recruit (again expressed as percent of current yield-per-recruit) for the 1976-1978, 1979, 1980, and 1981 fishing seasons. In place of F-multiples ranging from 0.5 to 1.5 in increments of 0.25, the new table ranges from 0.2 to 1.8 in increments of 0.4. Also, in place of ages at entry of 0.5, 1.0, 1.5 and 2.0, the new table uses ages at entry of 0.5, 1.0, 2.0 and 3.0.
- Table 1.7 In place of yield-per-recruit by area and overall for the 1974-1976 fishing seasons, the new table presents yield-per-recruit by area and overall for 1976-1978, 1979, 1980, and 1981 fishing seasons. Also included in both tables is percent change in yield-per-recruit for the same set of increasing ages at entry (1.0, 1.5, and 2.0 years).
- Table 4.1 The data indicates a sharp decline in the harvesting sector of the summer fishery associated principally with the closure of the Port Monmouth, NJ, plant after the 1981 season. Further significant reductions occurred in 1984-85 with the closure of the Southport, NC, plant and fleet reductions in Chesapeake Bay. similar reductions have occurred in the fall fishery in North Carolina, where the 1985 fleet was 79% below the size of the 1980 fleet, with a hold capacity 87% below that of 1980.
- Table 4.2 This processing capacity represents the eight reduction plants available in 1985, a reduction of three plants from 1981.
- Table 4.3 The revised data show the continued reduction in the number of operating Atlantic Coast menhaden plants, from eleven during 1975-81 to seven in 1985. The footnotes to the table indicate the decline from seven plants wholly dependent on menhaden during 1973-81 to five in 1985.

- Table 4.4 In place of landings by three principal areas for 1972 through 1980, the new table presents landings by two principal areas for 1976-1985. Landings from Long Island to Cape Hatteras had to be combined with landings north of Long Island to maintain confidentiality of landings data. Mean landings by area reflect those years presented in this table.
- Figure 4.1 In place of monthly landings for the 1978, 1979 and 1980 fishing seasons, this figure presents monthly landings for the 1983, 1984 and 1985 fishing season. December and January landings in the 1985 fishing season had to be combined to maintain confidentiality of landings data.
- Figure 4.2 Atlantic menhaden purse-seine landings have been revised to include additional fishing seasons 1981-1985.
- Figure 4.3 In place of purse-seine landings by four areas for 1940-1980 fishing seasons, this figure presents purse-seine landings for three areas for 1940-1984. The North Atlantic area was combined with the Middle Atlantic and Chesapeake Bay areas to maintain confidentiality of landings data.

Table 1.1. Atlantic menhaden purse seine landings by area, 1940-1985

Year	North Atlantic	Middle Atlantic	Chesapeake Bay	South Atlantic	North Carolina Fall Fishery	Total
	-----Thousands of metric tons-----					
1940	16.8	91.1	35.3	37.9	36.6	217.7
1941	33.5	104.1	60.2	45.2	34.9	277.9
1942	14.6	77.7	21.9	32.9	20.1	167.2
1943	9.8	96.8	42.1	59.7	28.8	237.2
1944	27.5	122.6	32.2	46.9	28.7	257.9
1945	34.0	136.4	35.1	58.5	31.9	295.9
1946	42.9	183.8	57.6	40.8	37.3	362.4
1947	44.2	185.8	81.2	34.2	32.9	378.3
1948	44.4	137.4	68.3	55.8	40.6	346.5
1949	52.2	149.8	62.8	59.3	39.7	363.8
1950	49.3	143.0	63.1	20.0	21.8	297.2
1951	51.0	168.6	56.1	54.6	31.1	361.4
1952	58.1	193.7	45.7	86.0	26.4	409.9
1953	59.7	363.2	77.8	52.8	39.7	593.2
1954	64.9	335.7	126.0	39.6	41.9	608.1
1955	83.3	317.6	132.7	43.4	64.4	641.4
1956	98.5	378.3	94.0	68.6	73.7	712.1
1957	83.5	304.5	126.0	36.4	52.0	602.8
1958	36.0	211.1	151.3	41.3	70.3	510.0
1959	66.0	250.9	196.8	63.1	82.3	659.1
1960	66.4	256.0	108.5	36.7	62.2	529.8
1961	58.6	274.6	128.7	44.1	69.9	575.9
1962	64.7	249.9	155.1	42.2	25.8	537.7
1963	35.2	111.7	104.0	34.2	61.8	346.9
1964	15.0	35.2	134.1	46.5	38.4	269.2
1965	11.9	45.8	126.1	36.7	52.9	273.4
1966	1.8	6.0	115.6	24.5	71.7	219.6
1967	0.0	17.1	91.1	34.1	51.2	193.5
1968	6.7	26.2	115.5	33.6	52.8	234.8
1969	2.9	12.4	72.0	32.8	41.3	161.4
1970	4.3	11.5	182.9	42.4	18.3	259.4
1971	10.4	23.0	170.7	38.3	7.9	250.3
1972	14.5	54.6	245.5	45.9	5.4	365.9
1973	29.9	277.4	1/	37.2	2.4	346.9
1974	35.8	194.8		45.9	15.7	292.2
1975	23.1	149.8		59.5	17.8	250.2
1976	28.4	243.3		50.7	18.1	340.5
1977	15.0	244.1		49.8	32.2	341.1
1978	31.4	214.1		60.3	38.2	344.0
1979	29.4	230.7		61.6	54.0	375.7
1980	29.7	282.8		53.2	35.8	401.5
1981	21.8	215.9	1/	79.1	64.5	381.3
1982		293.1		58.8	30.5	382.4
1983		318.9		31.3	68.4	418.6
1984		238.6		19.0	68.7	326.3
1985		287.7			1/	306.7
				19.0		

¹ Combined to retain confidentiality of landings data.

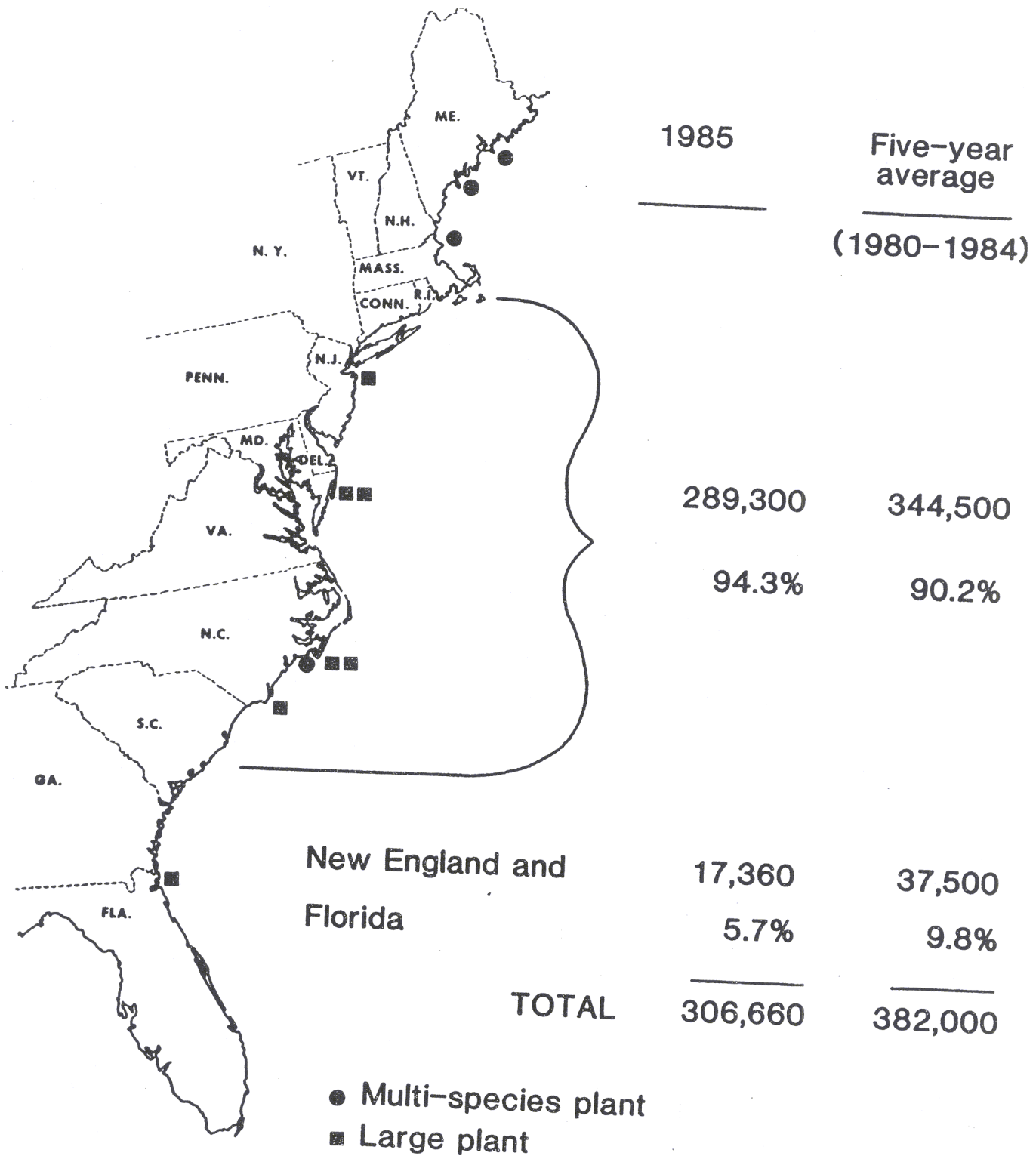


Figure 1.4 Locations of Atlantic menhaden processing plants and purse-seine landings (MT) by landing area.

Table 1.2. Number of purse-seine vessels that landed Atlantic menhaden during the fishing season by area, 1955-1985.

Fishing Season	North Atlantic ¹	Middle Atlantic	Chesapeake Bay ²	South Atlantic ³	Total ⁴	N.C. Fall Fishery
1955	39	48	20	34	150	51
1956	40	47	24	30	149	63
1957	33	46	25	31	144	64
1958	23	44	28	26	130	63
1959	34	45	31	25	144	59
1960	19	47	22	20	115	37
1961	21	47	23	20	117	44
1962	20	47	29	15	112	49
1963	10	46	36	16	112	46
1964	9	37	38	16	111	51
1965	6	13	38	19	84	46
1966	5	10	36	16	76	43
1967	0	4	32	16	64	46
1968	2	4	25	16	59	45
1969	3	4	22	16	51	36
1970	4	1	18	11	54	37
1971	5	2	20	11	51	32
1972	9	4	19	11	51	5
1973	10	6	23	11	58	4
1974	12	6	22	12	63	12
1975	9	5	22	14	61	17
1976	12	4	21	12	62	13
1977	12	5	24	10	64	16
1978	13	5	22	11	53	18
1979	11	4	22	13	54	18
1980	5	6	24	12	51	19
1981	8	7	23	13	57	19
1982	9	0	22	8	47	18
1983	7	0	24	10	41	17
1984	6	0	26	6	38	12
1985	1	0	18	5	24	3

¹ Vessels fishing from New England ports in recent years are mostly trawlers that convert to purse seiners in summer. Some fish regularly and others sporadically.

² Vessels that fish only in regular season. Does not include vessels added in October or November.

³ Includes only vessels that landed regularly in the summer fishery.

⁴ Includes all vessels that landed fish during the year.

Table 1.3. Atlantic menhaden fishing effort (vessel weeks) by area, 1955-1985. Area: North Atlantic (1); Middle Atlantic (2); Chesapeake Bay (3); South Atlantic (4); and North Carolina Fall fishery (5).

Year	Area					Total
	1	2	3	4	5	
1955	523	990	467	484	328	2,792
1956	557	929	468	545	384	2,883
1957	417	1,056	533	476	295	2,777
1958	273	788	556	387	373	2,377
1959	411	953	668	509	306	2,847
1960	324	952	430	299	179	2,184
1961	302	1,031	498	391	226	2,448
1962	330	1,024	593	335	114	2,396
1963	255	843	685	295	280	2,358
1964	140	378	788	288	213	1,807
1965	96	300	797	354	258	1,805
1966	38	100	818	248	208	1,412
1967	0	131	763	259	222	1,375
1968	22	115	603	259	212	1,211
1969	38	120	514	166	152	990
1970	30	59	499	174	144	906
1971	86	79	505	171	54	895
1972	87	97	552	208	28	972
1973	135	118	630	208	13	1,104
1974	153	124	591	232	43	1,143
1975	143	95	614	282	81	1,215
1976	142	123	574	249	74	1,162
1977	116	130	667	197	129	1,239
1978	112	113	588	268	129	1,210
1979	98	95	579	271	155	1,198
1980	67	129	638	226	98	1,158
1981	84	137	552	247	113	1,133
1982	136	0	534	202	76	948
1983	102	0	585	151	157	995
1984	102	0	580	98	112	892
1985	18	0	493	46	20	577

Table 1.4. Estimated numbers of Atlantic menhaden (in millions) by age landed by purse-seine vessels and the total weight landed (in thousands of metric tons), 1955-1985.

Year	Numbers by Age										Total Weight (thousands of metric tons)
	0	1	2	3	4	5	6	7	8-10	Total (in millions)	
1955	761.01	674.15	1,057.68	267.31	307.21	38.07	10.53	1.84	.64	3,118.44	641.4
1956	36.37	2,073.26	902.72	319.60	44.78	150.68	28.70	6.72	1.99	3,564.82	712.1
1957	299.58	1,599.98	1,361.77	96.73	70.80	40.52	36.93	4.26	1.10	3,511.67	602.8
1958	106.06	858.16	1,635.35	72.05	17.25	15.94	9.09	4.88	.43	2,719.21	510.0
1959	11.40	4,038.72	851.29	388.27	33.41	11.87	12.36	4.55	1.77	5,353.64	659.1
1960	72.17	281.01	2,208.63	76.37	102.20	23.77	7.95	2.36	.65	2,775.11	529.8
1961	0.25	832.42	503.60	1,209.57	19.18	29.38	2.86	.81	.24	2,598.31	575.9
1962	51.58	514.11	834.52	217.25	423.37	30.75	24.60	2.98	.70	2,099.86	537.7
1963	96.89	724.23	709.20	122.53	44.97	52.38	10.42	3.33	.56	1,764.51	346.9
1964	302.59	703.95	604.98	83.50	17.94	7.85	6.62	1.31	.32	1,729.06	269.2
1965	249.12	739.28	417.55	77.75	12.17	1.81	1.22	.74	.07	1,499.71	273.4
1966	349.46	550.83	404.11	31.70	3.88	.37	.11	.11	.04	1,340.61	219.6
1967	6.95	633.20	265.68	72.76	5.09	.49	.01			984.18	193.5
1968	154.61	376.28	535.52	65.68	10.67	.98	.06			1,143.80	234.8
1969	158.08	372.37	284.31	47.81	5.44	.14	.01			868.16	161.4
1970	21.42	870.85	473.92	32.63	4.02	.11				1,402.96	259.4
1971	72.85	263.29	524.32	88.29	17.84	2.51				969.10	250.3
1972	50.16	981.27	488.47	173.06	19.12	1.86				1,713.95	365.9
1973	55.98	588.47	1,152.94	38.63	7.00	.34				1,843.36	346.9
1974	315.55	636.68	985.97	48.59	2.49	1.35				1,990.63	292.2
1975	298.64	719.96	1,086.53	50.24	6.63	.20	.10			2,162.30	250.2
1976	274.23	1,611.96	1,341.09	47.97	7.95	.28				3,283.47	340.5
1977	484.62	1,004.54	2,081.77	83.46	17.80	1.41	.11			3,673.71	341.2
1978	457.41	664.09	1,670.91	258.12	31.19	3.48				3,085.20	344.1
1979	1,492.46	623.14	1,603.29	127.93	21.76	1.47	.09			3,870.13	375.7
1980	88.29	1,478.09	1,458.23	222.71	69.23	14.36	1.43			3,332.32	401.5
1981	1,187.57	698.66	1,811.46	222.20	47.47	15.37	1.27			3,984.02	381.3
1982	114.12	919.44	1,739.55	379.67	16.33	5.78	.53	.32		3,175.72	382.4
1983	964.41	517.22	2,293.06	114.35	47.37	5.01	.23		.46	3,942.11	418.6
1984	1,294.22	1,024.17	892.09	271.50	50.34	15.21	.51			3,548.04	326.3
1985	637.19	1,075.85	1,224.62	44.06	35.63	6.25	1.68			3,025.29	306.7

Table 1.5. Estimated number of Atlantic menhaden spawners, number of eggs produced, and number of fish recruited at age 1 for the 1955-1981 year classes.

Year Class	Estimated No. of Spawners (in millions)	Estimated No. of Eggs Produced (in trillions)	Number of Recruits at Age 1 (in millions)
1955	1891.8	214.0	5604.6
1956	1368.2	148.5	7145.7
1957	719.3	84.9	3264.5
1958	547.1	58.1	14773.2
1959	1295.7	89.1	2164.6
1960	792.3	76.5	2960.9
1961	2956.8	155.8	2210.7
1962	1293.1	106.6	2222.8
1963	425.9	37.4	1753.9
1964	255.1	21.4	1939.2
1965	186.1	13.8	1430.8
1966	116.1	7.6	2000.9
1967	214.7	17.0	1209.3
1968	172.5	12.9	1710.8
1969	139.1	10.5	2610.5
1970	151.7	11.7	1379.2
1971	214.7	15.0	3562.1
1972	296.4	25.7	2792.1
1973	76.0	7.0	3096.0
1974	90.6	5.7	3864.7
1975	117.0	7.1	6964.0
1976	159.8	8.1	5254.5
1977	254.1	12.2	4810.1
1978	571.2	19.5	4340.0
1979	530.3	18.8	6879.6
1980	643.1	26.0	4849.4
1981	516.0	20.8	6489.0
1982	799.4	19.5	NE
1983	514.8	16.7	NE
1984	697.8	25.9	NE

(NE = Not Estimable)

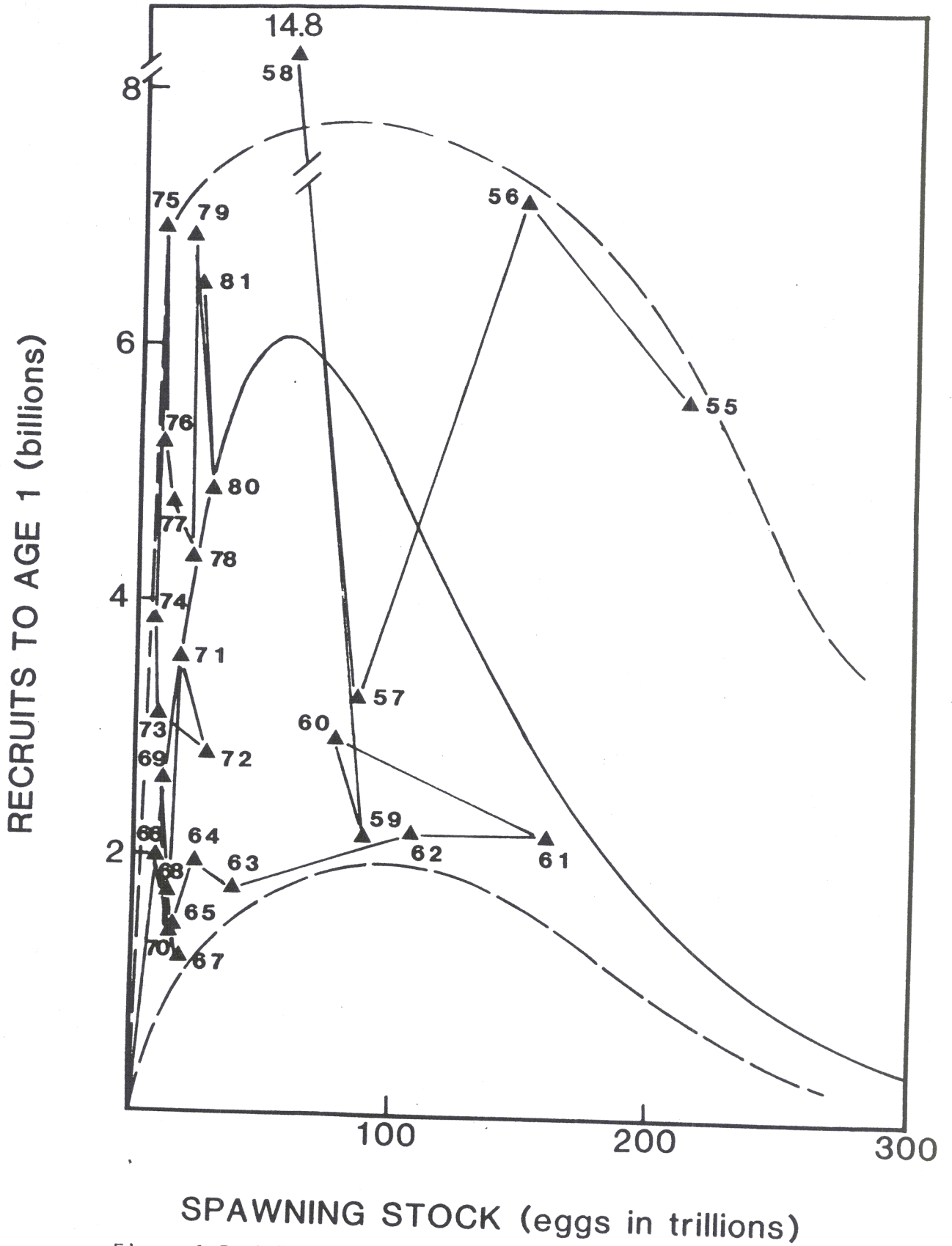


Figure 1.5 Atlantic menhaden spawner-recruit relationship, 1955-1981.

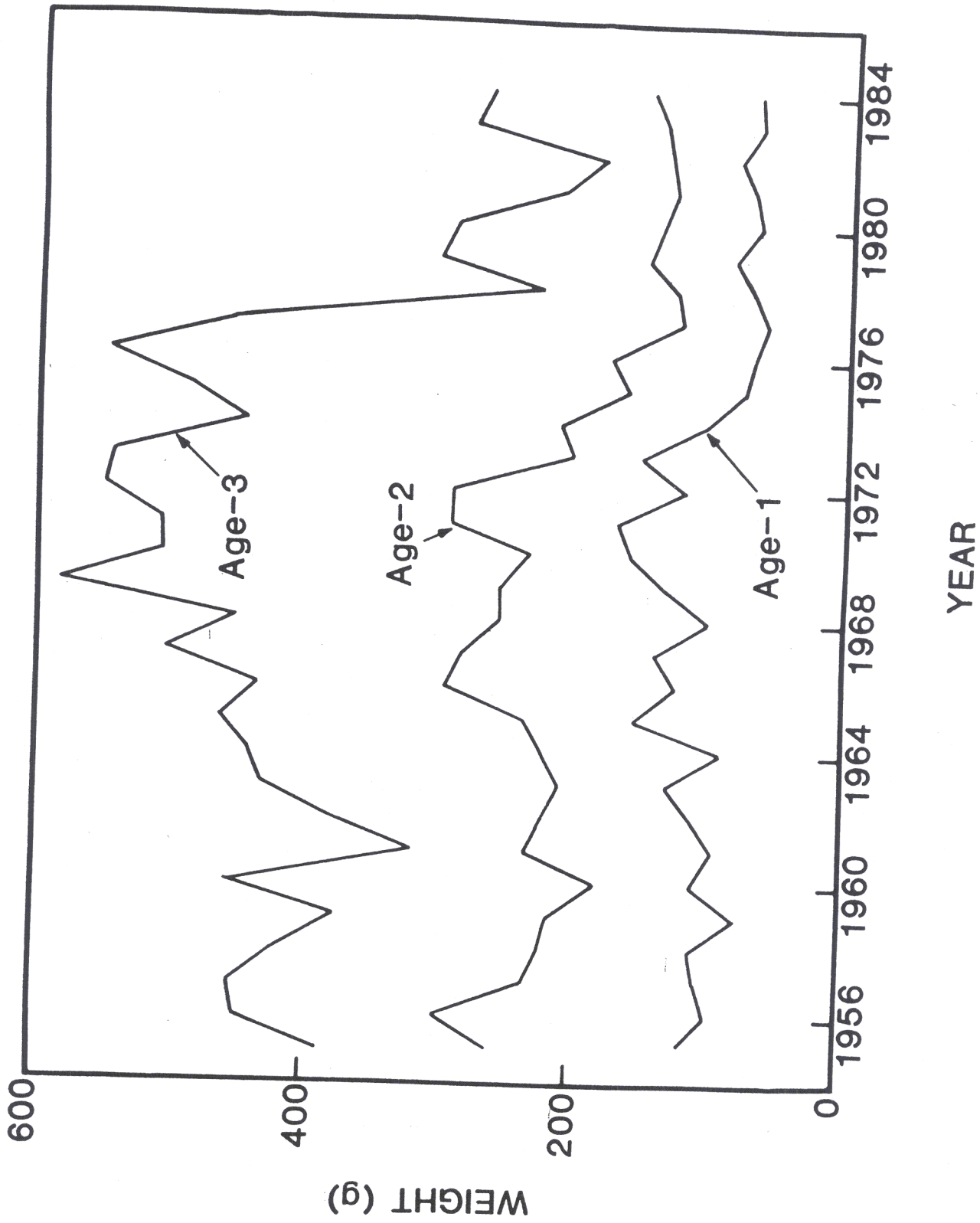


Figure 1.6. Atlantic menhaden mean weight (weighted) at ages 1, 2, and 3, 1955-1984.

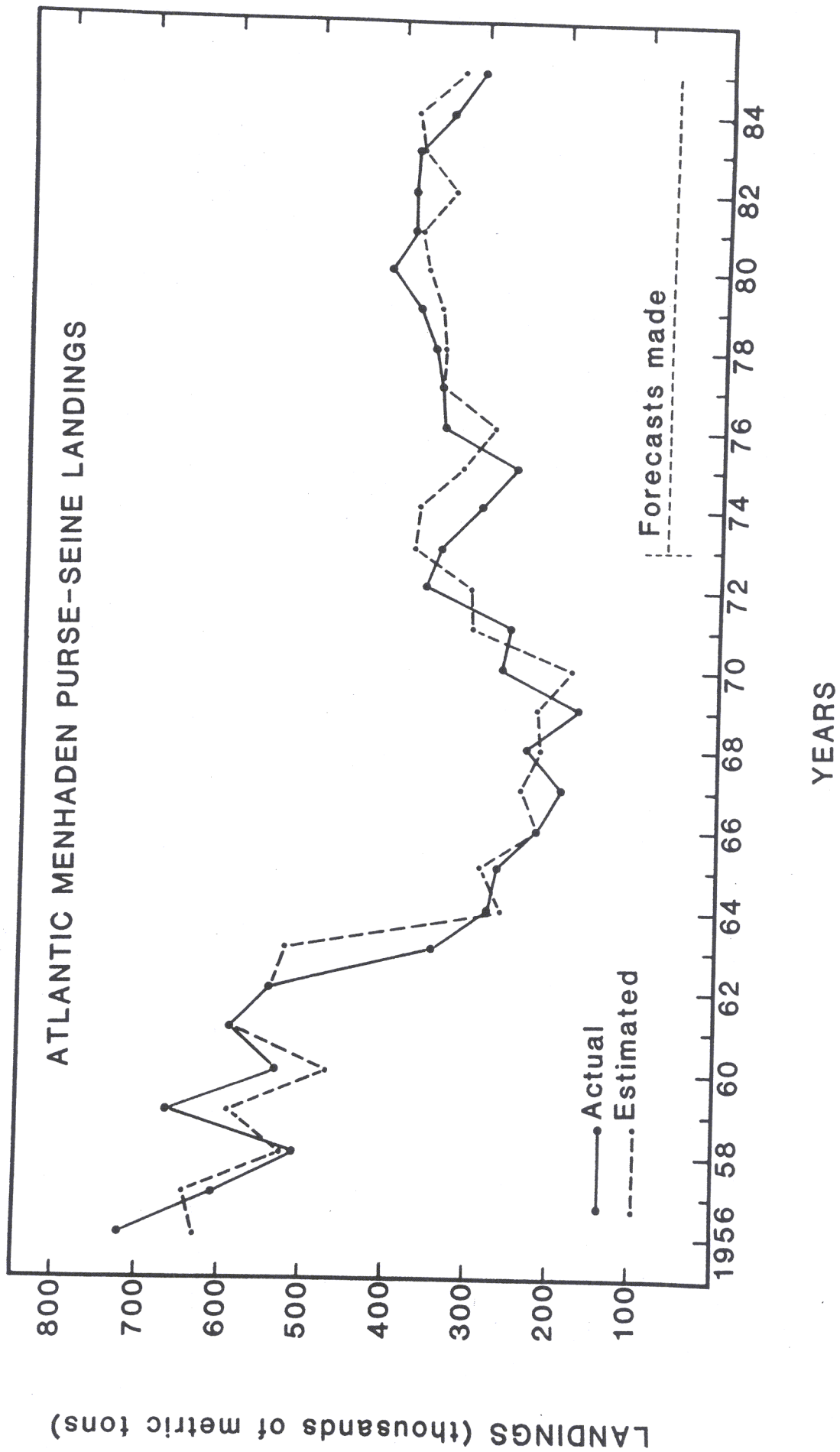


Figure 1.7. Atlantic menhaden purse-seine landings and forecasts.

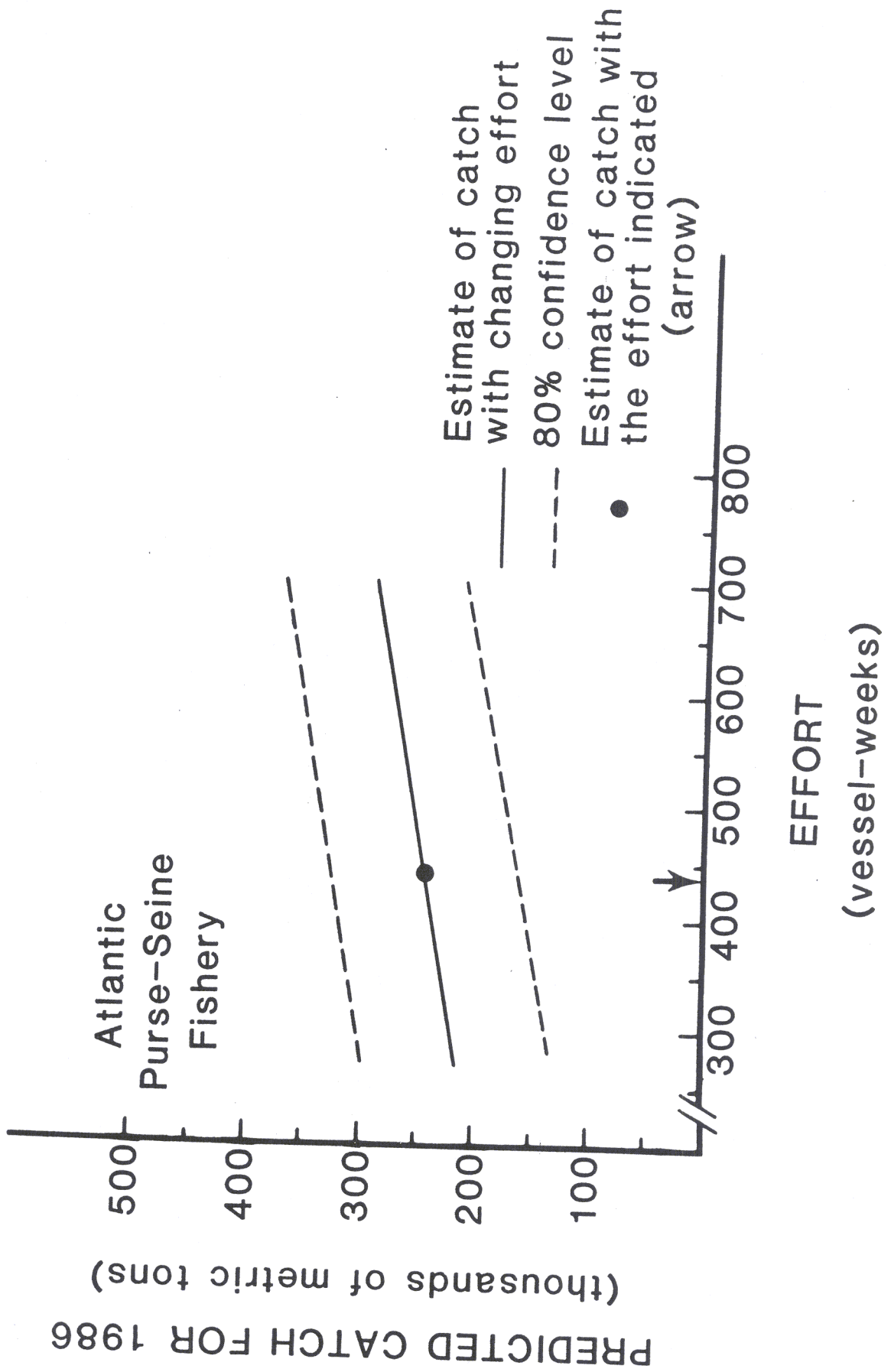


Figure 1.8. Forecast of Atlantic menhaden purse-seine landings for the 1986 season.

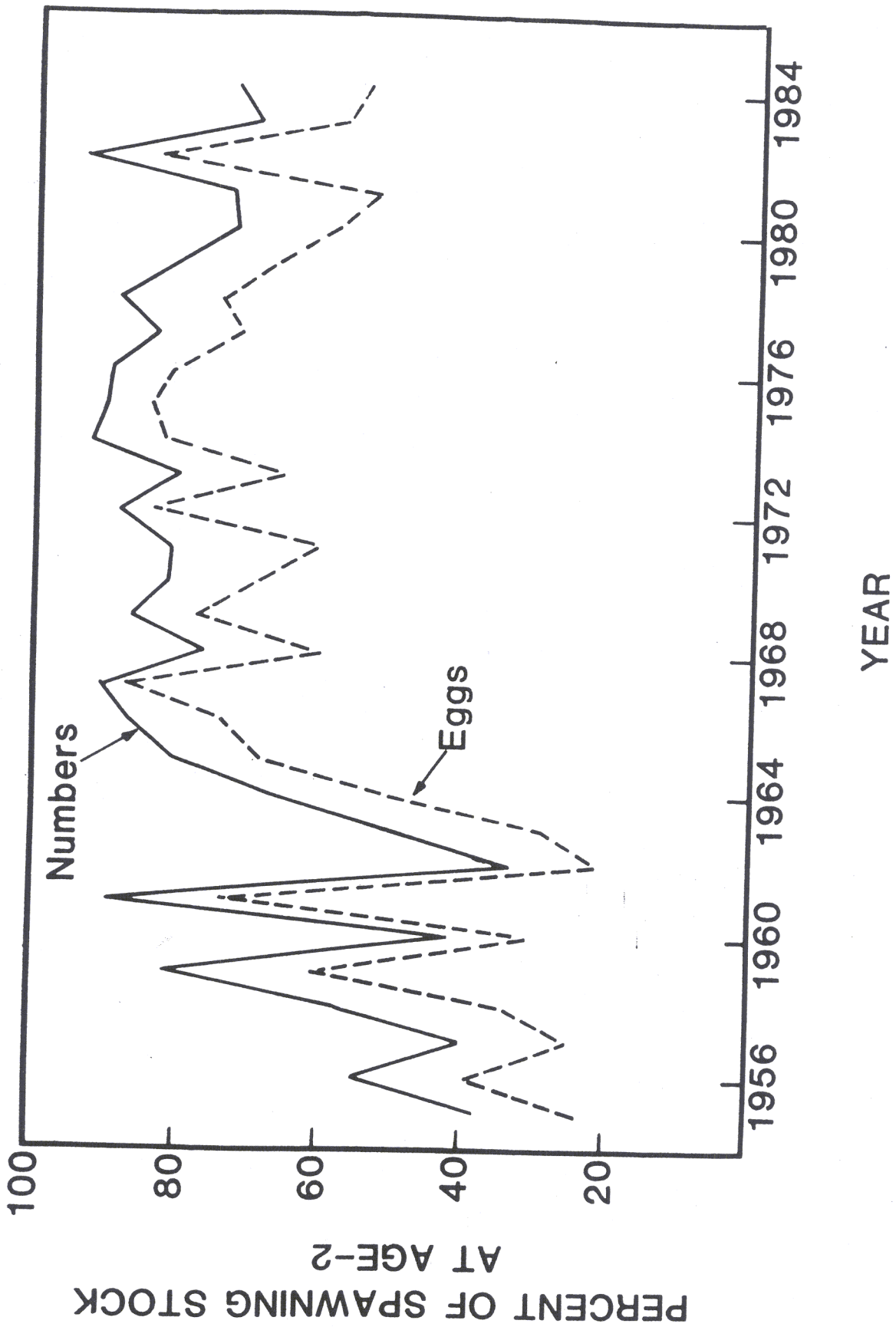


Figure 1.3. Contribution of late age 2 spawners (%) to total spawning stock (Numbers) and to total egg production (eggs) of Atlantic menhaden, 1955-1984.

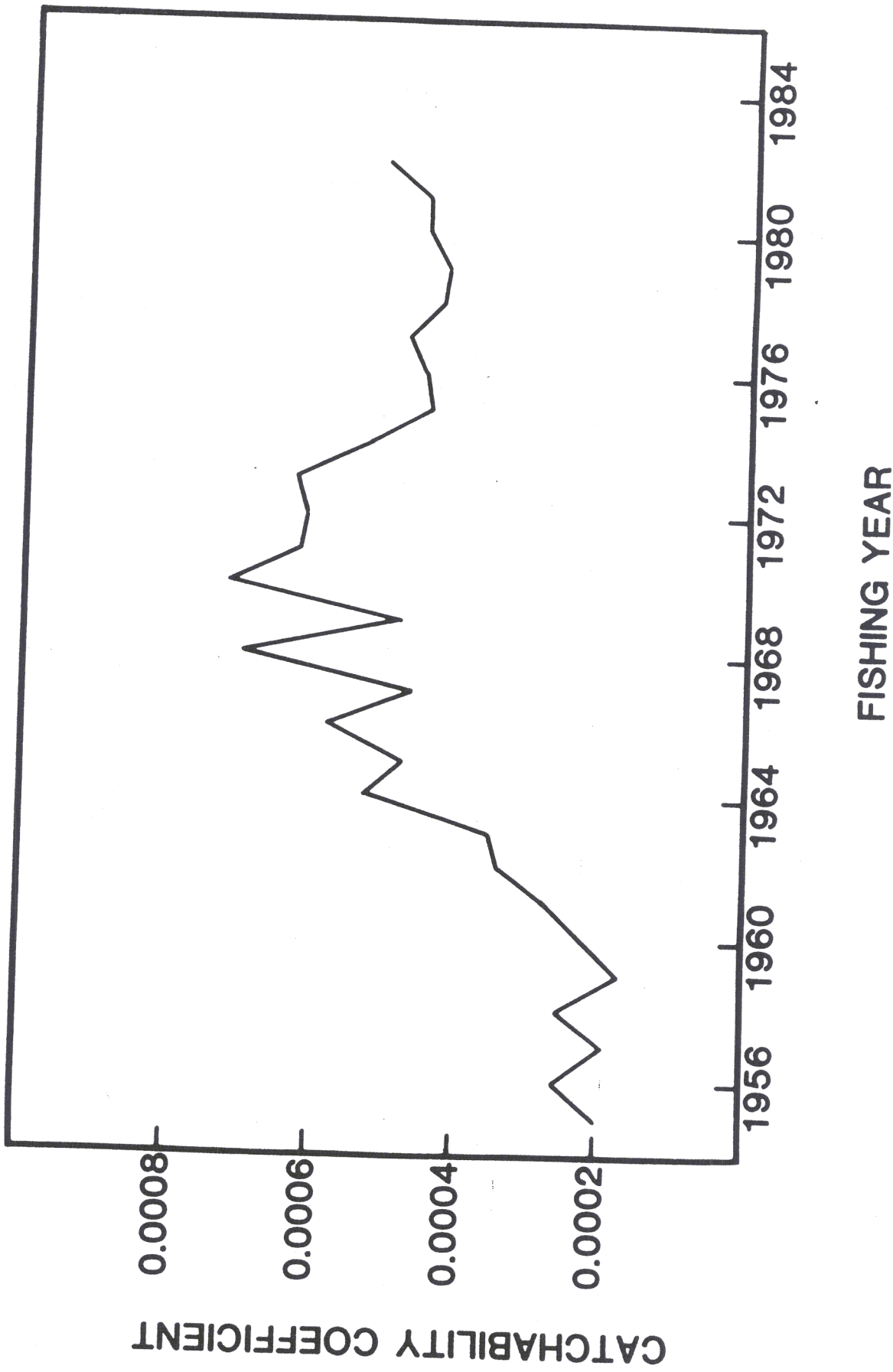


Figure 1.10. Catchability coefficient (fishing mortality per vessel-week) of Atlantic menhaden at ages 1 and older, 1955-1982.

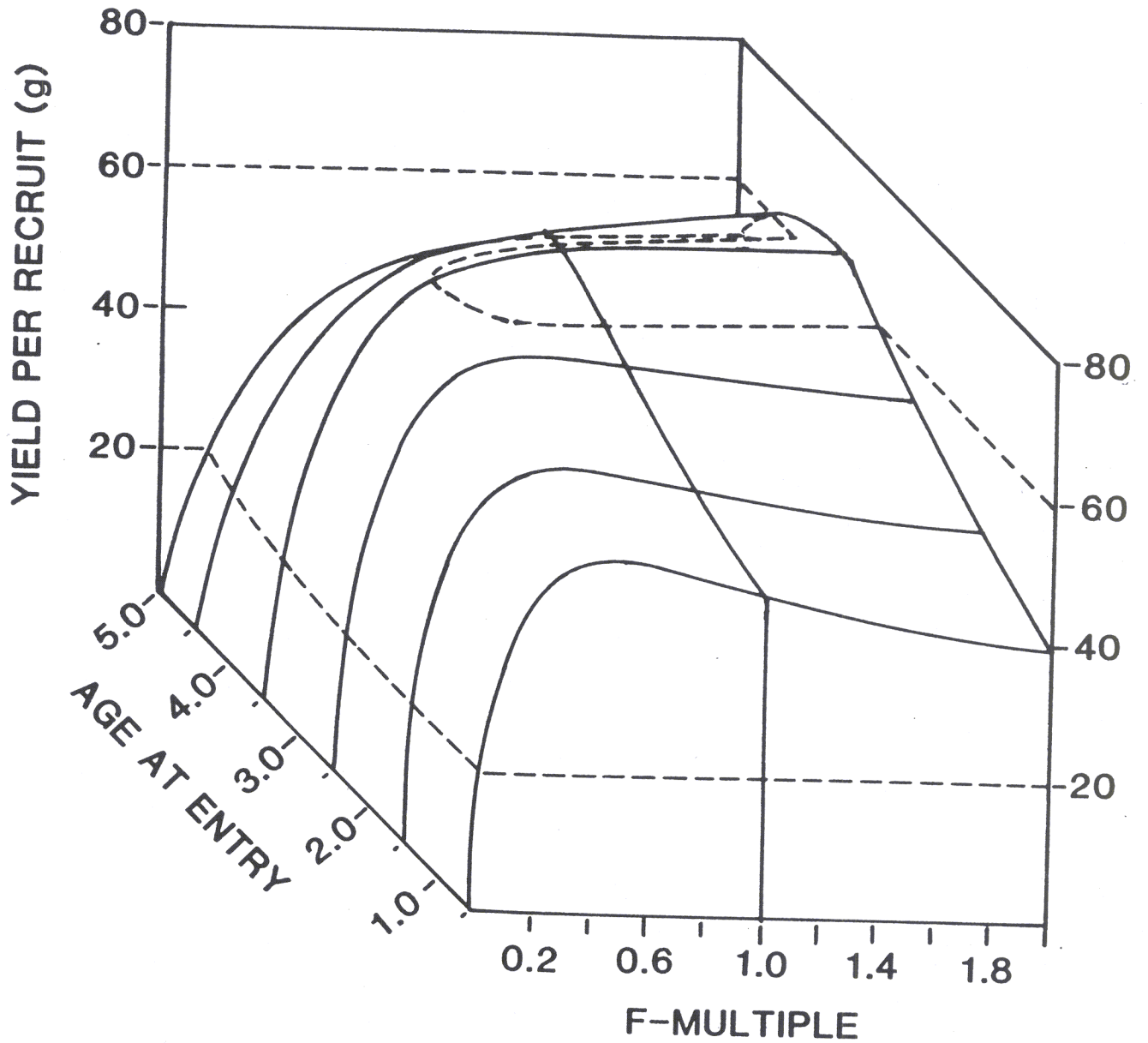


Figure 1.11. Overall yield-per-recruit of Atlantic menhaden under current conditions (F-multiple of 1.0 and age at entry of 0.5) using average fishing mortality values by quarter for the 1981 fishing season.

Table 1.6. Yield-per-recruit for the Atlantic menhaden fishery based on average fishing mortality (F-multiple = 1.0) for the 1976-1978, 1979, 1980, and 1981 fishing season at an array of ages at entry and F-multiples, expressed as percentages of current yield-per-recruit.

Age at Entry	Percent Y/R at F-multiple				
	0.2	0.6	1.0	1.4	1.8
1976-1978 Fishing Seasons					
3.0	-22	21	30	32	33
2.0	-12	16	15	13	12
1.0	-13	9	5	0	-4
0.5	-13	6	(58.62g)*	-6	-11
1979 Fishing Season					
3.0	-50	-7	8	14	18
2.0	-32	9	17	18	18
1.0	-31	6	11	10	8
0.5	-32	0	(53.04g)*	-5	-10
1980 Fishing Season					
3.0	-28	14	25	29	31
2.0	-17	13	14	13	12
1.0	-18	5	1	-4	-9
0.5	-18	4	(53.84g)*	-6	-10
1981 Fishing Season					
3.0	-2	36	41	41	41
2.0	-2	18	13	8	4
1.0	-2	15	9	3	0
0.5	-3	9	(45.95g)*	-7	-13

* Base value for calculation of percentage change.

Table 1.7. Percent change in yield-per-recruit by area and for the overall Atlantic menhaden fishery at ages of entry of 1.0, 1.5, and 2.0, compared with yield-per-recruit (g) under the current age at entry (0.5), at average fishing mortality rates for the 1976-1978, 1979, 1980, and 1981 fishing seasons. 20

Area	Age at Entry			
	0.5 Current (g)	1.0	1.5 Change (%)	2.0
1976-1978 Fishing Seasons				
North Atlantic	8.14	8	22	41
Middle Atlantic	8.53	8	21	36
Chesapeake Bay	26.57	8	12	11
South Atlantic	12.15	8	-10	-2
N.C. Fall Fishery	5.14	-26	-16	-47
Entire Fishery	58.62	5	10	15
1979 Fishing Season				
North Atlantic	9.23	20	25	48
Middle Atlantic	3.29	20	26	48
Chesapeake Bay	24.39	20	21	8
South Atlantic	8.29	20	14	33
N.C. Fall Fishery	6.90	-43	-40	-55
Entire Fishery	53.04	11	13	17
1980 Fishing Season				
North Atlantic	6.72	2	10	41
Middle Atlantic	2.08	1	11	40
Chesapeake Bay	33.51	2	6	10
South Atlantic	6.98	2	-10	8
N.C. Fall Fishery	5.04	-5	4	-4
Entire Fishery	53.84	1	5	14
1981 Fishing Season				
North Atlantic	7.72	17	23	44
Middle Atlantic	1.98	17	23	44
Chesapeake Bay	17.74	15	15	16
South Atlantic	11.95	16	4	9
N.C. Fall Fishery	9.28	-21	-17	-46
Entire Fishery	45.95	9	10	13

Table 4.1. Numbers of Atlantic menhaden processing plants, aircraft, vessels, hold capacity (standard fish) and other information for plants and vessels wholly dependent on the Atlantic menhaden fishery, 1972-1985 (one standard fish = 0.667 lb).

Year	Summer Fishery					Fall fishery				
	Number of plants	Number of aircraft	Number of vessels	Percent refri-gerated	Hold capacity	Number of vessels	Percent refri-gerated	Number of aircraft	Hold capacity	
					Total ('000)					Total ('000)
1972	7	23	35	29	29,085	15	40	15	14,285	952
1973	7	24	39	44	34,960	16	44	15	13,360	835
1974	7	26	41	49	38,160	18	39	16	13,710	762
1975	7	27	43	51	42,710	23	48	18	19,860	863
1976	7	26	41	56	40,560	20	60	17	18,260	913
1977	7	28	43	65	48,125	18	67	17	18,275	1015
1978	7	28	38	66	44,350	17	65	11	19,550	1150
1979	7	29	39	67	44,550	18	67	11	21,500	1194
1980	7	29	40	60	44,020	19	58	11	21,820	1148
1981	7	29	40	63	40,450	18	61	13	21,150	1175
1982	6	23	30	60	31,350	16	69	10	19,150	1197
1983	6	20	31	61	33,750	17	71	11	19,950	1174
1984	5	20	30	63	33,150	12	67	9	14,850	1238
1985	5	17	23	83	29,500	4	25	2	2,850	713

Table 4.2. Calculated processing capacity (MT) of eight reduction plants available during the 1985 purse seine fishery.

Hourly rate	Weekly rate ^{1/}	Season ^{2/}
361	21,660	541,500

¹ Weekly rate = 12 hours per day times 5 days

² Season = 25 weeks

Table 4.3. Distribution of menhaden reduction plants along the Atlantic coast in selected years, 1875-1985 (from Reintjes 1969, and NMFS records).

STATE	Y E A R																
	1875	1912	1929	1955	1965	1967	1970	1971	1972	1973	1974	1980	1981	1982	1983	1984	1985
ME ¹	22	1	-	2	-	-	-	-	-	-	-	2	2	2	2	1	1
MA ¹	4	-	-	2	-	-	1	1	1	1	1	1	1	1	1	1	1
RI ¹	13	-	-	1	-	-	1	1	1	1	-	-	-	-	-	-	-
CT	5	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
NY	26	5	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
NJ	5	5	3	3	2	2	1	1	1	1	1	1	1	-	-	-	-
DE	-	2	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
VA	4	19	12	6	7	7	4	3	3	2	2	2	2	2	2	2	2
NC	2	12	12	6	7	7	7	7	4	4	4	4	4	4	4	3	3
SC	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CA	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL	-	1	2	3	2	2	1	1	1	1	1	1	1	1	1	1	1
TOTAL	81	45	36	28	20	18	15	14	11	11	9	11	11	10	10	8	8

¹ Reduction plants located in ME, MA, RI and one in NC during 1970-1985 were not dependent solely on menhaden for raw material as were the other plants located in NJ, VA, NC, and FL. Thus, there were only seven full-time menhaden processing facilities on the Atlantic coast during 1973-81, six during 1982-83, and five during 1984-85.

² The Massachusetts plant did not process any menhaden in 1985. One North Carolina plant operated only during January 1985, the end of the 1984 season. Only two plants operated during the 1985 season in North Carolina.

Table 4.4. Atlantic menhaden catch (1000 MT) and percent by two principal landings areas,
1976-1985 seasons.

Area	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Mean
North of Cape Hatteras	271.7	259.1	245.5	260.1	312.5	237.7	293.1	318.9	238.6	287.7	272.5
	80%	76%	71%	69%	78%	62%	77%	74%	73%	94%	75%
South of Cape Hatteras (Including Fall Fishery)	68.8	82.0	98.5	115.6	89.0	143.6	89.3	99.7	87.7	19.0	89.3
	20%	24	29%	31%	22%	38%	23%	24%	27%	6%	25%
Total	340.5	341.1	344.0	375.7	401.5	381.3	382.4	418.6	326.3	306.7	361.8

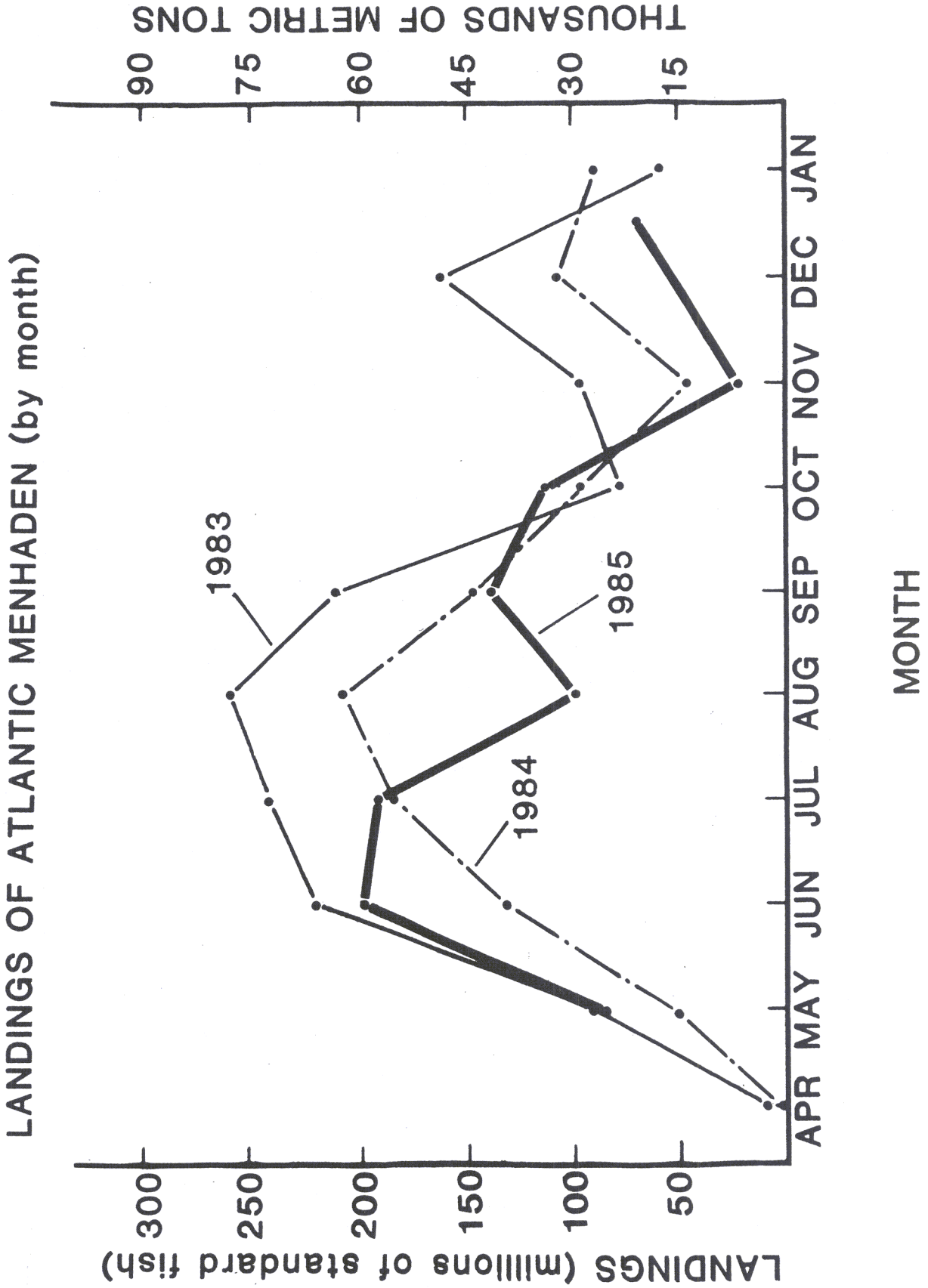


Figure 4.1. Monthly landings of Atlantic menhaden during the 1983-85 fishing seasons. December and January landings in 1985 were combined to maintain confidentiality.

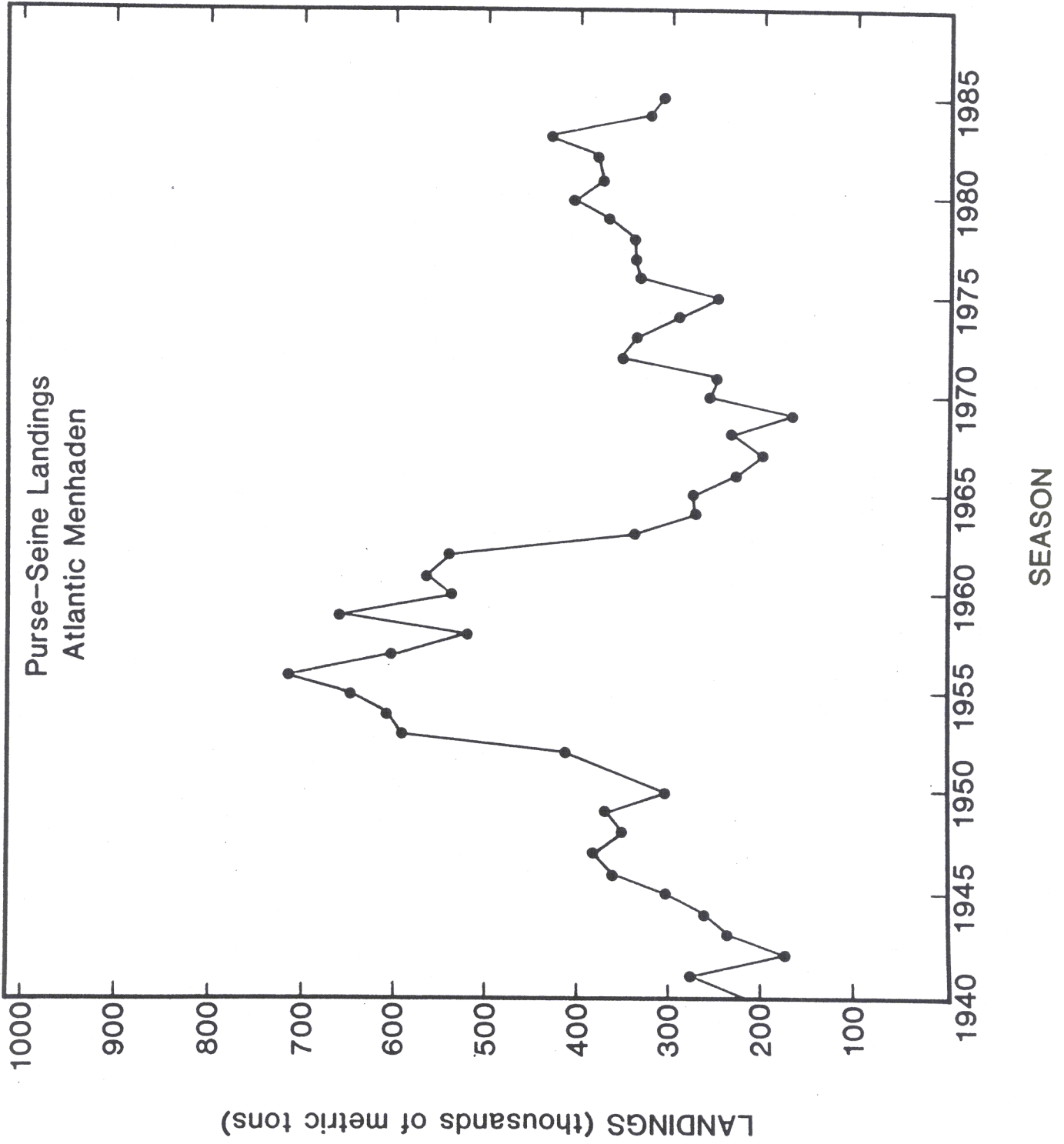


Figure 4.2. Atlantic menhaden purse-seine landings, 1940-1985.

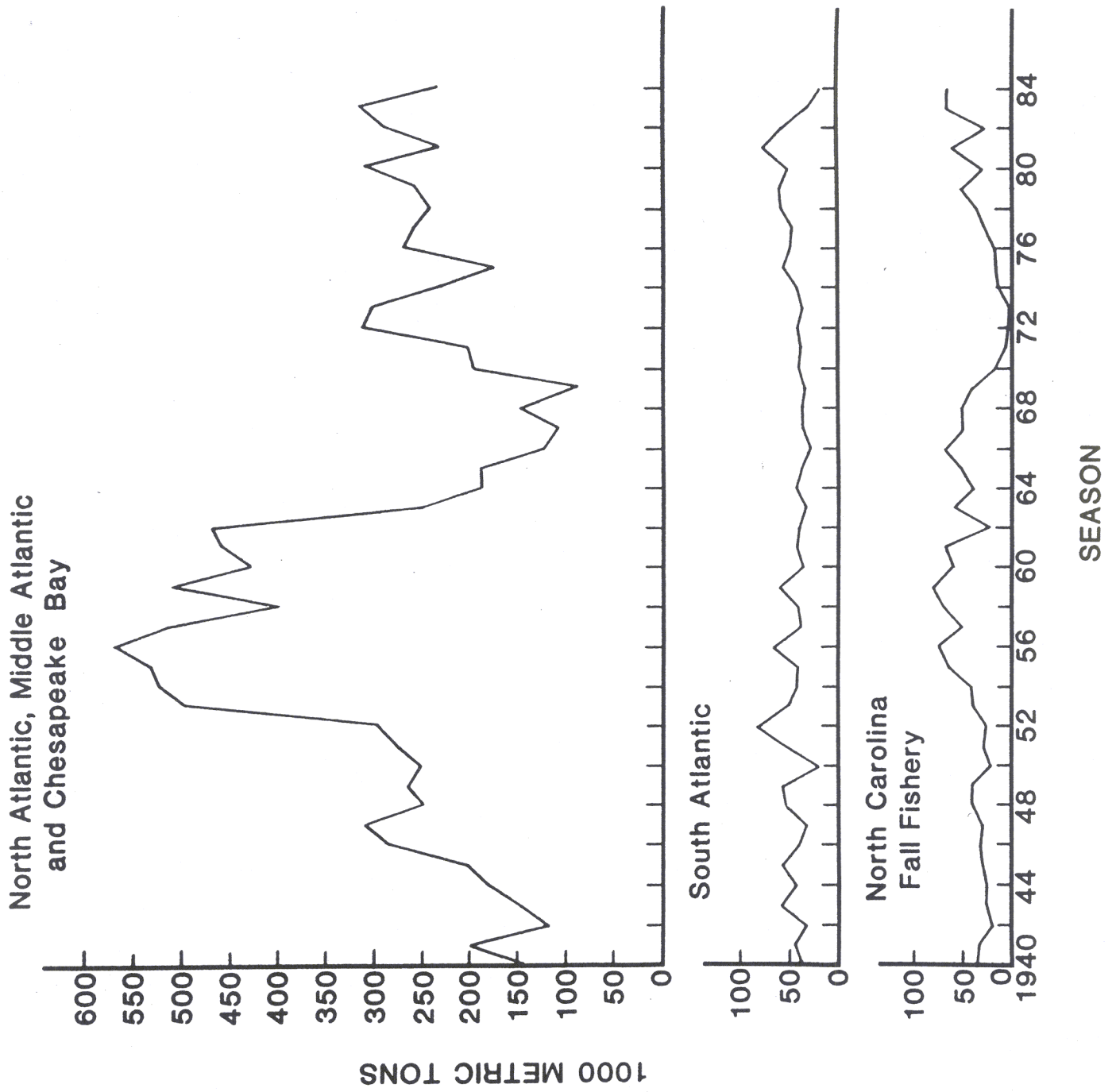


Figure 4.3. Atlantic menhaden purse-seine landings by area, 1940-1984 fishing seasons.

REGULATIONS AND LAWS

STATE DELEGATION OF AUTHORITY	LEGISLATIVE AUTHORIZATION	REGULATORY/ ADMINISTRATIVE AUTHORITY	LICENSES	OPEN SEASON	SPECIAL AREAS AND CONDITIONS	PENALTIES
MAINE Department of Marine Resources	Section 6171, Subsection 6191 and 6192	Commissioner may make regulations upon advice and consent of the advisory council. Method: time taken method, number taken, weight taken, length and location, when a condition endangering any marine species exists as determined by a hearing. In emergency, public hearing not required for 90 day rules.	None specifically for menhaden NRC - \$900 RC - \$ 53	No season except in special areas	Chapter 34 special Permit Casco Bay Damariscotta and Georges River--in certain areas. June 1 to Dec. 31. Boats transporting are limited to 30,590 lbs, 437 bushels, or 25 hogheads, must be measured, plainly marked and sealed by State sealer. 1) No setting of purse seine within 1500 ft. of any stop seine. 2) No setting of seine within 2000 ft. of the mouth of any weir. 3) No use of purse, drag of stop seine in ports of Kennebec, Sheepscot, Damariscotta, and St. Georges rivers.	Possible suspension of permit or where specific penalties are not provided. Fine - \$500 and/or jail for one year.
NEW HAMPSHIRE Fish and Game Department	R.S.A. 211.65 Division of Marine Fisheries created R.S.A. 206.1 Commission created R.S.A. 206.10 Powers and Duties of Director	The director may make rules and regulations. Methods: size, number, quantity, areas, and manner of their taking.	N.R. (for saltwater) by netting, dragging, or trawling is \$150 regardless of the size of boat or vessel	May 15 to October 10	Purse seines prohibited within 2 miles from shore.	General penalty misdemeanor

STATE DELEGATION OF AUTHORITY	LEGISLATIVE AUTHORIZATION	REGULATORY/ ADMINISTRATIVE AUTHORITY	LICENSES	OPEN SEASON	SPECIAL AREAS AND CONDITIONS	PENALTIES
MASSACHUSETTS Division of Marine Fisheries Marine Fisheries Advisory Commission	Mass. Ann. Laws 2.5, SA; Chapter 130	The Division may promulgate regulations with approval of Marine Advisory Commission. Method: taking fish, size, and seasons and hours, and opening and closing of areas.	Boats 100'- \$100; boats 60'- 99'- \$75; boats up to 59'- \$50. This permit is valid for taking, landing, and selling finfish, and may be endorsed for shellfish. A special permit (\$10) is required for regulated fisheries	No season	Special permits are issued for areas designated as a regulated fishery area or as an inshore permit area. Specific regulations may apply by individual area.	Violators are subject to fines of not less than \$10 - not more than \$1000, imprisonment not more than 1 month, or both
RHODE ISLAND Division of Fish and Wildlife	Title 20-1 General Laws of Rhode Island Title 42 Chapter 17	Marine Fisheries Council may promulgate regulations: Manner of taking fish, size of fish, seasons and hours, numbers and quantities and opening and closing of areas 1)c. Required to make monthly reports to Department 2) Equipment must be registered	Vessels to 50'- \$100. 50' to 99'- \$125. 99' or more \$10 per lineal foot	May 17 to October 4	Numerous areas within Narragansett Bay and Mt. Hope Bay are restricted if landings exceed 1,000,000 pounds per day	Fine up to \$500 and one year suspension of license. Fine of not less than \$500, no more than \$700 for violation of regulations 3
CONNECTICUT Department of Environmental Protection	C.G.S. Section 26.3	Commissioner is authorized to carry out administrative rather than management or protection of fishery resources.	Purse seine - \$500.	Third Monday in May through third Friday of October	Closed area: Buoy to buoy line from Byram River to Stonington. Sec. 26-1542	Fine up to and not exceeding \$500 or imprisoned not more than 50 days or both

STATE DELEGATION OF AUTHORITY	REGULATORY/ ADMINISTRATIVE AUTHORITY	LEGISLATIVE AUTHORIZATION	LICENSES	OPEN SEASON	SPECIAL AREAS AND CONDITIONS	PENALTIES
NEW YORK Department of Environmental Conservation	None specifically for menhaden; all rules are statutory	N.Y.E.C.L. Sections 13-0333, 13-0343	R.N.R. 30 gross tons (gt) or less - \$25; 30-100 gt - \$200 100-150 gt - \$500 150-200 gt - \$750 over 200 gt - \$1000 Licenses expire Dec. 31 following date of issue	Third Monday in May to third Friday in October	Buoy to buoy line in western half of Long Island Sound No fishing on weekends or legal holidays May 1 through September 15. All waters of New York Harbor and tributaries closed to all net fishing. Menhaden fishing prohibited within ½ mile of ocean beach from Rockaway Pt. to East Rockaway Inlet.	General civil penalty of \$60 plus \$25 per fish. Specific civil penalties of not less than \$250 nor more than \$1000 for each offense of Section 13-0333 General criminal penalty of fine up to \$250 and/or up to 15 days imprisonment
NEW JERSEY Division of Fish, Game and Wildlife	Division has the power to cooperate with other states, interstate and Federal departments and agencies to develop programs and policies for the conservation and protection of natural resources	New Jersey Stat. Ann. Title 23	R. 30-100 gt- \$125; 100-150 gt- \$250; 150-175 gt- \$400; 175-200 gt- \$550; 200 + gt - \$900; 20 tons or less used for taking menhaden for bait purposes only. N.R. 30-100 gt- \$ 450 100-150 gt- \$ 700 150-175 gt- \$1000 175-200 gt- \$1150 200 + gt - \$1500 Residents who lease vessels from out of state shall pay fees same as N.R.	Third Monday in May through third Friday in October	Fishing restricted to not closer than 0.6 nautical miles of the shore, jetties or fishing piers. No fishing on Saturdays, Sundays or legal holidays. Additional closures in Delaware Bay.	Violations are misdemeanors- \$1000 for each offense

STATE DELEGATION OF AUTHORITY	LEGISLATIVE AUTHORIZATION	REGULATORY/ ADMINISTRATIVE AUTHORITY	LICENSES	OPEN SEASON	SPECIAL AREAS AND CONDITIONS	PENALTIES
DELAWARE Division of Fish and Wildlife	Title 7, Section 903	Division has authority to protect, conserve and propagate the fisheries resources of State.	No license available	No open season	Menhaden purse seine fishing prohibited within 3 miles from shore	Violations are regarded as misdemeanors. \$500 - first offense; \$2500 - each offense thereafter.
MARYLAND Tidewater Administration	M.D. N.R. Section 1-101, 4-202	Regulations may include, but are not limited to, provisions enlarging, extending, restricting, or prohibiting the taking or catching of these resources	None issued for purse seines	No open season	Commercial menhaden fishery prohibited from use of purse seines in Maryland waters.	Violations are misdemeanors. Fine not less than \$100 nor more than \$1000; and shall stand committed to the Baltimore City Jail or to the County jail until such fines and costs are paid.
VIRGINIA Marine Resources Commission	Code of Virginia, Chapter 4, Fish and fishing generally, Sections 28.1-58 to 28.1-81.1. Specifically Chapter 4, Art. 2, Section 28.1-53 to 28.1-66 "fish for manufacture into fish meal, oil, etc."		Duration 1/1 to 12/31. R. A) (Sail vessel) purse nets of not more than 400 meshes deep \$21.50 B) (Sail vessel) more than 400 meshes - \$75 C) Power boat or steam vessel: under 100 gt - \$3/gt max. \$150. Over 100 gt - \$5/gt. max \$600. D) Power boat or steam vessel less than 20hp - \$37.50	Third Monday of May through third Friday of November	Selected smaller tributaries to Chesapeake Bay and major rivers are closed above designated lines. Mesh size not less than 1-3/4" stretched.	All violations are misdemeanors. Upon conviction shall be punished by a fine of not more than \$1000 or imprisonment for not more than 12 months, or both.

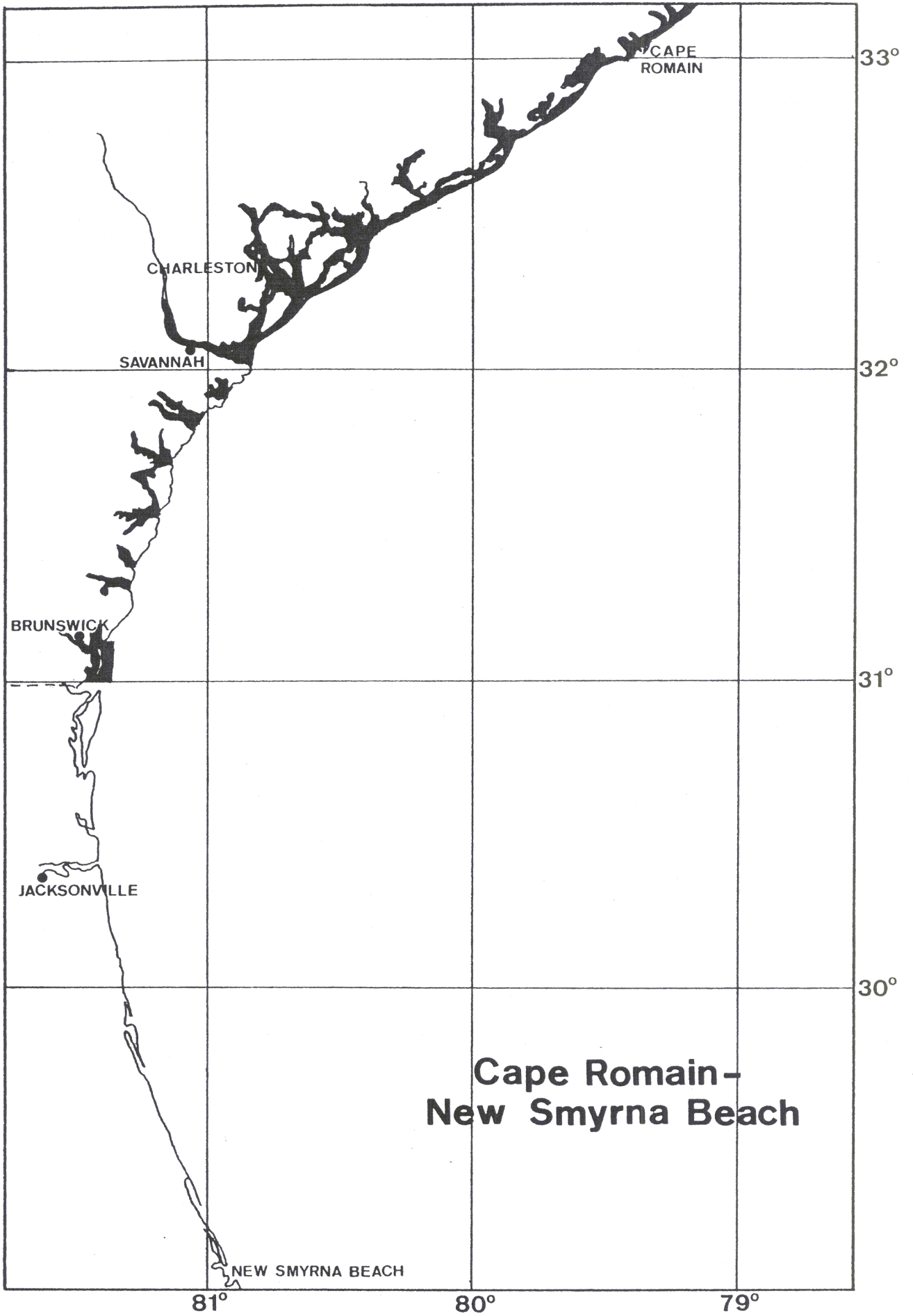
STATE DELEGATION OF AUTHORITY	LEGISLATIVE AUTHORIZATION	REGULATORY/ ADMINISTRATIVE AUTHORITY	LICENSES	OPEN SEASON	SPECIAL AREAS AND CONDITIONS	PENALTIES
NORTH CAROLINA	North Carolina General Statutes. See G.S. 113-152 113-156 113-163 113-182 113-185 113-186 143B-286	Marine Fisheries Commission power specifically includes the promulgation of rules and regulations implementing the provisions of Chapter 113 of the General Statutes. Commission can restrict gear, area, season, size and quantity and can delegate authority for management by Proclamation (Administrative order).	License must have name of man in command. Fees for mother ship are \$2.00 per ton, gt, customhouse measurements, and no license is required for a purse boat used in connection with a licensed mother ship. N.R. must pay \$200 in addition.	May 15 - January 15 within 1 mile of shore. Year 'round beyond 1 mile	Various estuarine and ocean areas restricted. Buying or selling menhaden for reduction must be done by a measure of 22,000 cubic inches for every 1,000 fish. Specific regulation prohibiting fishing applies to Wrightsville Beach. It is unlawful to fish in the ocean within 750 ft. of a marked oen pier. Purse seines for menhaden fishing shall not take foodfish in excess of 1 percent of the total amount of fish on board.	Violations of marine fisheries regulations is a misdemeanor punishable by a fine of not less than \$50 nor more than \$250 for the first offense and not less than \$100 nor more than \$500 for any offense thereafter or imprisonment for not more than 30 days, or both.
SOUTH CAROLINA Wildlife and Marine Resources Commission	S.C. Code Section 28	Statutory authority only	Required for each boat used. Fee based on net tonnage determined at \$1 per net ton for R and \$2 per net ton for NR. Individual license of \$4 for individual NR. Purse seines licensed at \$5 each.	No closed season	Purse seine fishing not allowed within 3 miles of beach from Little River to North Inlet. South of North Inlet, purse seine fishing restricted within 300 yd of ocean beach. Purse seine mesh must be at least 3/4 inch bar measured 1-1/2 inch diagonal.	Any person violating the provisions shall be guilty of a misdemeanor punishable as provided in paragraph 28-761 of South Carolina Title 28.

STATE DELEGATION OF AUTHORITY	LEGISLATIVE AUTHORIZATION	REGULATORY/ ADMINISTRATIVE AUTHORITY	LICENSES	OPEN SEASON	SPECIAL AREAS AND CONDITIONS	PENALTIES
GEORGIA Division of Coastal Resources	Official Code of Georgia, Section 27-4-14	Board of Natural Resources and Commissioner of Natural Resources may fix open and closed seasons for all wildlife regulating manner, method and devices of killing, taking, capturing and consuming wildlife, except as otherwise provided by law.	Personal- RC - \$2 NRC - \$5 Vessel - 50¢ per ft. over 18' or fraction thereof.	Set administratively by Commissioner of Dept. of Natural Resources	1,000 ft. restricted area from shore for Jekyll Island, St. Simons Island, Sea Island, Tybee Island. No purse seines inside rivers, creeks & sounds	Variable, civil or misdemeanor criminal prosecutions
FLORIDA All rules and regulations under the Florida Marine Fisheries Commission	Title 46	Marine Fisheries Commission	Purse seine - \$25 Non-resident - \$25 Purse boat - \$31 Carrier vessel - \$76 Dealer classification - \$10 Wholesale dealer: Resident - \$100 Non resident - \$150 Alien - \$500	No closed seasons	No menhaden by purse seine along designated areas of west coast. All fishing by nets (except small cast nets) prohibited in Broward County	Violations of Chapter 370 - not more than \$500 and/or imprisonment of 1 year. Other sections specify seizure of fishing gear, vessels, catch and vehicles.

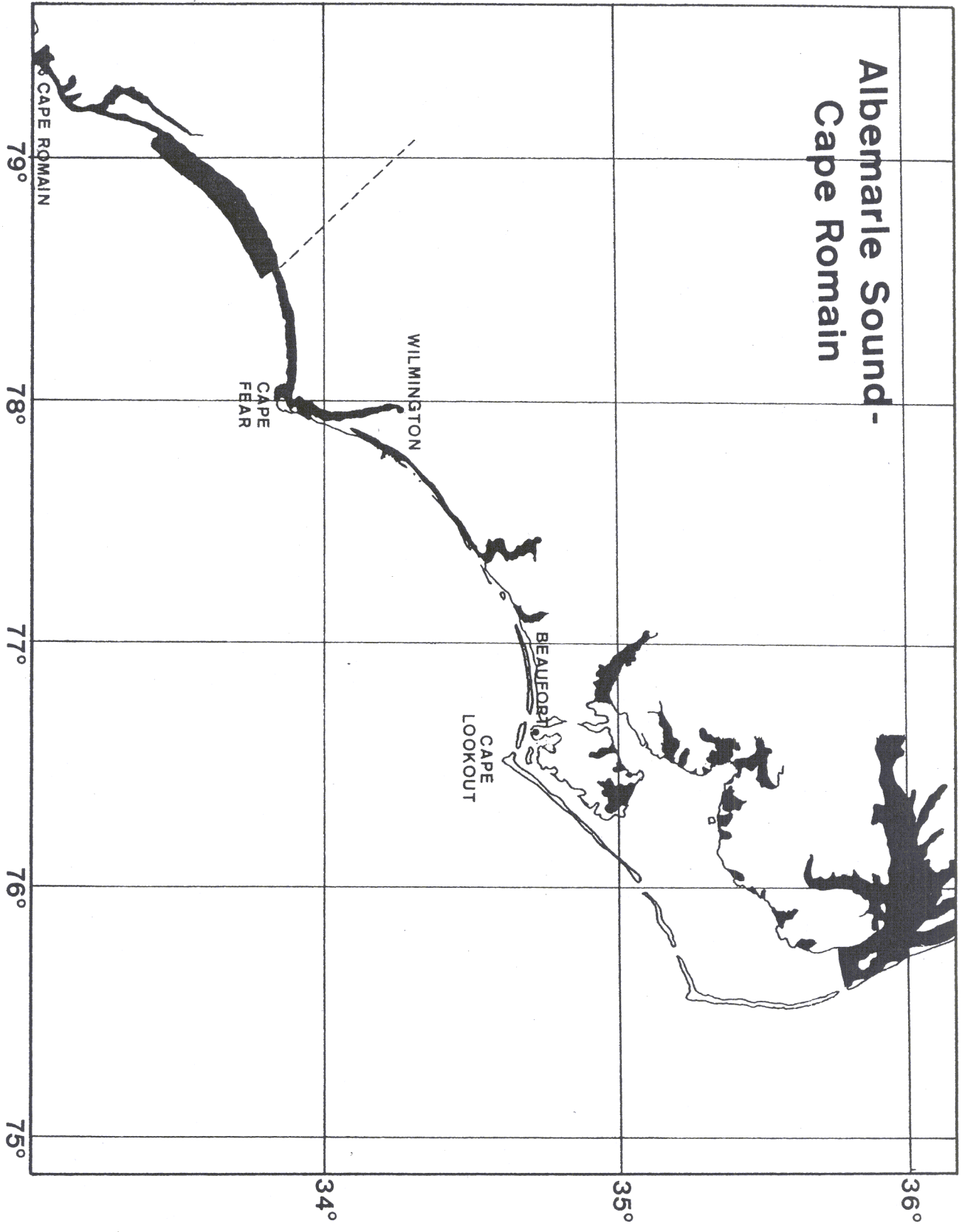
Terms used: NR = non resident
R = resident

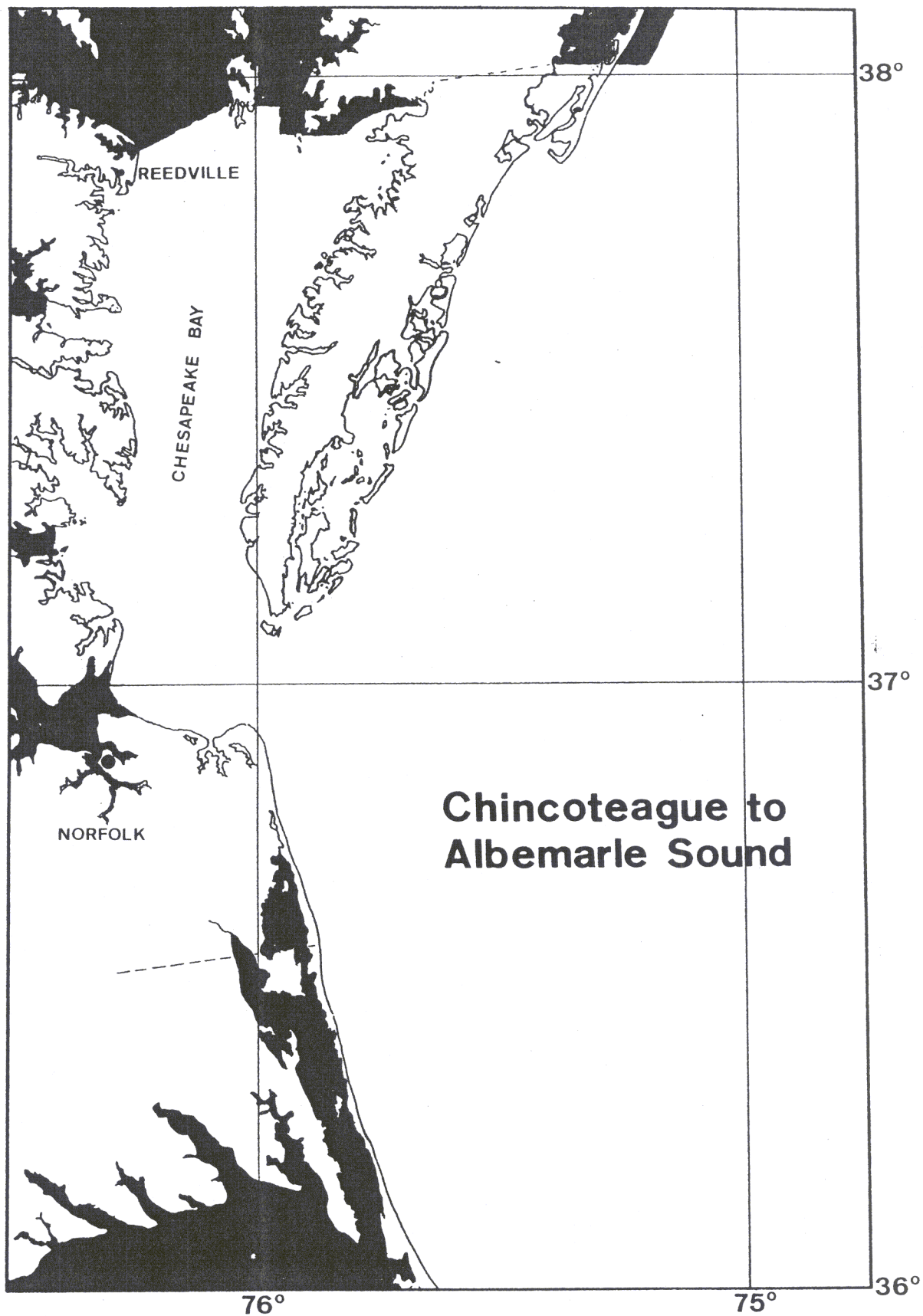
MAPS OF PROHIBITED AREAS

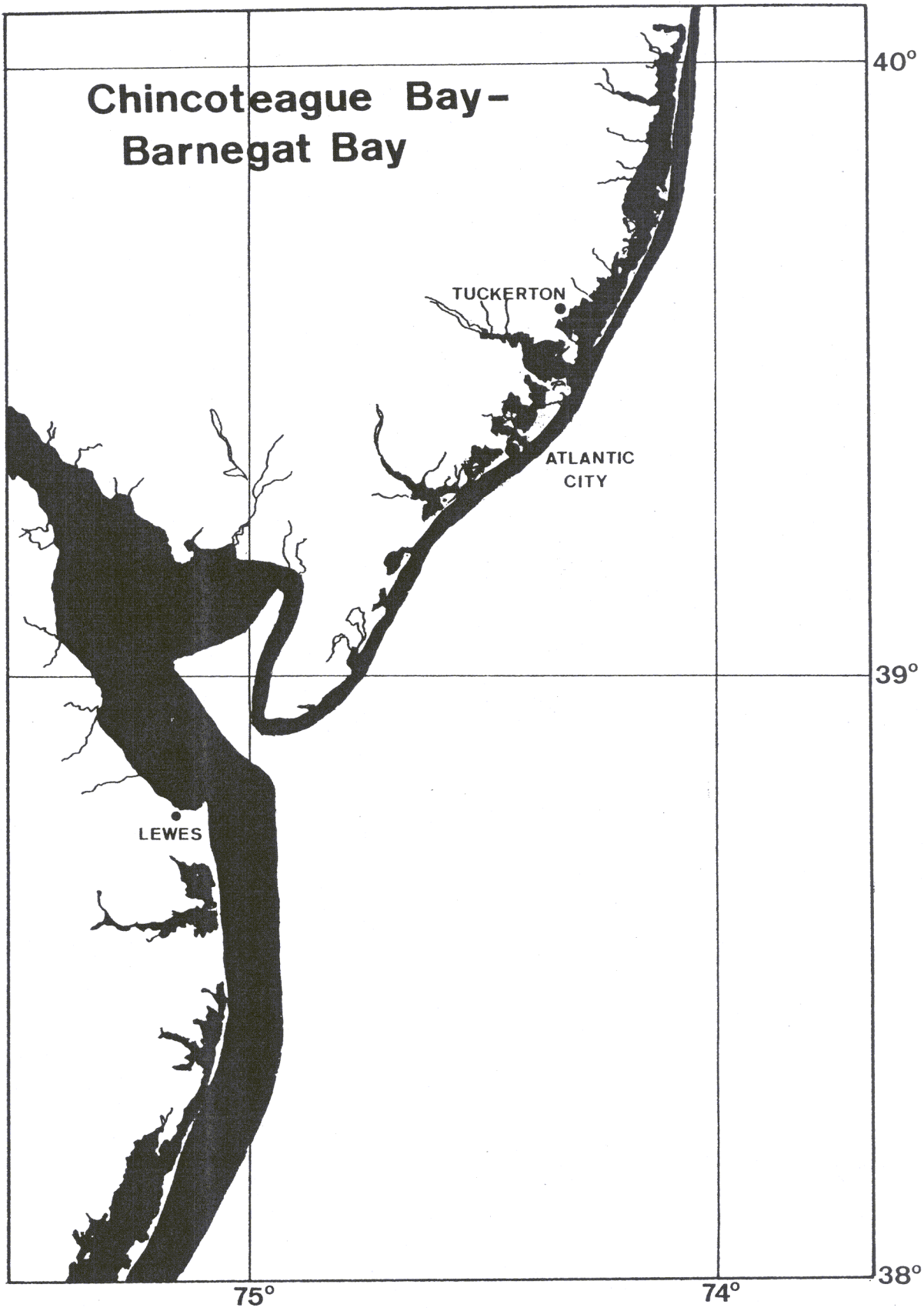
(Darkened areas on the following maps indicate those areas
in which menhaden purse seine fishing is prohibited)

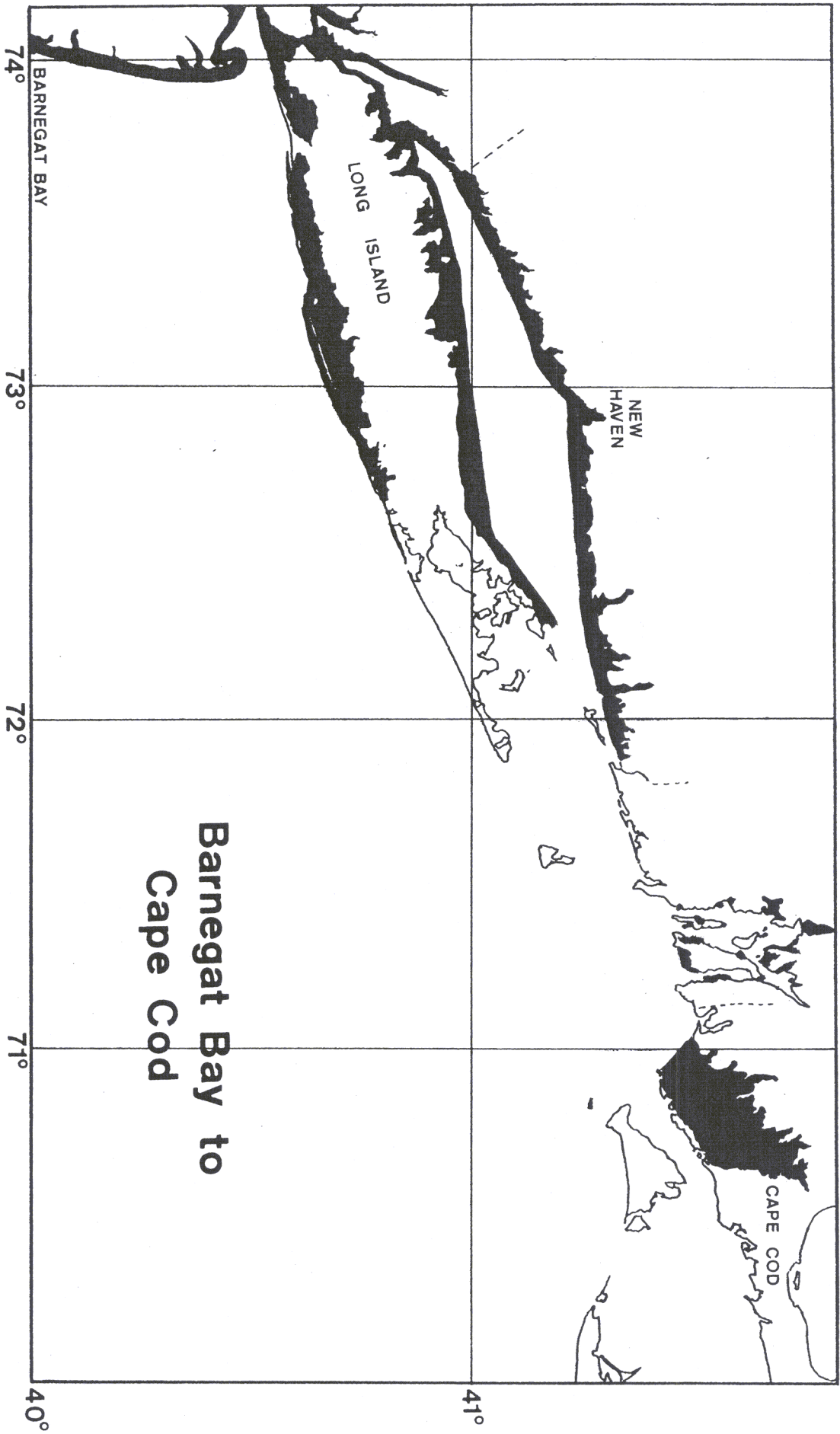


Cape Romain - New Smyrna Beach

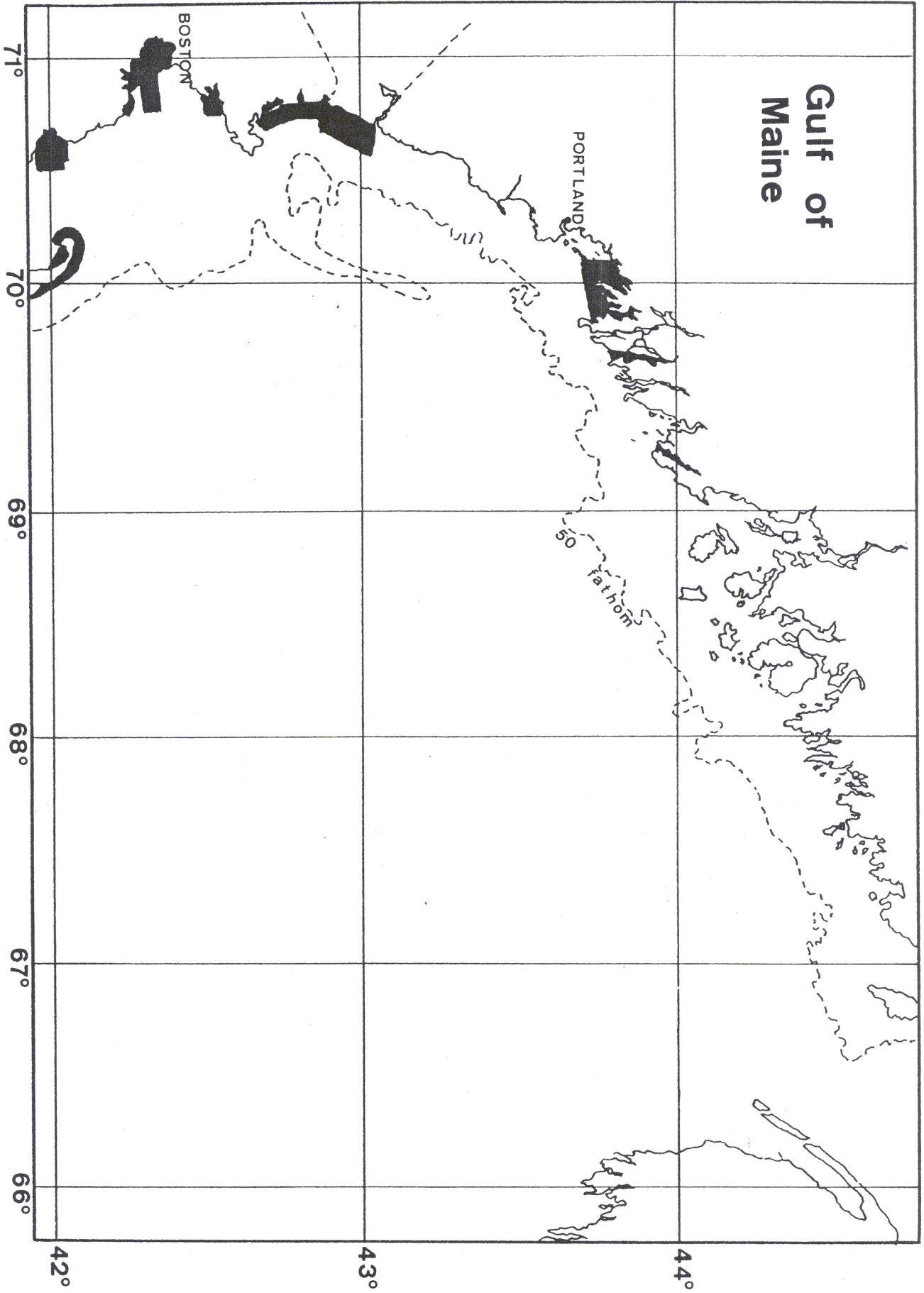








**Barnegat Bay to
Cape Cod**



A Stock Assessment of the
Atlantic Menhaden, Brevoortia tyrannus, Fishery

Douglas S. Vaughan and Joseph W. Smith

Executive Summary

A stock assessment of the Atlantic menhaden, Brevoortia tyrannus, fishery was conducted with purse-seine landings data from 1940-1984 and port sampling data from 1955-1984. Virtual population analysis was used to estimate stock size, year class size, and fishing mortality rates. These data were analyzed to determine growth rates, maximum sustainable yield (MSY), spawner-recruit relationships, and yield-per-recruit. A detailed study of the biological consequences of a shortened fishing season (Option 7) was made using a yield-per-recruit approach.

Landings and fishing effort rose from 1940 to highs during the 1950s. A rapid decline in landings during the 1960s, with a lagged decline in effort, was followed by a gradual rise in landings during the 1970s and early 1980s with little change in fishing effort. During the period studied, an average of 25% of age-1 fish and 65% of age-2 and older fish were taken by the fishery, while 30% and 20% respectively, were lost to natural causes annually.

Annual estimates of growth in fork length (mm) were determined for fishing years 1955-1984 based on the von Bertalanffy growth equation. Area-specific growth rates in length also were calculated for later use in the yield-per-recruit analyses. Weight (g) as a function of fork length was calculated annually for the fishing years 1970-1984, with the mean parameters giving the following relationship:

$$\ln W = -12.1 + 3.2 \ln L.$$

Trends in observed weight at age for the period 1970-1984 showed a decline. This is due in part to a shift of the center of fishing southward to smaller fish of the same age, and in part due to an inverse relationship noted between first year growth and year class size.

Surplus production models were employed to obtain estimates of maximum sustainable yield. Nominal fishing effort was adjusted to obtain effective fishing effort based on the pronounced inverse relationship between the catchability coefficient and population size. Estimates of MSY ranged from 450,000 to 490,000 metric tons (mt) depending on the underlying surplus production model used.

Recruitment to age-1 on March 1 ranged from 1.2 to 14.8 billion fish for year classes 1955-1981. Recruitment was generally high for the 1955-1958 year classes (averaging 7.7 billion age-1 recruits), followed by low recruitment for the 1959-1974 year classes (averaging 2.3 billion age-1 recruits), and high recruitment for the 1975-1981 year classes (averaging 5.7 billion age-1 recruits). The high average recruitment of the 1955-1958 year classes comes primarily from 14.8 billion recruits of the 1958 year class. Although Ricker spawner-recruit curves were found to be marginally significant for the Atlantic menhaden population, there was considerable scatter about fitted spawner-recruit curves due to environmental conditions. The continued dominance of late age-2 spawners within the spawning stock is of concern. A change from recent favorable environmental conditions could lead to several poor recruitment years and place the stock at risk.

Annual yield-per-recruit estimates were obtained for an array of fishing mortalities and ages at entry. For historical conditions (F-multiple of 1.0 and age at entry of 0.5 years), estimates of yield-per-recruit ranged from 45.95 g during the 1981 fishing year to 58.62 g during the 1976-78 fishing years. Increasing age at entry (at least to age-2) always would lead to an increase in yield-per-recruit. Increasing or decreasing the F-multiple (or rate of fishing) often would lead to a decrease in yield-per-recruit.

An analysis was conducted of the potential effect on yield by adoption of the Atlantic Menhaden Management Board (AMMB) recommended reduction of the fishing season by four weeks in each reporting area (Option 7). Opening and closing dates proposed for each area were:

<u>Reporting Area</u>	<u>Opening Period</u>	<u>Closing Period</u>
North Atlantic	05/17 - 05/23	10/04 - 10/10
Middle Atlantic	05/17 - 05/23	10/11 - 10/17
Chesapeake Bay	05/17 - 05/23	11/08 - 11/14
South Atlantic and North Carolina Fall Fishery	04/12 - 04/18	12/13 - 12/19

Six of the fifteen member states within the Atlantic States Marine Fisheries Commission (ASMFC) have adopted the shortened season option.

An updated yield-per-recruit analysis showed coastwide gains in yield-per-recruit that would have occurred if Option 7 had been in place (Table 1). The increased yield-per-recruit ranged between 10.2% for the 1979 fishing season and about 0.5% for the 1980 and 1981 fishing seasons. The 1976-78 fishing seasons produced an intermediate gain of 2.9%. Large numbers of age-0 fish were landed in both 1979 and 1981, but most of the age-0 fish landed in 1981 were landed before Option 7 would have closed the fishery. Few age-0 fish were landed during the 1980 fishing season.

Estimates of yield-per-recruit were also made with the assumption that greater numbers of age-0 fish were killed than were estimated from the landings (as by net escape or bias in calculating numbers at age for the fall fishery). If twice as many age-0 fish were killed in 1979 than were estimated in the 1979 landings, then the potential gain from Option 7 would be 19.1% (Table 1). If four times as many age-0 fish were killed, then the potential gain would be 33.8%. Conversely, for the 1980 and 1981 fishing season when few age-0 fish were caught after the closure dates and even with four times as many age-0 fish killed as estimated in the landings, the potential gain would only be between 1.0 and 1.8%.

The implication of these results for management is that there would be little gain to the stock for those fishing years when age-0 fish are landed in quantity prior to the proposed closing dates. In fishing years when the age-0 fish are not generally available until after the proposed closing dates, Option 7 would allow potentially large gains to accrue to the stock and to the fishing industry. Note that age-0 fish may contribute significantly to the landings in some years. Thus, a significant short term loss to the North Carolina Fall fishery may occur for those years when large numbers of age-0 fish would have been caught after the Option 7 closing dates.

Current levels of recruitment could have produced annual yields of Atlantic menhaden of approximately 470,000 mt since 1975 compared to an observed average of 356,000 mt, although yields averaging between 375,000 and 400,000 mt are more realistic. The modern fishery has a high dependency on pre-spawners (age-2 and younger fish), so large fluctuations in year-to-year availability and catches are to be

expected. To increase yield and enhance the stability of the resource, it is desirable that the number of age classes contributing significantly to the fishery be increased. This would create a buffer against future poor recruitment years, and dampen the year-to-year fluctuations in landings.

Table 1. Percent change in yield per recruit by fishing areas and for the entire Atlantic menhaden fishery for the 1976 through 1981 fishing years resulting if Option 7 had been in effect. The multiplicative factors, described in the text, increase the numbers of age-0 fish assumed caught or killed by the purse-seine fishery.

Fishing Area	Multiplicative Factor			
	1.0	1.5	2.0	4.0
1976-1978 Fishing Years				
North Atlantic	18.1	20.1	22.4	31.6
Middle Atlantic	2.5	4.4	6.4	14.4
Chesapeake Bay	5.2	7.3	9.3	17.5
South Atlantic	7.2	9.4	11.5	19.8
North Carolina Fall Fishery	-45.9	-46.3	-46.6	-47.5
SA + NCFE	-8.6	-8.9	-9.2	-10.2
Entire Fishery	2.9	4.0	5.1	9.5
1979 Fishing Year				
North Atlantic	23.0	32.8	42.7	81.9
Middle Atlantic	2.7	11.2	19.2	52.3
Chesapeake Bay	20.8	30.4	40.1	78.4
South Atlantic	21.2	30.8	40.6	78.7
NC Fall Fishery	-49.7	-55.7	-59.7	-67.3
SA + NCFE	-11.0	-13.4	-15.2	-19.7
Entire Fishery	10.2	14.8	19.1	33.8
1980 Fishing Year				
North Atlantic	-0.1	0.3	0.6	2.2
Middle Atlantic	6.7	7.3	7.8	9.1
Chesapeake Bay	1.9	2.3	2.6	4.0
South Atlantic	3.7	4.0	4.4	6.2
NC Fall Fishery	-20.4	-20.7	-21.1	-22.1
SA + NCFE	-6.4	-6.5	-6.7	-6.7
Entire Fishery	0.6	0.8	1.0	1.8
1981 Fishing Year				
North Atlantic	-0.1	0.3	0.4	1.7
Middle Atlantic	1.5	2.2	2.3	3.6
Chesapeake Bay	1.1	1.4	1.6	2.6
South Atlantic	1.2	1.5	1.7	2.7
NC Fall Fishery	-3.0	-2.9	-2.8	-2.7
SA + NCFE	-0.7	-0.6	-0.6	-0.5
Entire Fishery	0.4	0.5	0.6	1.0

EFFECTS OF MANAGEMENT ACTIONS

Management actions affecting Atlantic menhaden and its fishery originate from many directions. Such actions come from state legislatures, fisheries agencies, and environmental agencies and various federal agencies in response to economic conditions (local, national, international, recreational and coastal development conflicts and environmental conditions). The companies have responded in various ways to these forces.

The mission of the state and federal agencies is to define and protect public interests in the resource and habitat producing the resource. Public interest includes maintenance of the habitat and resource for long-term production and other uses and utilization of the habitat and resource for economic and social purposes. The public and private needs are dynamic, with continuing discussion and refinement of needs and actions. The goal of the cooperative state-federal-industry menhaden effort is to conduct a program for utilization of Atlantic menhaden that is biologically, economically and sociologically sound and which protects the resource and its users.

The Atlantic menhaden fishery management plan, as approved by the AMMB and the ASMFC in 1981, contains the long-term objective (p. 111) "Achieve the greatest continuing yield for each area by determining the age at which menhaden should be harvested and eliminating other restrictions which do not contribute to the management goals." Laws and regulations existing in 1981-82 are still in place and "new" ones have been enacted which conflict with the long-term objective, the Option 7 shortened season recommendation, and do not contribute to the ASMFC coastwide management plan for Atlantic menhaden.

The major state actions which go beyond the 1981 FMP and the Option 7 recommendation are area closures in New York, New Jersey, Delaware, and North Carolina. These closures, in conjunction with national and international economic factors, have seriously affected the viability of the Atlantic menhaden fishery in spite of improved stock conditions. Since 1981, plants have closed permanently in New Jersey and North Carolina. Another North Carolina plant did not fish during Fall, 1985. One of the two Virginia companies has stated that it may not participate in the Atlantic fishery in 1986. Recreational and coastal development

interests continue to press for additional restrictions beyond those of the AMMB or AMAC.

We emphasize that these restrictions, though frequently presented under the guise of conservation, have little relationship to actual stock condition as presented in the 1985 NMFS stock assessment report.

We strongly recommend that participating states take the steps necessary to assure that their regulations or laws are consistent with the management plan. We ask that the fishery directors of those states which have declared an interest in management of Atlantic menhaden provide the AMMB with a listing of the existing regulations and laws pertaining to Atlantic menhaden fishing within their jurisdictional area along with a statement on the rationale for each action. The AMMB/AMIS/AMAC should review that compilation and comment as appropriate. Also, we recommend that each state director refer any pending or future regulation or statute (bill) which bears upon the Atlantic menhaden fishery to the AMMB for comment. This procedure would use the ASMFC institutional framework, assure consistency in management measures among the coastal states, and try to reduce or eliminate those existing regulations and statutes which are not consistent with the plan and management actions approved by the ASMFC and AMMB.

APPENDIX A

SOCIOECONOMIC IMPACT STUDY

SOCIOECONOMIC IMPACT STUDY

With the assistance of Drs. James R. Waters (NMFS), Michael K. Orbach and Vito J. Blomo (both of East Carolina University) a draft Request for Proposal (RFP) has been prepared. We estimate a study of 12 to 18 months with cost not to exceed \$60,000. A study was conducted in North Carolina in 1983. A study is needed in all areas at the same time to produce a comparable database and estimate management impacts. Neither the state agencies nor NMFS can supply the data needed to update the socioeconomic database (1977-78 period) included in the 1981 FMP. The proposed study is necessary to update that database. The RFP follows.

REQUEST FOR PROPOSAL
FOR
A COASTWIDE STUDY OF THE SOCIO-ECONOMIC ASPECTS OF THE ATLANTIC MENHADEN
FISHERY, AND ANALYSIS OF THE SOCIO-ECONOMIC IMPACTS OF SELECTED PUBLIC
AND PRIVATE SECTOR MANAGEMENT DECISIONS AND ALTERNATIVES

I. Background and Need

The Atlantic menhaden fishery is the largest fishery on the Atlantic Coast. The combined fisheries for Atlantic and Gulf menhaden account for over 45% of the marine finfish and shellfish landings of the United States. The fishery is characterized by highly efficient harvest and processing procedures, with vessels, processing plants, and marketing under the control of vertically integrated companies. The major products, meal, oil, and solubles, are involved in national and international trade.

In 1981 the Atlantic States Marine Fisheries Commission (ASMFC) adopted a cooperative interstate fishery management plan (FMP) for the Atlantic fishery. No regulations were proposed, but several possible conservation approaches were discussed. In 1982, a specific measure was proposed and adopted by the ASMFC to reduce the traditional fishing season in all areas by approximately one month. This proposal became known as "Option 7" and has been implemented in six states. Further, the plan calls for elimination of rules contrary to its management goal.

During the 1981-1985 period conflicts occurred in several areas among various recreational concerns, coastal development and menhaden fishing. Resulting management restrictions and changing economic conditions during this period resulted in company decisions to close plants and reduce fleets. These changes have affected the menhaden work force which consists largely of minority persons.

At the same time the Atlantic menhaden stock has expanded from low points in the early and mid-1970s. Current stock size (in numbers of fish) is similar to that existing during the peak of the fishery (1953-1962).

Potential socioeconomic impacts of management alternatives and recent changes in industry conditions have been evaluated only in North Carolina. The actual changes in the total fishery, its work force, regulatory scheme, and economic condition have not been evaluated. The changes and impacts are believed to be significant.

State, federal and interstate fisheries management agencies and the industry have worked jointly since 1976 to foster management of the Atlantic menhaden fishery. This cooperative program has brought a number of regulatory and operational changes to the fishery. Other changes have also occurred because of economic and social conditions. For management decisions to properly balance the needs of the resource, the industry, the public, and the management agencies, the reasons for and effects of recent changes in the fishery must be identified and understood. The results of this study will provide the basis for that understanding.

II. Objectives of the Study

This study will have two general objectives:

- A. To compile socioeconomic data and information on the menhaden industry of the Atlantic coast of the U.S. for each year from 1977 through the current year, and to describe and document the trends in socioeconomic factors in the industry during this period;
- B. To assess the actual and potential socioeconomic impact of specific public and private sector management decisions and alternatives on the industry. For example, such decisions and alternatives could include regulations or new product forms.

III. Statement of Work

The contractor will compile and document the recent history, present status, and potential future socioeconomic condition of the Atlantic menhaden fishery in the following manner:

A. Establishment of baselines

The contractor shall compile and document the following categories of information on the socioeconomics of the Atlantic menhaden industry for each year from 1977 through the current year. All data and information shall be compiled for the entire Atlantic coast, and shall be broken down by state. It is recognized that breaking down this information by state involves matters of confidentiality. The

contracting agency will work closely with the contractor and the industry to achieve a mutually agreeable format for the collection and dissemination of this information. Because the regional and distributive impacts of management decisions and alternatives are of paramount importance to this study, breakdowns by state are necessary.

A.1. Economics

A.1.1. Catch and Landings

A.1.2. Value

- a. Value by product type
- b. Value by age/size of fish
- c. Total value based on retail value of products
- d. Assessment of measure of value used by NMFS

A.1.3. Industry structure and organization

- a. Number, location and size of firms
- b. Industry capitalization and investment patterns

A.1.4. Products flow and market interactions

- a. Traditional products and markets
- b. Potential products and markets
- c. Competing products

A.1.5. Profitability

- a. Harvesting and processing costs
- b. Important sources of cost and revenue changes
- c. Rate of return on investment

A.2. Sociology

A.2.1. Employment

- a. Total employment by category
- b. Total employment and income by job classification
- c. Annual rounds of remunerative activities

A.2.2. Labor force and fishing community characteristics

- a. Demographic data
- b. Occupational alternatives
- c. Community structure

A.2.3. Labor migration patterns

- A.2.4. Local and regional demographic data
 - a. Income distributions
 - b. Unemployment rates
 - c. Job opportunities
- A.3. This should be a listing of the actions taken by the menhaden companies and management agencies and other events and circumstances that affected the menhaden industry during the period between the two baselines.
- B. Analysis of the trends in A.1 and A.2 between the baseline periods
- C. Impact analysis

This task would involve specific analysis of the effects of items listed in (A.3) and (B) on the socioeconomic factors outlined in (A.1) and (A.2), including:

 - C.1 Impact of past public and private sector management actions
 - C.1.1 Plant closures and effort reductions or shifts
 - C.1.2. Market changes
 - C.1.3. Public sector management actions
 - C.2. Potential impacts of management alternatives
 - C.2.1 Option seven of the ASMFC menhaden plan
 - C.2.2 Other alternatives (to be specified after contractor consultations with AMAC).
 - C.3 Potential impacts of new industry options (to be specified after contractor consultations with AMAC).

Work on the program will be closely coordinated with the Atlantic States Marine Fisheries Commission's Atlantic Menhaden Advisory Committee (AMAC). During the period of this contract, the contractor will be required to meet periodically with AMAC, as part of the project, to review the direction and progress of the research. Quarterly progress reports will also be submitted to AMAC for review and comment. The AMAC will review research proposals and recommend the contractor in conjunction with the funding agency.

IV. Proposals will be evaluated on the following points, weighted as noted:

Weight

- | | |
|-----|--|
| 60% | A. Proposed research and analytical methods and how they are to be applied to achieve the project objectives |
| 20% | B. Applicability of the applicant's background to the research problem |
| 10% | C. Qualifications of the applicant's organization to support the proposed research |
| 10% | D. Cost, not to exceed \$60,000 |

Project duration is estimated at 12-18 months.

APPENDIX B

ULCERATIVE MYCOSIS STATUS AND RESEARCH

ULCERATIVE MYCOSIS DISEASE

Atlantic menhaden and several other estuarine fishes at multiple sites along the Atlantic coast have exhibited deep lesions on the flank, caudal peduncle, head and vent areas. Menhaden have been the species most frequently noted; some others include weakfish, summer flounder, silver perch, gizzard shad, mullet, and spot. Infected young-of-the-year menhaden (1984 and 1985 year-classes) collected in 1984-5 in the Pamlico River (NC), St. Johns River (FL), Charleston SC area, Chesapeake Bay tributaries (VA and MD) and Delaware Bay tributaries (DE and NJ) have been examined by pathologists from the Florida Department of Natural Resources, North Carolina State University Veterinary School, Virginia Institute of Marine Science, and NMFS-Oxford laboratory. The lesions are believed to be caused by or associated with oomycete fungi (genus Aphanomyce). It is not known whether these outbreaks of lesions are rare events, epidemic cases of disease or symptoms of environmentally stressed estuaries.

Menhaden sampled from purse-seine landings during the 1984 North Carolina fall fishery revealed only a few specimens with lesions (62 out of 3,394 fish sampled, or 1.6% during January 8-16, 1985). Effects (if any) of the disease on the size of the 1984 year class would first be seen during the 1986 season, since this is their first year of full recruitment to the fishery. In the summer and fall of 1985 the incidence of lesioned menhaden was low in North Carolina, Virginia, and Florida streams where the disease had flourished earlier. Reports of high incidence of ulcers on Atlantic menhaden in 1985 were limited to two tributaries of Delaware Bay and one river in the Maryland portion of Chesapeake Bay. Individual state's projects are monitoring estuarine fish populations and will track incidence of diseased and lesioned fishes coastwide. Beaufort laboratory staff will continue to sample purse-seine catches throughout the range of the fishery, conduct sampling surveys for juvenile abundance, and engage in a coastwide tagging program each fall. They will examine sampled fishes for the presence of lesions and evidence of old lesions (healed). Results will be reported to AMAC, AMMB, industry and individual states.

A technical committee (with members from NMFS, NC, VA, FL and the Fish and Wildlife Service) has been formed to coordinate research and distribute results. Field and laboratory research focus on geographic and temporal incidence of the disease, descriptive pathology, identification of causative organism(s) and epidemiology. Projects in North Carolina, Virginia, and Florida are underway in 1986. A summary of research by Dr. E. J. Noga (North Carolina State University) and others follows.

Ulcerative Mycosis of Atlantic Menhaden: Biology,
Epidemiology and Pathogenesis

by

Edward J. Noga¹, Michael J. Dykstra¹, Jay F. Levine¹,
Jess H. Hawkins², and David W. Moye¹

Ulcerative mycosis (UM) is a skin disease primarily affecting Atlantic menhaden (Brevoortia tyrannus) that was first recognized as a serious disease problem in 1984. First observed in the Pamlico River in North Carolina, it was soon also reported from other North Carolina estuarine systems including the New River, Neuse River, and Albemarle Sound. Investigations in other states, including Delaware, Maryland, Virginia and Florida have reported fish having similar ulcers. Our examination of tissues from these areas lead us to believe that a similar disease is occurring in these areas.

Since 1984, UM has continued to cause repeated outbreaks along the eastern seaboard of the United States that in some instances has resulted in up to 90% infection rates in randomly sampled populations of Atlantic menhaden. The highest prevalence rates for UM are seen in low to moderate salinities within the Pamlico River. Many fish that inhabit this ecological zone appear susceptible to UM. We have observed the disease on southern flounder (Paralichthys lethgostigma), gizzard shad (Dorosoma cepedianum), striped bass (Morone saxatilis), weakfish (Cynoscion regalis), silver perch (Bairdiella chrysura), spot (Leiostomus xanthurus) and hogchoker (Trinectes maculatus).

Ulcerative mycosis has several characteristic features that help to distinguish it from other diseases that cause sores on fish. First and most obvious is the very deep penetrating lesions caused by this disease. These lesions are so aggressive that they commonly penetrate through the body wall, exposing the internal organs. When the dead

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tissue sloughs, it leaves a crater-shaped lesion that appears as if a bite had been taken out of the fish. Such lesions had been previously attributed to bites from predaceous fish. Usually only one lesion is found on a fish.

The lesions in menhaden are caused by infection with water molds of the genus Aphanomyces. Another water mold, Saprolegnia, has been isolated from lesions in other species. Studies are currently underway to determine the genetic similarities of the Aphanomyces isolates to one another. These fungi have never been previously known to cause disease in any estuarine species. The water molds or Oomycetes are common freshwater inhabitants that usually cause a fuzzy cotton-ball type of growth on the skin of freshwater fishes. Such lesions do not penetrate deeply into the body as is the case for ulcerative mycosis. The host's response to UM is also unusually severe for a water mold infection but may reflect the fact that the fungus aggressively grows into the tissue. We have also found that our Aphanomyces isolate is stimulated by low concentrations of salt. The water molds affecting fish are normally inhibited by any salt. This salt tolerance correlates with the ecological range of UM and may also explain why this fungus can penetrate deep into fish's tissue, which has a relatively high salt concentration.

Bacteria do not appear to be important in initiating UM lesions, but a number of different types of bacteria are commonly present in the larger sores and may contribute to the death of the fish. However, no predominant bacterial species has been consistently isolated from UM lesions of any stage, indicating that these organisms are opportunistic secondary invaders.

While these Oomycete fungi appear to be the primary infectious pathogen associated with these lesions, further studies are needed to confirm this hypothesis. In cooperation with the National Marine Fisheries Service Laboratory, Beaufort, NC and the North Carolina Sea Grant Aquaculture Facility, Aurora, NC, we have initiated studies to determine if our fungal isolates can reproduce the disease in menhaden and how stress may influence the development of the disease. Stress may be extremely important in initiating these lesions since fungi, in general, do not cause disease in healthy hosts but can rapidly take

advantage of an individual with compromised immunity. Our laboratory studies are being performed in conjunction with a field survey that is being used to pinpoint areas in the Pamlico River that are at high risk for fish developing UM.

There remain many important questions about ulcerative mycosis, but hopefully finding answers to them will help us to understand the cause of this and other disease problems in our fisheries.

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