SEABROOK ENVIRONMENTAL STUDIES 1978
FINFISH ECOLOGY INVESTIGATIONS IN HAMPTON-SEABROOK ESTUARY AND ADJOINING COASTAL WATERS
TECHNICAL REPORT X-4

Prepared for

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TABLE OF CONTENTS

PAGE

1.0 INTRODUCTION. 1

2.0 METHODS 3

2.1 OFFSHORE SAMPLING. 3

2.1.1 Otter Trawls. 3

2.1.2 Gill Nets 3

2.2 ESTUARINE SAMPLING 3

2.2.1 Beach Seining 3

2.3 CUNNER (*TAUTOGOLABRUS ADSPERSUS*) 6

2.4 ALEWIFE (*ALOSA PSEUDOHARENGUS*) 6

2.5 ICHTHYOPLANKTON. 6

2.6 DATA COMPILATION 7

2.6.1 Otter Trawls. 7

2.6.2 Gill Nets 7

2.6.3 Beach Seines. 8

2.6.4 Cunner Age and Growth 8

2.6.4.1 Back-calculation of Length at Age. . . 8

2.6.4.2 Length-Weight. 9

2.6.4.3 Standard to Total Length Conversion. . 9

2.6.5 Ichthyoplankton 9

3.0 RESULTS 11

3.1 OTTER TRAWLS 11

3.2 GILL NETS. 16

3.3 BEACH SEINE. 16

3.4 CUNNER AGE AND GROWTH. 16

3.4.1 Length and Weight at Capture. 16

3.4.2 Length-Weight Relationships 21

PAGE

3.4.3 Growth/Body-Scale Relationships. 21
3.4.4 Sex Ratio. 23
3.5 ALEWIFE SURVEY. 24
3.6 ICHTHYOPLANKTON 24
3.6.1 Spatial Trends 24
3.6.2 Temporal Distribution. 28

4.0 DISCUSSION 34

4.1 JUVENILE AND ADULT FISH 34
4.1.1 Ground Fish. 34
4.1.2 Pelagic Species. 39
4.1.3 Estuarine Species. 45
4.1.4 Indicator Species. 52
4.2 ICHTHYOPLANKTON 59
4.3 IMPACT OF CONSTRUCTION. 65

5.0 SUMMARY. 68

5.1 OTTER TRAWLS. 68
5.2 GILL NETS 68
5.3 BEACH SEINE 68
5.4 ICHTHYOPLANKTON 68

6.0 LITERATURE CITED 70

7.0 APPENDICES 73

LIST OF FIGURES

PAGE

2.1-1. Finfish sampling stations, 1978. 4

3.6-1. Abundance and percent composition of fish eggs in ichthyoplankton collections from the Hampton-Seabrook region, July 1976 through December 1978 30

3.6-2. Abundance and percent composition of fish larvae in ichthyoplankton collections from the Hampton-Seabrook region, July 1976 through December 1978 33

4.1-1. Total monthly catch of hake, *Urophycis* spp., in otter trawls and gill nets from 1975 through 1978. . . . 36

4.1-2. Total monthly catch of silver hake, *Merluccius bilinearis*, in otter trawls and gill nets from 1975 through 1978. 36

4.1-3. Total monthly catch of yellowtail flounder, *Limanda ferruginea*, in otter trawls from 1975 through 1978 . . . 38

4.1-4. Total monthly catch of Atlantic cod, *Gadus morhua*, in otter trawls and gill nets from 1975 through 1978 38

4.1-5. Total monthly catch of Atlantic herring, *Clupea harengus*, in gill nets from 1975 through 1978. 42

4.1-6. Total monthly catch of Atlantic mackerel, *Scomber scombrus*, in gill nets from 1975 through 1978. 42

4.1-7. Total monthly catch of river herring, *Alosa pseudoharengus* and *A. aestivalis*, in otter trawls, gill nets and beach seines from 1975 through 1978 44

4.1-8. Total monthly catch of Atlantic silversides, *Menidia menidia*, in otter trawls and beach seines from 1975 through 1978 44

4.1-9. Total monthly catch of American sand lance, *Ammodytes* [illegible], in otter trawls and beach seines from 1975 through 1978 49

4.1-10. Total monthly catch of killifish, *Fundulus* spp., in beach seines from 1975 through 1978. 49

PAGE

4.1-11. Total monthly catch of winter flounder, *Pseudopleuronectes americanus*, in otter trawls and beach seines from 1975 through 1978. 50

4.1-12. Total monthly catch of rainbow smelt, *Osmerus mordax*, in otter trawls, gill nets and beach seines from 1975 through 1978. 50

4.1-13. Total monthly catch of Atlantic menhaden, *Brevoortia tyrannus*, in gill nets from 1975 through 1978 55

4.1-14. Total monthly catch of pollock, *Pollachius virens* in otter trawls and gill nets from 1975 through 1978 55

4.2-1. Mean abundance[a] of selected species of fish eggs by transect[b], 1976-1978. 62

4.2-2. Mean abundance[a] of selected species of fish larvae by transect[b], 1976-1978. 64

PAGE

3.6-3. SUMMARY OF STRUCTURAL IMPORTANCE ANALYSIS OF THE FIVE DOMINANT FISH EGGS AND LARVAE IN COASTAL NEW HAMPSHIRE WATERS, 1976-1978. 29

3.6-4. TEMPORAL DISTRIBUTION OF ICHTHYOPLANKTON SPECIES RICHNESS IN COASTAL NEW HAMPSHIRE WATERS 31

4.1-1. CATCH PER UNIT OF OTTER TRAWL EFFORT FOR SIX FINFISH SPECIES COLLECTED DURING 1976, 1977 and 1978 35

4.1-2. CATCH PER UNIT OF GILL NET EFFORT (C/E = 3-DAY SET) FOR FIVE FINFISH SPECIES COLLECTED DURING 1976, 1977 AND 1978 41

4.1-3. CATCH PER UNIT OF SEINING EFFORT (TWO HAULS) FOR FIVE FINFISH SPECIES COLLECTED DURING 1976, 1977 AND 1978 . . 46

4.1-4. SUMMARY OF BIOLOGICAL INDEX VALUES FOR DOMINANT FISH SPECIES COLLECTED IN SEINED, 1976-1978 47

4.1-5. TEMPORAL AND SPATIAL ABUNDANCE OF INDICATOR FINFISH SPECIES WITHIN THE HAMPTON-SEABROOK REGION 53

4.1-6. MEAN TOTAL LENGTH (mm) AT CAPTURE FOR CUNNER, *TAUTOGOLABRUS ADSPERSUS*, FROM FOUR LOCATIONS 58

4.1-7. BACK-CALCULATED TOTAL LENGTHS AT ANNULUS FORMATION FOR CUNNER, *TAUTOGOLABRUS ADSPERSUS*, FROM THREE LOCATIONS. 60

4.3-1. WATER QUALITY OF THE SEABROOK WASTEWATER SETTLING POND DURING 1978 66

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1.0 INTRODUCTION

The study of finfish in the Hampton-Seabrook nearshore region and estuary by Normandeau Associates, Inc. began in 1969 with a survey of estuarine fish populations (NAI, 1971). A study of fish eggs and larvae in the estuary was completed in 1971 (NAI, 1972); a third study (NAI, 1973) provided information on adult and larval fishes both in the estuary and offshore. An intensive study of the eggs, larvae and adult finfish utilizing the nearshore region was initiated in 1973 (NAI, 1974). This program has continued with the collection of information concerning distribution and abundance of fishes utilizing the Hampton-Seabrook nearshore region and estuary (NAI, 1975, 1976, 1977). A review of the literature through 1977 pertinent to life history and abundance of New Hampshire coastal marine fishes was also presented in those reports. Since that review additional information has been published on the biology of winter flounder (Howe *et al.*, 1976; Pierce and Howe, 1977), Atlantic herring (Messieh, 1976), blueback herring (Loesch and Lund, 1977) and Atlantic silverside (Conover and Ross, 1978).

The purpose of the present study is to expand the historical data base characterizing the temporal and spatial distribution of finfish that utilize the Hampton-Seabrook nearshore region and estuary. Special programs, such as age and growth of a resident benthic species (*Tautogolabrus adspersus*) and spawning run identification of a local anadromous species (*Alosa pseudoharengus*) were also continued. This report presents information collected during the third year (1978) of preoperational monitoring for Seabrook Station and compares these data and conclusions with those from the previous years (1975 through 1977).

Among-year comparisons of larval, juvenile and adult fish relative abundance and spatial and temporal occurrence within the estuary and nearshore waters are discussed.

2.0 METHODS

2.1 OFFSHORE SAMPLING

2.1.1 Otter Trawls

The inshore groundfish community was sampled monthly by trawling at night along Transects 1, 2 and 3 (Figure 2.1-1) with a 9.2 m shrimp trawl (3.8 cm nylon mesh body; 1.3 cm mesh cod end liner). Four replicates were taken at each transect. The net was towed at approximately 2 kn (engine operating at 900 rpm) for 10 minutes, with successive tows taken in opposite directions. Transects 1 and 3 were located in deeper water than Transect 2 (Table 2.1-1).

2.1.2 Gill Nets

Gill nets were set for three consecutive 24-hr periods per month at three stations (Figure 2.1-1). Two net arrays, each consisting of a surface and bottom net, were set at each station, one parallel to and one perpendicular to the isobath (Figure 2.1-1). The nets were positioned on permanent buoys and tended daily by SCUBA divers. Stations A and B are situated over soft substrate, while C is located over rocky substrate (Table 2.1-1).

2.2 ESTUARINE SAMPLING

2.2.1 Beach Seining

Seine samples were taken biweekly from April to November at Stations S1, S2 and S3 (Figure 2.1-1; Table 2.1-1). Duplicate hauls were taken at each station with a 30.7 x 2.7 m bag seine. The nylon bag was 2.5 m square with 1.2 cm stretch mesh. Seine samples were collected monthly in previous years, with four replicates per station.

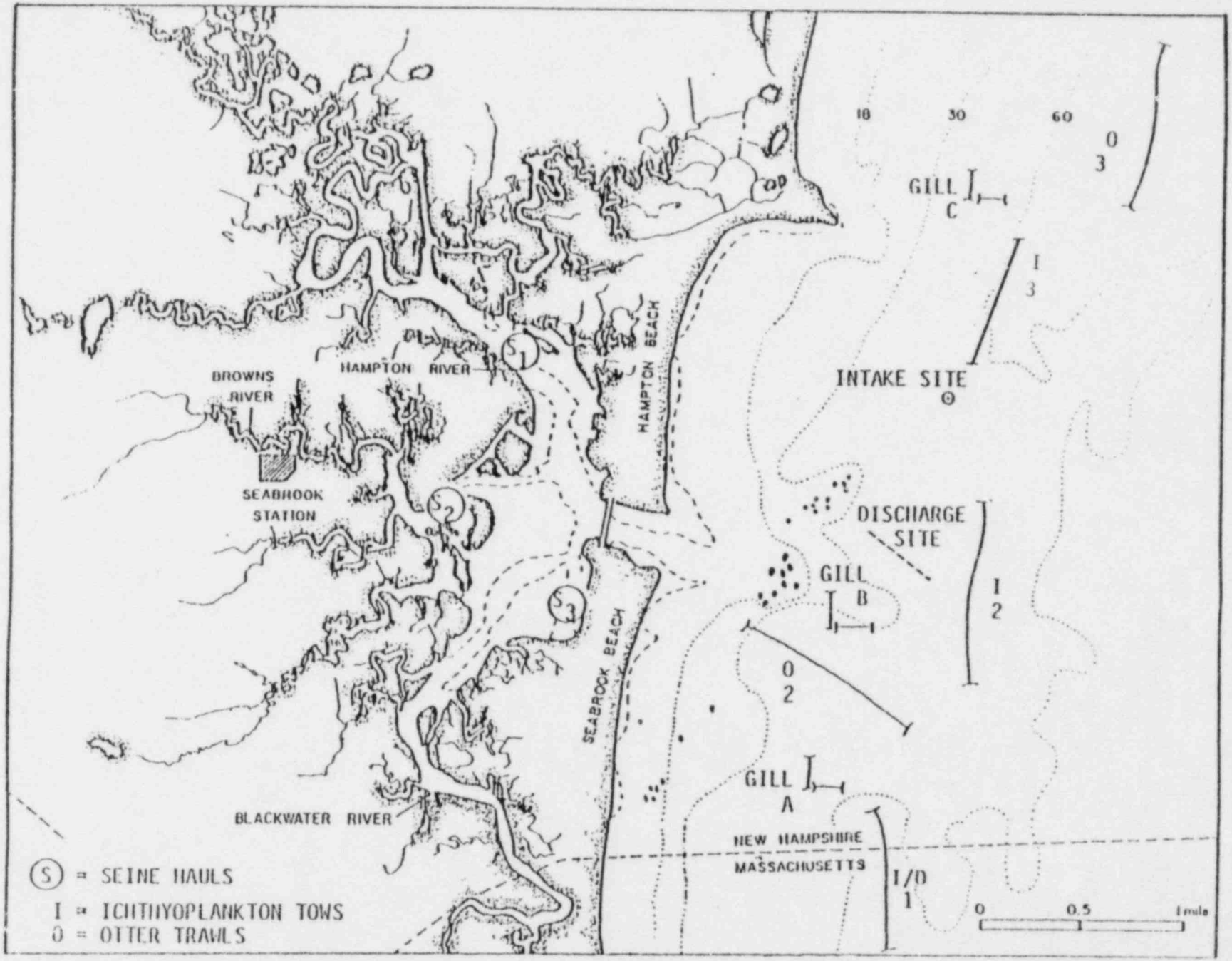


Figure 2.1-1. Finfish sampling stations, 1978. Seabrook Ecological Studies, 1978.

TABLE 2.1-1. DESCRIPTION OF FINFISH SAMPLING STATIONS. SEABROOK FINFISH STUDIES, 1978.

OTTER TRAWLS			
TRANSECT	TOW DEPTH	BOTTOM TYPE	REMARKS
1	20-28 meters	sand	150-200 m from rock outcroppings
2	15-17 meters	sand, drift algae w/shell debris	Scoured by tidal currents; large quantities of drift algae. 100 m from Inner Sunk Rocks
3	22-30 meters	sandy; littered with shell debris	Located off Great Boars Head; just seaward of a cobble area (Rocks 15-50 cm diameter).
GILL NETS			
STATION	BOTTOM NET DEPTH	BOTTOM TYPE	REMARKS
A	20 m	sand	Seaward from rocky outcropping off Seabrook.
B	17 m	sand	Seaward of Inner Sunk Rocks.
C	17 m	rock/cobble	Offshore from Great Boars Head
BEACH SEINES			
STATION	DEPTH	BOTTOM TYPE	REMARKS
S1	.5-2 m	sand	Scoured by tidal currents; approximately 300 m upriver from Hampton Beach Marina.
S2	.5-1 m	sand	Scoured by tidal currents; approximately 200 m from the mouth of the Brown's River.
S3	.5-3 m	sand	Scoured by tidal currents; located in Seabrook Harbor, approximately 300 m from Hampton Harbor bridge.

Biweekly sampling was initiated in 1978 to obtain more data on seasonality and movements of finfish through the estuary.

2.3 CUNNER (*TAUTOGOLABRUS ADSPERSUS*) AGE AND GROWTH

Cunner were captured in the discharge area throughout the summer and fall. Most were collected by SCUBA divers using a seine, and the remainder were captured in lobster traps. Each fish was measured (±1 mm standard length), weighed (±0.1 g) and sexed by gonad examination. Scales were removed from the left side, posterior to the insertion to the dorsal fin and just below the lateral line. In the laboratory, scales were washed and mounted between glass slides, then projected at 92X magnification to determine scale radius and annular distances.

2.4 ALEWIFE (*ALOSA PSEUDOHARENGUS*) SURVEY

An alewife survey was conducted on the Taylor River by the New Hampshire Fish and Game Department. The objective of this survey was to monitor the river until the migration reached a maximum so alewives could be transferred to the Winnacunnet River. As a result, the survey was sporadic, and counts were made on only four days. The average number of fish observed passing through the fishway per minute was expanded to estimate the number of alewives passing on the day when counts were made. Counting time varied from two to 50 minutes per day.

2.5 ICHTHYOPLANKTON

Four replicate oblique plankton tows for fish eggs and larvae were conducted at night along Transect 1 (south), 2 (discharge) and 3 (intake) (Figure 2.1-1) using a 1-m diameter 505 µm me[illegible] The net

with depressor was lowered to mid-water and towed at 2-3 kn; speed was varied at two-minute intervals to sample a range of water levels from near-bottom to sub-surface. The standard 10-minute tow was reduced to 5 minutes during periods of high biological productivity to minimize net clogging. Volume filtered was measured with a calibrated General Oceanics digital flowmeter mounted in the net mouth.

Ichthyoplankton samples were subsampled with a Folsom plankton splitter and presorted for eggs and larvae. Successive aliquots were analyzed until about 200 eggs/100 larvae were sorted or, if there were less than 75 eggs/25 larvae in one half of the sample only one half of the sample was sorted. In most cases larvae were identified to species. Some eggs, however, were more difficult to identify, and were grouped with eggs of similar appearance [e.g., cunner (*Tautogolabrus adspersus*) with yellowtail flounder (*Limanda ferruginea*)].

2.6 DATA COMPILATION

2.6.1 Otter Trawls

Catch data for 1978 were reduced to catch per unit effort for the major species at each transect; one ten-minute trawl was one unit of effort. The results were compared with 1976 and 1977 catch per effort data to describe the relative abundance among transects and years.

2.6.2 Gill Nets

The 1978 gill net data were converted to catch per unit effort for the major species by station and by surface and bottom nets; catch per three days equals one unit of effort. These results were compared with 1976 and 1977 catch per effort data for the same species. The analysis gives relative spatial distribution between surface and bottom

nets throughout the three years of sampling, and relative abundance among transects and years for the major pelagic species.

2.6.3 Beach Seines

Sanders (1960) Biological Index was used to measure and compare community dominance from 1976 through 1978. A rank was assigned to the ten most abundant species during a given sampling period, and a point value was given to each rank (e.g., 10 points for the most abundant species, 9 points for second ... 1 point for tenth). These scores were summed for each year to obtain the biological index value. The maximum potential score was 80 points, assuming eight beach seine months per year. Catch per unit effort (two 100' hauls = unit of effort) of the major species was also calculated and compared among stations and years.

2.6.4 Cunner Age and Growth

2.6.4.1 Back-calculation of Length at Age

The body length scale radius relationship was calculated for males, females and all fish using linear regression. This yielded the constants in the Lee equation (Lagler, 1956; Miller, 1966):

$$\text{standard length} = a + cs$$

where (a) is the intercept,
(c) is the slope of the regression line and
(s) is the scale radius.

Assuming that standard length at annulus formation is proportional to the scale radius/standard length relationship, the following equation was used to determine back-calculated lengths at annulus formation for each specimen (Lagler, 1956; Tesch, 1968).

$$ln = [\frac{S_n}{S} (l-a)] + a$$

where l_n = fish length at formation of annulus "n"

l = fish length at capture

S_n = radius of annulus "n"

S = scale radius

a = intercept from Lee equation

2.6.4.2 Length-Weight

Length-weight relationships were calculated for males, females and both sexes combined according to the equation:

$$\log W = \log c + n(\log L)$$

where W = weight (g)

L = standard length (mm)

c,n = coefficients

2.6.4.3 Standard to Total Length Conversion

Fifty-five cunner were measured for both total and standard length. Linear regression was used to calculate the relationship between these measurements so that length data from New Hampshire cunner may be compared with total length data from other regions.

2.6.5 Ichthyoplankton

Bray-Curtis Similarity (Boesch, 1977) was calculated using mean annual abundance for both eggs and larvae to compare transects during 1978. Structural Importance Analysis (SIA) was utilized to

evaluate the "importance" of all species based on both their relative abundance (Percent Dominant Score) and their rank (Rank Dominance Score).

3.0 RESULTS

A total of 63 taxa were collected in 1978 in the Hampton-Seabrook study area, across all gear types (Table 3.0-1). Of these taxa, 95% were collected as juveniles or adults, 49% as larvae and 13% as eggs. Two new records for the study area, one striped anchovy (*Anchoa hepsetus*) and six sheepshead (*Archosargus probatocephalus*), were collected in 1978; both species are extremely rare to the Gulf of Maine according to Bigelow and Schroeder (1953).

3.1 OTTER TRAWLS

A total of 8,465 fish representing 40 species were collected in trawls during 1978 (Table 3.1-1). Six species accounted for 84.6% of the total catch with the yellowtail flounder (*Limanda ferruginea*) the most abundant (22.9%). Species richness was similar among the three transects, but the catch abundance at Transect 2 was much lower than catches at Transects 1 and 3 (Table 3.1-2). Decreased abundance at Transect 2 may reflect the influence of drift algae on the efficiency of otter trawling as well as the fact that this transect is somewhat more shallow. Transect 2 is the station at which measurable drift algae is encountered consistently during otter trawling (Appendix Table 7-4). Analysis of the relationship between the amount of algae encountered and the catch abundance has shown that algal clogging reduces net efficiency and yields a lower catch, although the number of species encountered remains similar to that observed at the stations without algae (NAI, unpublished data). Thus, low otter trawl catches at Transect 1 during February and at Transect 2 during May coincide with conditions of severe net clogging. Algal interference does not appear to be the cause of low catches at Transect 1 during April, at Transect 2 during August or at Transect 3 during February (Appendix Tables 7-1 to 7-4).

TABLE 3.0-1. LIST OF FISH SPECIES ENCOUNTERED IN THE MARINE AND ESTUARINE WATERS IN THE VICINITY OF THE HAMPTON-SEABROOK ESTUARY FROM JANUARY THROUGH DECEMBER 1978. SEABROOK FINFISH STUDIES, 1978.

SCIENTIFIC NAME[a]	COMMON NAME	LIFE STAGE		
		JUVENILE AND/OR ADULT	LARVAE	EGGS
Alosa aestivalis	Blueback herring	X		
Alosa mediocris	Hickory shad	X		
Alosa pseudoharengus	Alewife	X		
Alosa sapidissima	American shad	X		
Ammodytes americanus	American sand lance	X	X	
Anarhichas lupus	Wolffish	X		
Anchoa hepsetus	Striped anchovy	X		
Archosargus probatocephalus	Sheepshead	X		
Aspidophoroides monopterygius	Alligatorfish	X	X	
Brevoortia tyrannus	Atlantic menhaden	X		X
Brosme brosme	Cusk		X	X
Centropristis striata	Sea bass	X		
Clupea harengus	Atlantic herring	X	X	
Cyclopterus lumpus	Lumpfish	X	X	
Enchelyopus cimbrius	Fourbeard rockling	X	X	X
Fundulus spp.	Mummichog/killifish	X		
Gadus/Melanogrammus	Cod and/or haddock			X
Gadus morhua	Cod	X	X	
Gasterosteus aculeatus	Threespine stickleback	X	X	
Glyptocephalus cynoglossus	Witch flounder	X	X	X
Hemitripterus americanus	Sea raven	X		
Hippoglossus hippoglossus	Halibut	X		
Hippoglossoides platessiodes	American plaice	X	X	X
Labridae/*Limanda*	Cunner and/or flounder			X
Limanda ferruginea	Yellowtail flounder	X	X	
Liopsetta putnami	Smooth flounder	X		
Liparis sp.	Striped and/or common seasnail		X	
Liparis atlanticus	Seasnail	X		
Liparis liparis	Striped seasnail	X		
Lophius americanus	Goosefish	X	X	
Lumpenus lumpretaeformis	Snakeblenny	X		

(Continued)

TABLE 3.0-1. (Continued)

SCIENTIFIC NAME	COMMON NAME	LIFE STAGE		
		JUVENILE AND/OR ADULT	LARVAE	EGGS
Macrozoarces americanus	Ocean pout	X	X	
Melanogrammus aeglefinus	Haddock	X	X	
Menidia menidia	Atlantic silversides	X		
Merluccius bilinearis	Silver hake	X	X	X
Microgadus tomcod	Tomcod	X	X	
Myoxocephalus aenaeus	Grubby sculpin	X	X	
Myoxocephalus octodecemspinosus	Longhorn sculpin	X	X	
Myoxocephalus scorpius	Shorthorn sculpin	X		
Oncorhynchus kisutch	Coho salmon	X		
Osmerus mordax	Rainbow smelt	X	X	
Paralichthys oblongus	Fourspot flounder	X		
Peprilus triacanthus	Butterfish	X		X
Pholis gunnellus	Rock gunnel	X	X	
Pollachius virens	Pollock	X	X	X
Pomatomus saltatrix	Bluefish	X		
Prionotus carolinus	Common searobin	X		
Pseudopleuronectes americanus	Winter flounder	X	X	
Pungitius pungitius	Ninespine stickleback	X		
Raja spp.	Skates	X		
Salmo gairdneri	Rainbow trout	X		
Salmo trutta	Brown trout	X		
Salvelinus fontinalis	Brook trout	X		
Scomber scombrus	Atlantic mackerel	X	X	X
Scophthalmus aquosus	Windowpane	X	X	X
Sebastes marinus	Ocean perch		X	
Squalus acanthias	Spiny dogfish	X		
Syngnathus fuscus	Northern pipefish	X	X	
Tautoga onitis	Tautog		X	
Tautogolabrus adspersus	Cunner	X	X	
Triglops murrayi	Sculpin	X		
Ulvaria subbifurcata	Radiated shanny	X	X	
Urophycis spp.	Hake	X	X	X

[a] According to Bailey (1970)

TABLE 3.1-1. SPECIES RANK FOR FISHES COLLECTED IN OTTER TRAWLS. SEABROOK FINFISH STUDIES, 1978.

SPECIES	TOTAL NUMBER	%
Limanda ferruginea	1938	22.9
Urophycis spp.	1632	19.3
Gadus morhua	1206	14.2
Osmerus mordax	843	10.0
Pseudopleuronectes americanus	782	9.2
Myoxocephalus octodecemspinosus	765	9.0
Merluccius bilinearis	311	3.7
Macrozoarces americanus	289	3.4
Raja spp.	190	2.2
Scophthalmus aquosus	111	1.3
Pollachius virens	67	<1.0
Microgadus tomcod	56	<1.0
Hemitripterus americanus	56	<1.0
Glyptocephalus cynoglossus	32	<1.0
Paralichthys oblongus	30	<1.0
Hippoglossoides platessoides	25	<1.0
Aspidophoroides monopterygius	22	<1.0
Liparis atlanticus	16	<1.0
Myoxocephalus aenaeus	12	<1.0
Pholis gunnellus	10	<1.0
Enchelyopus cimbrius	10	<1.0
Alosa pseudoharengus	7	<1.0
Ammodytes americanus	6	<1.0
Archosargus probatocephalus	6	<1.0
Myoxocephalus scorpius	5	<1.0
Menidia menidia	5	<1.0
Tautogolabrus adspersus	5	<1.0
Lophius americanus	5	<1.0
Syngnathus fuscus	4	<1.0
Clupea harengus	3	<1.0
Cyclopterus lumpus	3	<1.0
Liparis liparis	3	<1.0
Melanogrammus aeglefinus	2	<1.0
Anarhichas lupus	2	<1.0
Alosa sapidissima	1	<1.0
Triglops murrayi	1	<1.0
Hippoglossus hippoglossus	1	<1.0
Centropristis striata	1	<1.0
Lumpenus lumpretaeformis	1	<1.0
Ulvaria subbifurcata	1	<1.0
TOTAL	8465	

TABLE 3.1-2. NUMBER OF SPECIES AND INDIVIDUALS COLLECTED PER MONTH AT EACH OTTER TRAWL TRANSECT. SEABROOK FINFISH STUDIES, 1978.

	TRANSECT 1		TRANSECT 2		TRANSECT 3	
	# SPECIES	# INDIVIDUALS	# SPECIES	# INDIVIDUALS	# SPECIES	# INDIVIDUALS
January 1978	13	306	10	311	16	168
February	12	92	9	128	9	53
March	13	107	11	121	9	266
April	12	89	12	187	13	242
May	18	324	12	63	16	383
June	14	327	14	115	13	322
July	12	368	14	160	15	383
August	15	358	10	25	13	258
September	11	247	14	224	14	413
October	15	346	14	210	15	350
November	12	304	15	159	15	361
December	13	322	11	141	15	332
TOTAL	31	3190	32	1744	31	3531

3.2 GILL NETS

In 1978, 6,371 fish representing 25 species were collected in gill nets (Table 3.2-1). Numerically dominant species, comprising 91% of the total catch, were Atlantic herring (*Clupea harengus*), blueback herring (*Alosa aestivalis*) and silver hake (*Merluccius bilinearis*).

Gill net stations A and C were similar with regard both to the number of species and total abundance of finfish captured. In contrast, the finfish were more diverse at Station B, but less abundant than at the other two stations (Table 3.2-2). Maximum abundance occurred during April and from September through November at all stations. These peaks were caused primarily by the seasonal abundance of Atlantic and blueback herring (Appendix Tables 7-5 to 7-7).

3.3 BEACH SEINE

A total of 18,823 fish representing 24 species were collected in beach seines during 1978 (Table 3.3-1). Atlantic silversides (*Menidia menidia*) comprised 74.9% of the total catch. Other dominant species were American sand lance (*Ammodytes americanus*), Atlantic herring and killifish (*Fundulus* spp.). Species richness was greatest during June (Table 3.3-2), but greatest abundance occurred during the late summer and fall when Atlantic silversides and sand lance were captured in large quantities (Appendix Tables 7-8 to 7-10).

3.4 CUNNER AGE AND GROWTH

3.4.1 Length and Weight at Capture

Ninety-one cunner ranging from 23.0 to 189.0 mm standard length were collected during 1978. Mean length at capture was slightly higher for females at Ages II and III, and for males at Ages IV to VI

TABLE 3.2-1. SPECIES RANK FOR FISHES COLLECTED IN GILL NETS DURING 1978. SEABROOK FINFISH STUDIES, 1978.

SPECIES	TOTAL NUMBER	%
Clupea harengus	4736	74.3
Alosa aestivalis	910	14.3
Merluccius bilinearis	151	2.4
Alosa pseudoharengus	119	1.9
Scomber scombrus	119	1.9
Pollachius virens	72	1.1
Osmerus mordax	60	<1.0
Urophycis spp.	44	<1.0
Pomatomus saltatrix	34	<1.0
Gadus morhua	26	<1.0
Brevoortia tyrannus	26	<1.0
Peprilus triacanthus	16	<1.0
Squalus acanthias	12	<1.0
Myoxocephalus octodecemspinosus	10	<1.0
Clupeidae	10	<1.0
Alosa sapidissima	8	<1.0
Tautogolabrus adspersus	6	<1.0
Pseudopleuronectes americanus	3	<1.0
Oncorhynchus kisutch	2	<1.0
Hemitripterus americanus	2	<1.0
Scophthalmus aquosus	1	<1.0
Alosa mediocris	1	<1.0
Syngnathus fuscus	1	<1.0
Prionotus carolinus	1	<1.0
Macrozoarces americanus	1	<1.0
TOTAL	6371	

TABLE 3.2-2. NUMBER OF SPECIES AND INDIVIDUALS COLLECTED PER MONTH AT EACH GILL NET STATION. SEABROOK FINFISH STUDIES, 1978.

MONTH	STATION A		STATION B		STATION C	
	# SPECIES	# INDIVIDUALS	# SPECIES	# INDIVIDUALS	# SPECIES	# INDIVIDUALS
January 1978	3	58	4	65	4	63
February	1	2	1	4	2	4
March	6	28	5	125	8	315
April	3	159	1	219	4	748
May	6	28	6	61	6	114
June	2	13	5	15	4	10
July	8	132	8	79	8	55
August	6	15	10	31	5	52
September	4	1103	12	416	8	494
October	9	228	7	28	11	277
November	9	282	9	285	9	315
December	3	69	4	85	3	141
TOTAL	16	2117	23	1666	18	2588

TABLE 3.3-1. SPECIES RANK FOR FISH COLLECTED IN BEACH SEINES DURING 1978. SEABROOK FINFISH STUDIES, 1978.

SPECIES	TOTAL NUMBER	%
Menidia menidia	14,097	74.9
Ammodytes americanus	1,418	7.5
Clupea harengus	1,022	5.4
Fundulus spp.	888	4.7
Pseudopleuronectes americanus	322	1.7
Gasterosteus aculeatus	237	1.3
Pollachius virens	219	1.2
Pungitius pungitius	204	1.1
Alosa aestivalis	158	<1.0
Liopsetta putnami	89	<1.0
Salmo trutta	57	<1.0
Urophycis spp.	39	<1.0
Myoxocephalus octodecemspinosus	21	<1.0
Osmerus mordax	11	<1.0
Myoxocephalus aenaeus	9	<1.0
Alosa pseudoharengus	6	<1.0
Salmo gairdneri	6	<1.0
Syngnathus fuscus	6	<1.0
Microgadus tomcod	4	<1.0
Tautogolabrus adspersus	4	<1.0
Scophthalmus aquosus	3	<1.0
Anchoa hepsetus	1	<1.0
Oncorhynchus kisutch	1	<1.0
Salvelinus fontinalis	1	<1.0
TOTAL	18,823	

TABLE 3.3-2. NUMBER OF FINFISH SPECIES AND INDIVIDUALS COLLECTED AT THREE BEACH SEINING STATIONS DURING 1978. SEABROOK FINFISH STUDIES, 1978.

MONTH	S1		S2		S3	
	# SPECIES	# INDIVIDUALS	# SPECIES	# INDIVIDUALS	# SPECIES	# INDIVIDUALS
April	5	15	4	11	3	10
May	5	20	6	91	8	418
June	12	109	12	1057	15	235
July	7	41	9	47	9	65
August	6	1148	6	466	8	3217
September	8	1066	9	1361	11	1367
October	3	567	9	2048	9	1352
November	5	192	10	2946	8	974
TOTAL	15	3158	18	8027	23	7631

(Table 3.4-1). Mean weight of females was also higher than males at Ages II and III, identical at Age IV, and lower at Ages V and VI.

3.4.2 Length-Weight Relationships

Length-weight relationships were used as indices of the relationship between growth in length and weight for cunner captured during 1978. Slopes, intercepts and correlation coefficients for the model:

$$\log \text{weight (g)} = \log a + c \log \text{length (mm)}$$

are presented in Table 3.4-2. The slopes and y-intercepts were not biologically different between males and females.

TABLE 3.4-2. LENGTH-WEIGHT RELATIONSHIPS FOR MALE AND FEMALE CUNNER CAPTURED DURING 1978.

	NUMBER OF FISH	LENGTH RANGE (mm)	Log a	c	r
Males	46	69-182	-4.9641	3.1491	0.9747
Females	38	76-189	-5.1022	3.2182	0.9827
All fish	91	23-189	-5.0061	3.1702	0.9941

3.4.3 Growth/Body-Scale Relationships

The body/scale relationship was derived from 77 cunner ranging from 23 to 145 mm standard length; seven fish were eliminated from the sample because of regenerated scales.

TABLE 3.4-1. LENGTH AND WEIGHT AT CAPTURE AND BACK-CALCULATED STANDARD LENGTH AT ANNULUS FORMATION FOR CUNNER, *TAUTOGOLABRUS ADSPERSUS*, CAPTURED DURING 1978. SEABROOK FINFISH STUDIES, 1978.

	YEAR CLASS	NUMBER OF FISH	MEAN S.L. (mm) AT CAPTURE FOR AGE GROUPS (I-VI)	MEAN WEIGHT AT CAPTURE	CALCULATED STANDARD LENGTH AT FORMATION OF ANNULUS 1	2	3	4	5	6
FEMALES	1977	0	0	0						
	1976	4	78.5	10.9	40.5	62.5				
	1975	2	94.5	16.1	46.0	66.5	80.5			
	1974	13	99.4	20.9	40.6	57.8	75.1	89.3		
	1973	6	111.7	31.3	41.3	56.5	69.7	86.2	101.3	
	1972	4	128.5	49.1	42.3	56.8	72.5	89.0	104.0	120.0
	Grand Average				41.3	58.7	73.8	88.4	102.4	120.0
	Sample size (N)				29	29	25	23	10	4
	Confidence Interval (α=.05)			Low	40.2	56.4	71.2	86.1	99.3	114.6
				High	42.5	60.9	76.4	90.7	105.5	125.4
	Average Annual Increment				41.3	17.4	15.1	14.6	14.0	17.6
MALES	1977	0	0	0						
	1976	2	75.5	9.8	41.5	59.0				
	1975	7	88.1	15.0	44.4	63.9	77.4			
	1974	8	101.9	20.9	41.6	60.4	76.9	90.3		
	1973	13	119.6	39.7	42.8	61.3	80.5	98.6	110.8	
	1972	11	131.7	54.4	42.2	65.4	83.2	98.6	112.7	124.0
	Grand Average				42.6	62.5	80.0	96.5	111.7	124.0
	Sample size (N)				41	41	39	32	24	11
	Confidence Interval (α=.05)			Low	41.5	60.2	77.4	93.3	107.6	116.8
				High	43.7	64.9	82.5	99.8	115.8	131.2
	Average Annual Increment				42.6	19.9	17.5	16.5	15.2	12.3
ALL FISH	1977	4	24.7	0.3						
	1976	6	77.5	10.5	40.8	61.3				
	1975	12	89.3	14.8	44.1	63.3	78.5			
	1974	21	100.3	20.9	41.0	58.8	75.8	89.7		
	1973	19	117.1	37.0	42.3	59.8	77.1	94.7	107.8	
	1972	15	130.9	53.0	42.2	63.1	80.3	96.1	110.4	122.9
	Grand Average				42.1	60.9	77.7	93.1	109.0	122.9
	Sample size (N)				73	73	67	55	34	15
	Confidence Interval (α=.05)			Low	41.3	59.3	75.8	90.8	105.6	117.5
				High	42.9	62.5	79.5	95.5	112.3	128.4
	Average Annual Increment				42.1	18.8	16.8	15.4	15.9	13.9

The calculated (a) value for cunner collected in 1978 was 25.89. This (a) value was much higher than the 16.02 obtained in the 1977 study. The difference can be attributed to the absence of juvenile cunner in the 1978 samples.

Back-calculations of mean length at annulus formation (Table 3.4-1) could be validated only through Age Class VI, because the older fish have less annual scale growth than younger groups due to decreasing scale growth with age. Back calculation for males collected in 1977 could only be validated through the Age Class VI, females through Age Class VIII and all fish through Age Class VI (NAI, 1978). Serchuk and Cole (1974) reported they could back-calculate only to Age VI and Dew (1976) calculated to Age IV.

Calculated lengths for all year classes were similar (Table 3.4-1). There was reasonable agreement between the calculated lengths and the actual lengths of fish at capture. The average standard length for each age group at capture was greater than the average calculated length at annulus formation, but less than the calculated average length for the succeeding annulus.

Standard and total length measurements collected from 55 cunner ranging in size from 23 to 179 mm standard length were used to calculate the following length relationship:

$$\text{total length} = 0.1051 + 1.1861 \text{ standard length} \quad (r = 0.9986)$$

3.4.4 Sex Ratio

The male:female ratio was 1.2:1 for the 84 cunner collected during 1978. This was different from the 1977 results, with a male: female ratio of 0.29:1, but there were also 389 individuals collected in 1977, compared to the low sample size of 84 individuals in 1978.

3.5 ALEWIFE SURVEY

The alewife run in the Taylor River began on April 26 and ended by mid-June. The New Hampshire Fish and Game Department began counts on April 26 (Table 3.5-1) when the first group of alewives passed through the fish ladder. Subsequent counts were made throughout the next two weeks until May 10 when 1800 river herring (*Alosa* spp.) were transported to the Winnicut River. No counts were made after May 10, although the river was periodically checked for the presence of river herring. The run was still strong on May 28 and did not end until mid-June.

3.6 ICHTHYOPLANKTON

3.6.1 Spatial Trends

Fourteen taxa of finfish eggs and 32 species of larvae were identified from New Hampshire coastal waters during 1978 (Tables 3.6-1 and 3.6-2). Throughout 1978, mean abundances of both eggs and larvae were greatest at the South and Intake transects (Table 3.6-1 and 3.6-2). The lower densities at the Discharge transect were not consistent throughout the year and were, in part, species specific. Differences in egg distribution were indicative of the spatial distribution of the two most abundant species, Labrid/*Limanda* and hake, both of which occurred in lowest densities along the Discharge transect (Table 3.6-1). Distribution of total fish larvae was related to the spatial patterns of a larger suite of species (Table 3.6-2). Sand lance, cunner and rockling were each more abundant at the Intake and South transects, plaice and witch flounder at the South transect and seasnails and winter flounder were more abundant at the Intake.

Based on mean annual abundances (log n + 1 transformed) of both eggs and larvae, Bray-Curtis similarity (Boesch, 1977) was 77-96% for transect comparisons (Appendix Table 7.6-11). With untransformed

TABLE 3.5-1. SUMMARY OF ALEWIFE PASSAGE AT THE TAYLOR RIVER, APRIL 25 TO MAY 10, 1978. SEABROOK FINFISH STUDIES, 1979.

DATE	TIME	WATER TEMPERATURE	TIDE STAGE	NUMBER OF FISH PASSED PER MINUTE
April 25	1110	12.2°C	Flooding	4.8
April 27	1235	12.8	Flooding	9.0
	2100	12.8	Ebbing	0.0
May 4	1510	14.4	Ebbing	4.9
	2115	13.3	Flooding	1.4
May 8	1,000 *Alosa* spp. transported to Winnicunnet River			
May 10	800 *Alosa* spp. transported to Winnicunnet River			

TABLE 3.6-1. RANKED MEAN SPECIES DENSITY (NO./100 m^3) BY STATION[a] FOR FISH EGGS COLLECTED IN COASTAL NEW HAMPSHIRE WATERS. SEABROOK FINFISH STUDIES, 1978.

SPECIES	MEAN DENSITY			ALL TRANSECTS	%
	INTAKE(3)	DISCHARGE(2)	SOUTH(1)		
Labrid/*Limanda*	7,236	4,922	6,503	6,220	55.6
Urophycis spp.	2,166	1,883	5,766	3,272	29.2
Scomber scombrus	762	785	329	625	5.6
Hippoglossoides platessoides	266	303	565	378	3.4
Gadus/Melanogrammus	178	185	351	238	2.1
Scophthalmus aquosus	159	169	161	163	1.5
Merluccius bilinearis	85	68	145	99	0.9
Enchelyopus cimbrius	90	88	113	97	0.9
Glyptocephalus cynoglossus	95	43	58	65	0.6
Peprilus triacanthus	27	4	4	12	0.1
Pollachius virens	5	16	12	11	<0.1
Brosme brosme	6	5	8	6	<0.1
Brevoortia tyrannus	<1	<1	0	<1	<0.1
Unidentified	<1	1	4	2	<0.1
Total	11,074	8,472	14,018	11,188	

[a] Means based on 15 comparable sample periods

TABLE 3.6-2. RANKED MEAN SPECIES DENSITY (NO./1000 m^3) BY STATION[a] FOR FISH LARVAE COLLECTED IN COASTAL NEW HAMPSHIRE WATERS. SEABROOK FINFISH STUDIES, 1978.

SPECIES	MEAN DENSITY			ALL TRANSECTS	%
	INTAKE(3)	DISCHARGE(2)	SOUTH(1)		
Ammodytes americanus	342	84	330	252	32.5
Tautogolabrus adspersus	196	19	118	111	14.3
Hippoglossoides platessoides	32	71	176	93	12.0
Liparis spp.	104	57	20	60	7.7
Gadus morhua	58	57	22	46	5.9
Pseudopleuronectes americanus	76	25	23	41	5.3
Ulvaria subbifurcata	40	20	39	33	4.3
Glyptocephalus cynoglossus	17	11	68	32	4.1
Limanda ferruginea	10	13	57	26	3.4
Enchelyopus cimbrius	32	10	33	25	3.2
Merluccius bilinearis	4	1	69	25	3.2
Scomber scombrus	12	1	12	9	1.2
Melanogrammus aeglefinis	3	9	4	5	0.6
Pholis gunnellus	4	2	4	3	0.4
Scophthalmus aquosus	7	1	2	3	0.4
Sebastes marinus	1	<1	6	2	0.3
Aspidophoroides monopterygius	2	1	3	2	0.3
Pollachius virens	1	2	1	1	0.1
Myoxocephalus aenaeus	2	1	1	1	0.1
Clupea harengus	1	1	1	1	0.1
Urophycis spp.	2	1	1	1	0.1
Cyclopterus lumpus	1	<1	1	1	0.1
Osmerus mordax	<1	1	1	1	0.1
Syngnathus fuscus	1	<1	<1	<1	<0.1
Lophius americanus	<1	0	1	<1	<0.1
Myoxocephalus octodecemspinosus	<1	<1	<1	<1	<0.1
Brosme brosme	<1	<1	0	<1	<0.1
Macrozoarces americanus	0	<1	0	<1	<0.1
Microgadus tomcod	0	<1	0	<1	<0.1
Gasterosteus aculeatus	0	<1	0	<1	<0.1
Tautoga onitis	0[b]	0	0	0	0.0
Menidia menidia	0[b]	0	0	0	0.0
Total	950	390	997	775	

a = Means based upon 15 comparable sample periods

b = Present at Intake transect during a date when it was the only transect analyzed

data, stations were still >70% similar for egg distributions, but only 44-70% for larvae. The high similarities based upon fish egg abundances reflect the high and generally similar mean densities at each transect for the two most abundant egg types (Table 3.6-1). Spatial differences were, however, particularly marked for total fish larvae as well as for larvae of cunner and sand lance (Table 3.6-2). Mean annual abundance of these species was lower at the Discharge transect than at the Intake and South transects.

Ichthyoplankton species richness was similar at all transects (12-14 eggs; 26-31 larval species). Species which were not present at all transects were those whose mean annual abundance was <1/1000 m^3 (Tables 3.6-1 and 3.6-2).

3.6.2 Temporal Distribution

Annual comparisons of the Structural Importance Analysis (SIA) emphasized the contribution of gadid, plaice and hake eggs, in addition to those of Labrid/*Limanda*, to the structure of the ichthyoplankton assemblage (Table 3.6-3). SIA also emphasized the dominance of sand lance and cunner larvae in the Hampton-Seabrook area. Seven species of eggs and larvae, including the indicator species (see Section 4.4) cunner and pollock, were listed among the five dominants for the period 1976-1978, indicating that the ichthyoplankton assemblage has been consistent in terms of dominant taxa.

Fish eggs were most abundant during June and July when Labrid/*Limanda* eggs were dominant (Appendix Table 7-12, Figure 3.6-1). A secondary early spring peak was largely the result of Gadid and American plaice spawning. Egg densities were lowest during January and November when only Gadidae eggs were collected. Species richness peaked during both spring and early fall months (Table 3.6-4). Species succession during 1978 was:

TABLE 3.6-3. SUMMARY OF STRUCTURAL IMPORTANCE ANALYSIS OF THE FIVE DOMINANT FISH EGGS AND LARVAE IN COASTAL NEW HAMPSHIRE WATERS, 1976-1978. SEABROOK FINFISH STUDIES, 1978.

EGGS	PDS (RDS) VALUES[a]		
SPECIES	1976	1977	1978
Gadus/Melanogrammus	39.1(71.8)	22.9(69.7)	24.1(77.0)
Hippoglossoides platessoides	14.2(50.0)	13.4(34.2)	19.4(54.4)
Urophycis spp.	11.3(31.0)	15.8(46.5)	19.6(41.3)
Labrid[b]/*Limanda*	13.2(52.8)	13.7(61.5)	19.4(69.1)
Merluccius bilinearis	---	16.8	---
Pollachius virens[b]	---	---	8.8(29.9)
Enchelyopus cimbrius	7.9(49.8)	---	---

LARVAE	PDS (RDS) VALUES[a]		
SPECIES	1976	1977	1978
Ammodytes americanus	27.3(53.4)	19.7(52.4)	33.6(59.8)
Tautogolabrus adspersus[b]	7.0(24.7)	12.0(40.7)	9.4(21.6)
Enchelyopus cimbrius	10.1(41.8)	8.0(50.0)	6.3(37.8)
Clupea harengus	14.6(31.3)	9.9(38.1)	---
Pollachius virens[b]	9.5(39.7)	12.3(30.3)	---
Liparis sp.	---	---	7.4(65.7)
Hippoglossoides platessoides	---	---	6.1(38.1)

[a] Percent Dominant Score (Rank Dominance Score)

[b] Indicator Species

--- = not ranked in first five

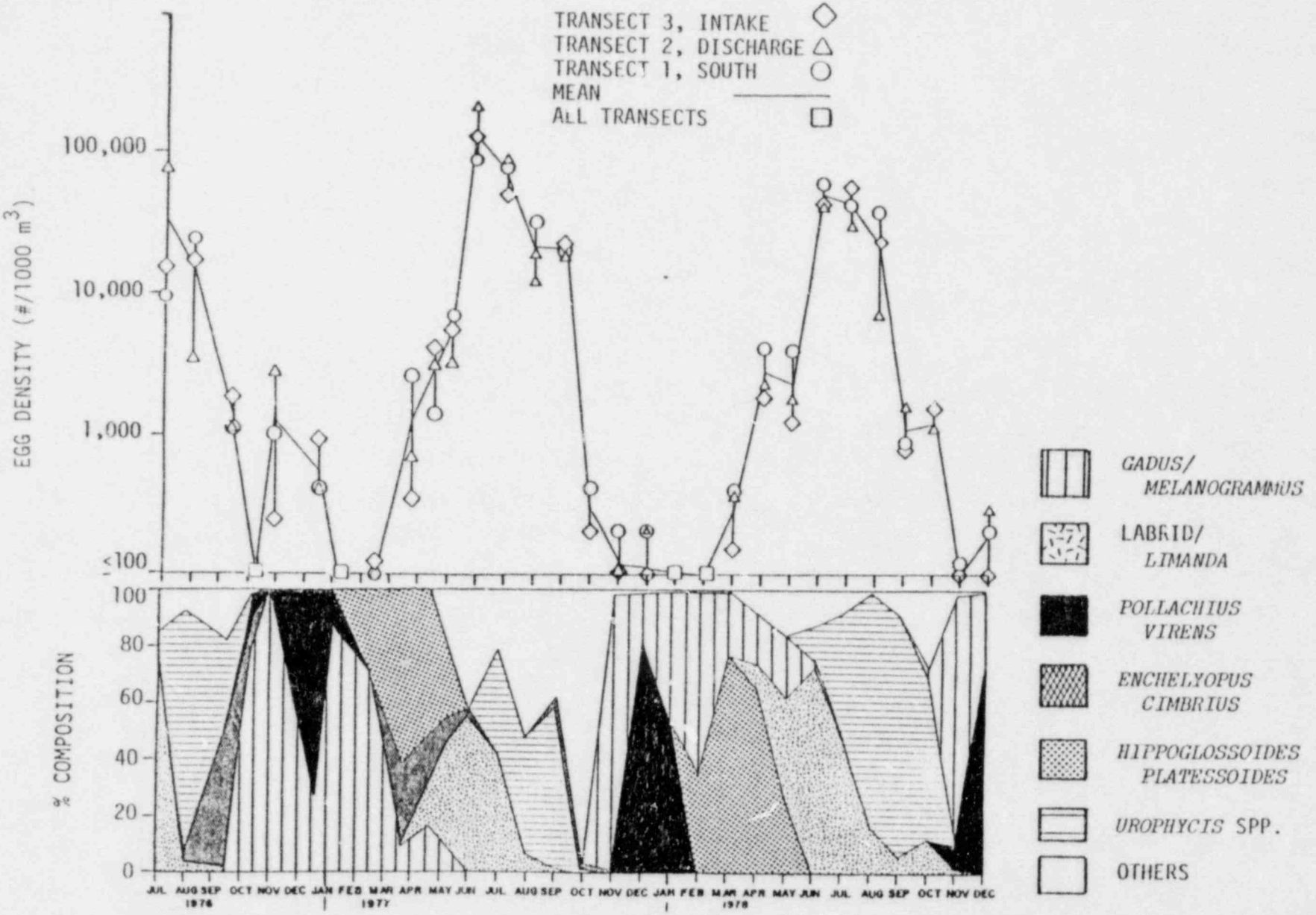


Figure 3.6-1. Abundance and percent composition of fish eggs in ichthyoplankton collections from the Hampton-Seabrook region, July 1976 through December 1978. Seabrook Finfish Studies, 1978.

TABLE 3.6-4. TEMPORAL DISTRIBUTION OF ICHTHYOPLANKTON SPECIES RICHNESS IN COASTAL NEW HAMPSHIRE WATERS. SEABROOK FINFISH STUDIES, 1978.

DATE	NUMBER OF SPECIES	
	EGGS	LARVAE
16 January	3	4
15 February	2	4
8 March[a]	2	4
20 March	4	5
29 March[a]	3	6
12 April	4	7
26 April	6	12
10 May	8	13
24 May	12	14
8 June	12	11
22 June	11	16
14 July	14	19
26 July[a]	9	14
9 August	7	18
23 August[a]	6	11
6 September	10	6
1 October	12	9
2 November	7	7
5 December	6	8
26 December[a]	2	7

[a] Data from Intake Transect only; all other dates include all transects

Winter: Cod/haddock, pollock

Spring: American plaice, Labrid/*Limanda*

Summer: Labrid/*Limanda*, *Urophycis* spp.

Fall: *Urophycis* spp., cod/haddock, silver hake

Fish larvae were most abundant during spring and summer (Appendix Table 7-13; Figure 3.6-2). Sand lance dominated the winter/spring assemblage, cunner and yellowtail flounder the summer and early autumn. Pollock and herring larvae were dominant during late fall, but actual densities were low. Species richness of fish larvae was unimodal with a winter minimum and a summer maximum (Table 3.6-4). Species succession during 1978 was:

Winter: Sand lance, pollock

Spring: Sand lance, seasnail

Summer: Cunner, several species

Autumn: Cunner, rockling, pollock, herring

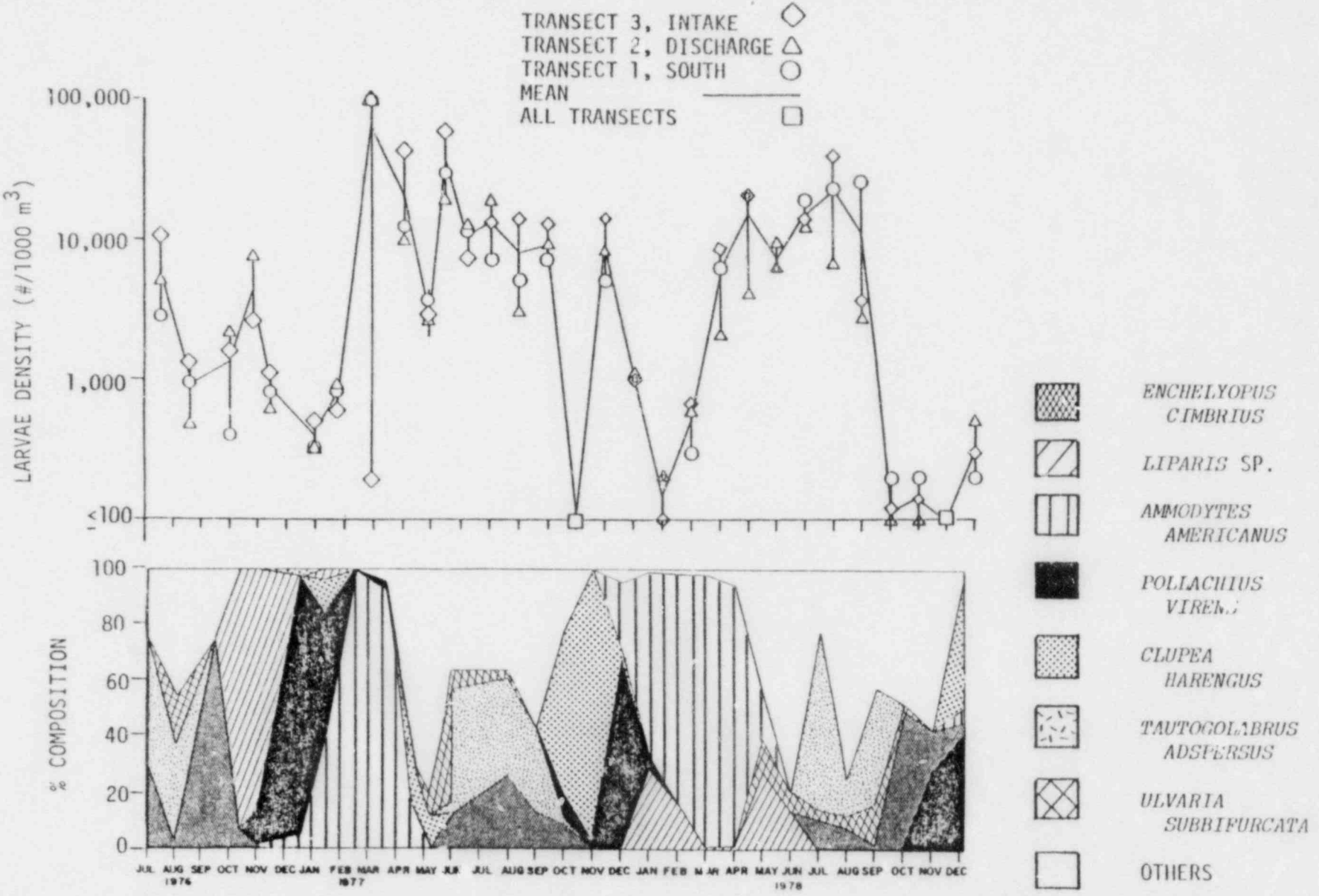


Figure 3.6-2. Abundance and percent composition of fish larvae in ichthyoplankton collections from the Hampton-Seabrook region, July 1976 through December 1978. Seabrook Finfish Studies, 1978.

4.0 DISCUSSION

4.1 JUVENILE AND ADULT FISH

4.1.1 Groundfish

The principal ground and near-bottom fish species encountered along the New Hampshire coast in these studies were yellowtail flounder, rainbow smelt, hake, silver hake, Atlantic cod and winter flounder. Yellowtail flounder, hake and Atlantic cod were most abundant at the deeper, more-offshore locations (Transects 1 and 3). These transects were moved into deeper water during 1975, and subsequent catches of yellowtail, hake and cod increased. Thereafter the catch per unit effort for these species has remained consistently higher than at the more-inshore Transect 2 (Table 4.1-1). All these species except silver hake are considered by Bigelow and Schroeder (1953) and Leim and Scott (1966) to have distributions that favor deeper water, particularly among the older individuals. The silver hake is a predator whose distribution is dependent primarily on the availability of prey.

The rainbow smelt and the winter flounder are primarily inshore species (Bigelow and Schroeder, 1953). As a result, their abundance in New Hampshire coastal waters has been greatest at Transect 2, the most inshore sampling location (Table 4.1-1). These species will be discussed in more detail as "indicator species" below.

Hake have consistently been one of the most abundant groundfish collected in nearshore New Hampshire waters in these studies. The abundance of these species as indicated by the catch per unit effort has been fairly stable from 1976 through 1978 (Table 4.1-1). Hake are encountered from March through December, with maximum abundance during the summer and early autumn (Figure 4.1-1). Bigelow and Schroeder (1953) and Musick (1974) report that the hakes tend to move offshore during the winter to avoid water below 5°C; this is most likely the cause of the seasonal abundance pattern observed near the Hampton-

TABLE 4.1-1. CATCH PER UNIT OF OTTER TRAWL EFFORT FOR SIX FINFISH SPECIES COLLECTED DURING 1976, 1977 AND 1978. SEABROOK FINFISH STUDIES, 1978.

TAXON	YEAR	TRANSECTS					
		1		2[a]		3	
		C/E	% TOTAL[b]	C/E	% TOTAL	C/E	% TOTAL
Limanda ferruginea							
	1978	23.1	34.7	2.3	6.5	14.9	20.2
	1977	28.5	40.2	3.0	12.7	12.8	22.8
	1976	37.3	80.6	5.7	18.4	22.2	33.8
Osmerus mordax							
	1978	5.2	7.9	8.8	24.3	3.5	4.7
	1977	1.4	2.0	2.1	8.8	1.8	3.3
	1976	6.6	14.2	11.8	38.3	7.0	10.6
Urophycis spp. (*Urophycis chuss* and *U. tenuis*)	1978	14.7	22.2	6.3	17.3	12.9	17.6
	1977	21.3	30.2	4.6	19.5	17.0	30.5
	1976	17.1	37.0	4.6	14.9	11.3	17.2
Merluccius bilinearis							
	1978	4.3	6.5	0.3	0.8	1.9	2.5
	1977	2.2	3.1	0.6	2.7	1.7	3.3
	1976	6.2	13.4	0.7	2.3	4.6	17.0
Gadus morhua							
	1978	5.9	8.9	1.9	5.2	17.3	23.5
	1977	1.7	2.3	0.5	1.9	1.9	3.4
	1976	2.7	5.9	0.4	1.2	4.2	6.3
Pseudopleuronectes americanus	1978	2.9	4.4	9.7	26.6	3.6	4.9
	1977	3.5	4.9	6.4	26.7	1.9	3.4
	1976	1.6	3.4	5.1	16.6	1.6	2.4

[a] Some tows in 1976 and 1977 only five minutes, but all data converted to catch/10 min.

[b] % Total by transect

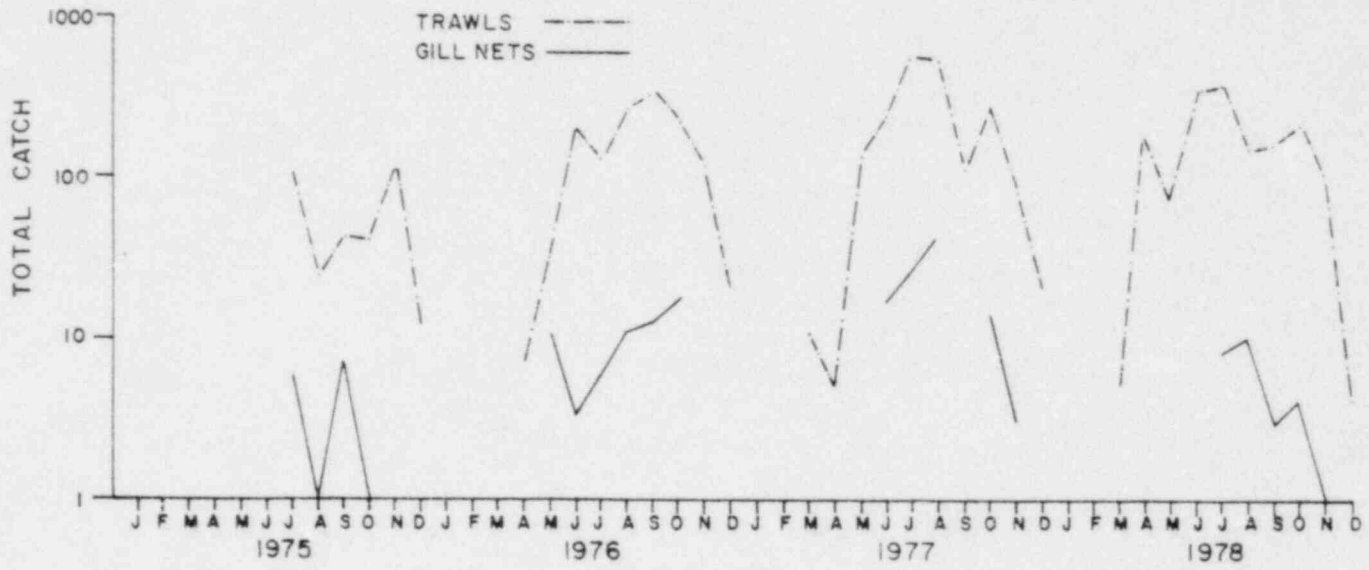


Figure 4.1-1 . Total monthly catch of hake, *Urophycis* spp., in otter trawls and gill nets from 1975 through 1978. Seabrook Finfish Studies, 1978.

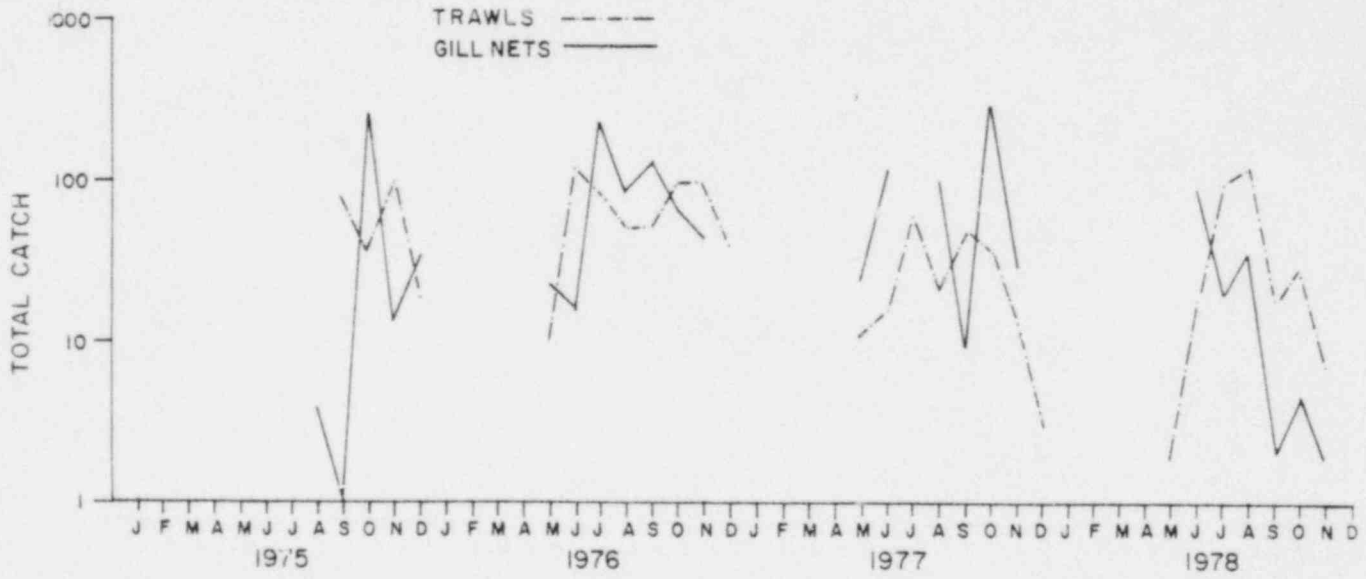


Figure 4.1-2. Total monthly catch of silver hake, *Merluccius bilinearis*, in otter trawls and gill nets from 1975 through 1978. Seabrook Finfish Studies, 1978.

Seabrook estuary. Richards (1963) has reported that *U. chuss* are migratory, appearing in the spring and fall, but did not correlate this movement with temperature. Both adult and juvenile hake are found in the vicinity of the Hampton-Seabrook estuary from spring through autumn, with juveniles (4.0 to 28 cm S.L.) captured primarily by seining and trawling, and adults (29 to 57 cm) captured by trawling and gillnetting.

The silver hake is a summer migrant; both adults and juveniles utilize New Hampshire coastal waters for feeding from May through November (Figure 4.1-2). In addition, silver hake eggs have been collected in the study area consistently since 1975, suggesting near-shore spawning during mid-summer; Bigelow and Schroeder (1953) report that spawning occurs in coastal water less than 91 m (50 fm) deep. The absence of silver hake during the winter and reduced abundance during mid-summer is due to a temperature-dependent movement pattern in which this species moves offshore to avoid temperature extremes (Bigelow and Schroeder, 1953; Richards, 1963). Sarnits and Sauskan (1967) observed that changes in silver hake distribution on the Scotia Shelf and Georges Bank were influenced by annual hydrographic conditions, particularly water temperature. Both gill net and otter trawl catches from 1975 through 1978 indicated similar abundances among years (Figure 4.1-2), although otter trawls captured smaller hake than the gill nets. The silver hake is primarily a predatory groundfish, but since its distribution is generally determined by the distribution of its prey, it can be found throughout the water column.

The yellowtail flounder is a dominant member of the groundfish community along the New Hampshire coast. Although they are present in the inshore regions throughout the year, yellowtail abundance tends to be lowest in mid-winter (Figure 4.1-3). Percent of the total catch at all transects and catch per effort at Transects 1 and 2 declined from 1976 to 1978 (Table 4.1-1), suggesting a possible decrease in population size during that period. In 1978 yellowtail ranging from 3.0 to 48.5 cm standard length were observed; mean length was 15.8 cm. Because yellowtail mature at 29 to 32 cm standard length (Royce *et al.*, 1959), the

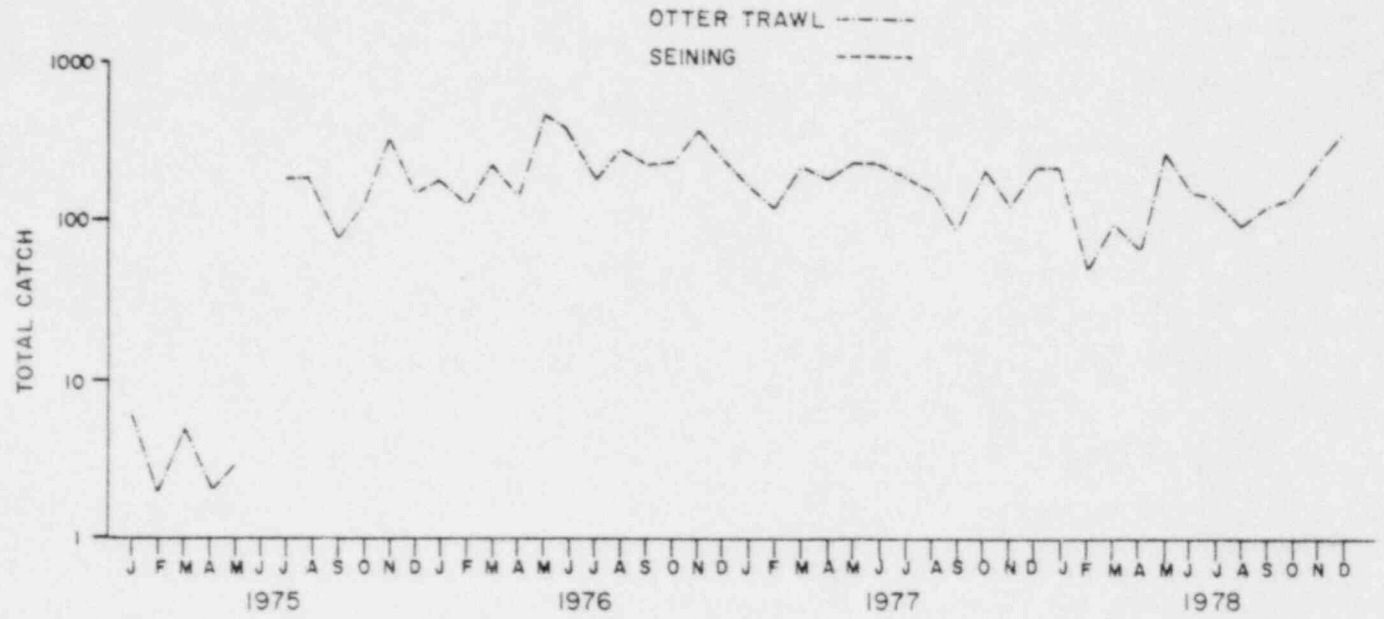


Figure 4.1-3. Total monthly catch of yellowtail flounder, *Limanda ferruginea*, in otter trawls from 1975 through 1978. Seabrook Finfish Studies, 1978.

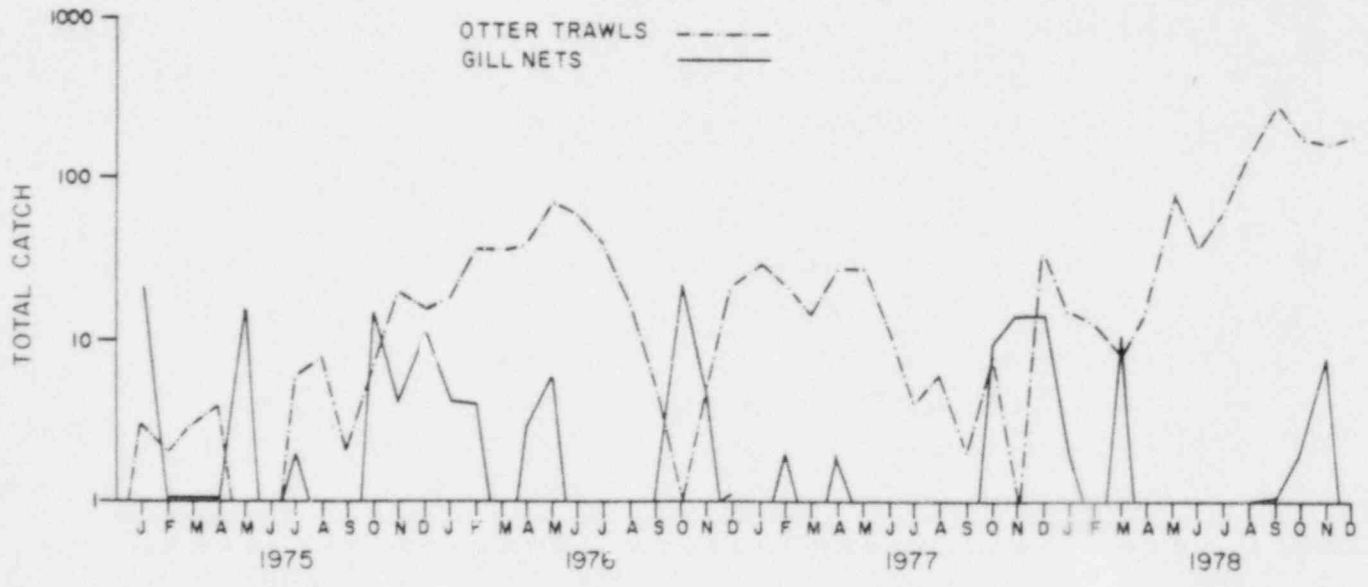


Figure 4.1-4. Total monthly catch of Atlantic cod, *Gadus morhua*, in otter trawls and gill nets from 1975 through 1978. Seabrook Finfish Studies, 1978.

1978 catch statistics, as well as those of previous years (NAI, 1978), indicate that most of the yellowtail collected in the inshore regions are immature. Bigelow and Schroeder (1953) have indicated that adults prefer deeper water (40-60 m) for general habitat and spawning. Clayton *et al.* (1978) indicate that the general depth range for this species is 10 to 120 m, with most commercial catches occurring between 40 and 80 m.

Atlantic cod inhabit the inshore regions throughout the year, but seasonally varied with year type (Figure 4.1-4). Examination of length data (NAI, 1977, 1979) indicates that during the fall and early winter and again in the spring the larger cod are caught in gill nets. Over a broader seasonal period more cod are caught in the trawls, but are smaller in size. Mean standard length for cod captured during 1978 was 16.1 cm with a range of 3.8 to 90.2 cm. Since cod mature at 64 cm standard length, most of the individuals caught were immature. Immature cod have predominated in the finfish samples collected since 1975. Bigelow and Schroeder (1953) report that small cod are somewhat less stenothermal than larger cod, which is usually reflected by the abundance of juveniles in shallow water throughout the summer. Adults are usually found from 5 to 75 fathoms. This inshore preference of the juveniles plus the inefficiency of otter trawls and gill nets in catching adult cod are likely responsible for the predominance of juveniles in the inshore samples from 1975 to 1978. The abundance of Atlantic cod increased from 1976 to 1978 (Table 4.1-1), likely reflecting natural changes in population size.

The rainbow smelt and winter flounder are primarily inshore species, and will be discussed with the estuarine community (Section 4.1.3).

4.1.2 Pelagic Species

The principal pelagic species encountered along the New Hampshire coast are the Atlantic herring, Atlantic mackerel, blueback

herring, alewife and silver hake. The abundance of all these species has been erratic among the sampling stations (Table 4.1-2). This spatial variability is likely attributable to the pelagic, wandering behavior of these species, their schooling nature, and the physical similarity of the sampling stations. Atlantic mackerel, blueback herring, and alewife were typically captured near the surface, silver hake were most often observed in gill nets set near the bottom, and Atlantic herring distribution varied between the surface and bottom nets. These finfish species prey on planktonic crustacea, and their depth distribution is dependent primarily on the distribution of their food organisms (Bigelow and Schroeder, 1953).

The Atlantic herring is the most abundant pelagic finfish observed along the New Hampshire coast (Figure 4.1-5; Table 4.1-2). This species is well known for its erratic and inconsistent abundance both spatially and temporally (Bigelow and Schroeder, 1953), and this characteristic has been observed in the Hampton-Seabrook study area from 1975 through 1978. One consistent feature, however, has been their extremely low abundance in the inshore region during mid-summer (Figure 4.1-5). Bigelow and Schroeder (1953) report that the regional abundance of this species varies with location and age of the herring schools, but that young herring tend to leave the shallow regions when water temperatures are the highest. Most of the herring encountered in inshore coastal regions were sub-adults, with a mean standard length of 18 cm (range = 9.5 to 36 cm); this species matures when 27 to 30 cm long and 4 years old. Some juvenile herring (4 to 10 cm S.L. during 1978) also enter the estuary during the spring and fall, but not during the summer. Thus, the inshore and estuarine portions of the Hampton-Seabrook region appear to be most important as feeding and over-wintering grounds for the immature Atlantic herring. Clayton *et al.* (1978) report that Atlantic herring larvae first appear along the coast during the autumn, with young herring (>40 mm) appearing in the upper reaches of Massachusetts estuaries during the winter and early spring. This pattern of abundance has been observed along the New Hampshire coast since 1975 in the present study.

TABLE 4.1-2. CATCH PER UNIT OF GILL NET EFFORT (C/E = 3-DAY SET) FOR FIVE FINFISH SPECIES COLLECTED DURING 1976, 1977 AND 1978. SEABROOK FINFISH STUDIES, 1978.

		STATIONS					
		A		B		C	
		C/E	% TOTAL[a]	C/E	% TOTAL	C/E	% TOTAL
Clupea harengus							
1978	S	90.7	82.7	27.7	62.5	75.7	62.1
	B	60.9	91.4	67.1	71.0	72.4	77.3
1977[b]	S	68.0	64.8	53.7	68.7	56.6	46.8
	B	16.1	36.2	18.5	39.1	17.6	27.3
1976	S	15.1	43.9	18.3	46.7	48.9	67.4
	B	35.2	63.5	20.4	52.7	21.1	44.0
Scomber scombrus							
1978	S	1.6	1.4	2.9	6.6	1.2	1.0
	B	1.1	1.6	1.7	1.8	1.5	1.6
1977	S	11.7	11.2	7.1	9.1	7.2	7.1
	B	1.1	2.4	0.9	1.8	0.9	3.3
1976	S	7.3	21.3	10.7	27.3	12.9	17.8
	B	0.6	1.1	1.5	4.1	1.2	2.4
Alosa aestivalis							
1978	S	5.9	5.4	5.3	12.0	35.4	29.4
	B	1.6	2.3	18.1	19.2	9.4	10.5
1977	S	7.0	6.6	9.4	12.1	32.5	26.9
	B	1.0	2.2	1.5	3.3	1.8	2.7
1976	S	8.5	19.4	1.7	4.3	2.9	4.0
	B	2.5	4.6	1.0	2.6	0.2	1.0
Alosa pseudoharengus							
1978	S	1.7	1.6	1.9	4.3	5.2	4.3
	B	0.2	0.2	0.1	<0.1	0.7	0.8
1977	S	1.5	1.4	2.4	3.0	1.6	1.3
	B	0.3	0.8	1.0	2.0	0.8	1.2
1976	S	0.5	1.4	1.5	3.8	0.2	0.2
	B	0.5	0.9	0.5	1.3	0.5	1.0
Merluccius bilinearis							
1978	S	6.8	6.2	3.0	6.7	0.9	0.7
	B	0.4	0.6	0.5	0.5	0.9	1.0
1977	S	11.6	11.0	8.8	11.3	13.9	11.5
	B	17.6	39.5	19.8	41.7	25.8	40.0
1976	S	3.5	10.2	6.5	16.7	7.0	9.6
	B	7.3	13.4	9.6	24.7	14.5	30.1

[a]Only one 24 hr set in March; weathered out.

[b]Percent of total catch by station and net depth.

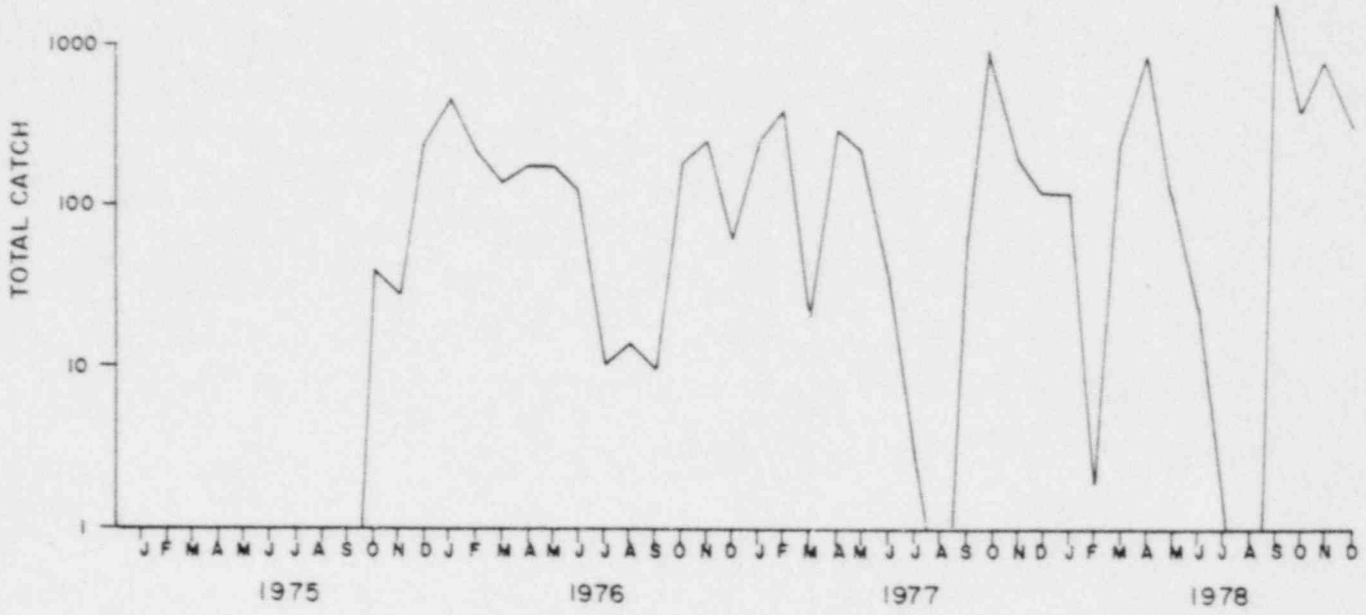


Figure 4.1-5. Total monthly catch of Atlantic herring, *Clupea harengus*, in gill nets from 1975 through 1978. Seabrook Finfish Studies, 1978.

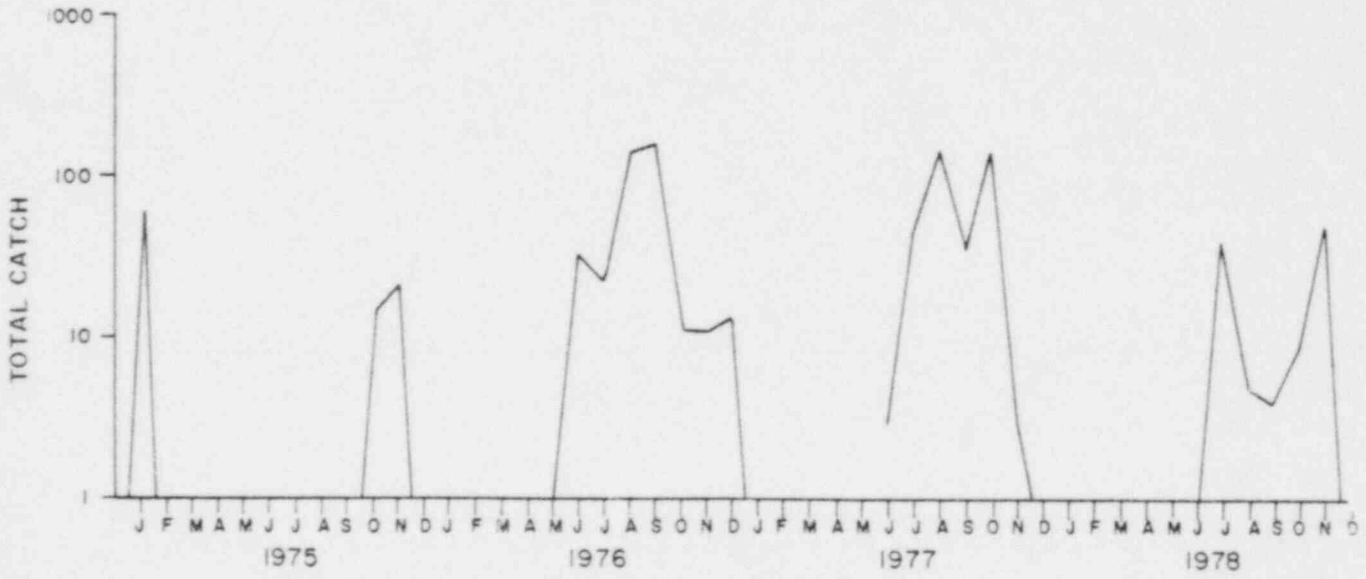


Figure 4.1-6. Total monthly catch of Atlantic mackerel, *Scomber scombrus*, in gill nets from 1975 through 1978. Seabrook Finfish Studies, 1978.

The Atlantic mackerel is a schooling, pelagic species that winters in deep water (Bigelow and Schroeder, 1953) and utilizes the inshore coastal waters as a feeding ground from June through November (Figure 4.1-6). The abundance of this species decreased during 1978, but this is probably a result of natural population cycles; the mackerel fishery is commonly dominated by strong year classes (Clayton et al., 1978). Summer water temperatures were similar during 1976 and 1978 peaking at 16.7°C, but the seasonal pattern of mackerel abundance was different (Figures 4.1-6; 4.2-3), suggesting that water temperature is not the sole factor regulating mackerel abundance in the inshore region. Bigelow and Schroeder (1953) and Recksick and McCleave (1973) reported that 12 to 14°C is the preferred temperature range for Atlantic mackerel. Therefore, the water temperatures during 1976 and 1978 were probably not great enough to cause exclusion of this species from the inshore waters. Mackerel caught along the New Hampshire coast are mostly adults (17 to 45 cm; mean = 33 cm in 1978), although a few juveniles are also captured. This has been consistent since 1975, but is, in part, due to the selective nature of the sampling gear.

The alewife and blueback herring are anadromous clupeids, collectively called river herring. They enter freshwater to spawn from March through May, and return to the ocean in mid summer. Juveniles remain in fresh or brackish water throughout their first summer, migrating downstream from late summer through autumn. While in the marine environment, river herring are pelagic and are usually found near the surface (Table 4.1-2). Most of the river herring captured in inshore coastal waters were subadults; blueback herring were generally caught throughout the year, while alewife were captured primarily from March through November (Figure 4.1-7). During 1978 adult blueback herring (>20 cm S.L.) were captured inshore from late May through October. Young of the year blueback were observed within the estuary during September and October. No adult alewives (>25 cm) were observed inshore, but subadult alewives were present in the Hampton-Seabrook estuary from May through October. Blueback have been more abundant than alewife from 1976 through 1978 (Table 4.1-2), and the catch per unit of

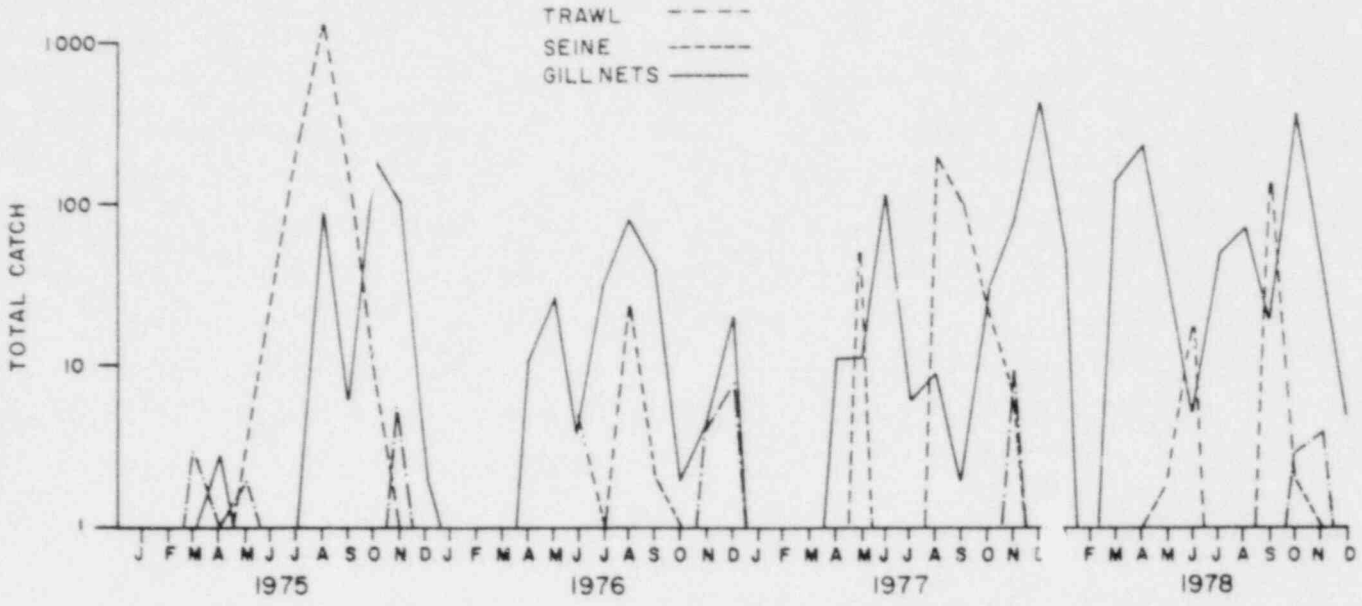


Figure 4.1-7. Total monthly catch of river herring, *Alosa pseudoharengus* and *A. aestivalis*, in otter trawls, gill nets and beach seines from 1975 through 1978. Seabrook Finfish Studies, 1978.

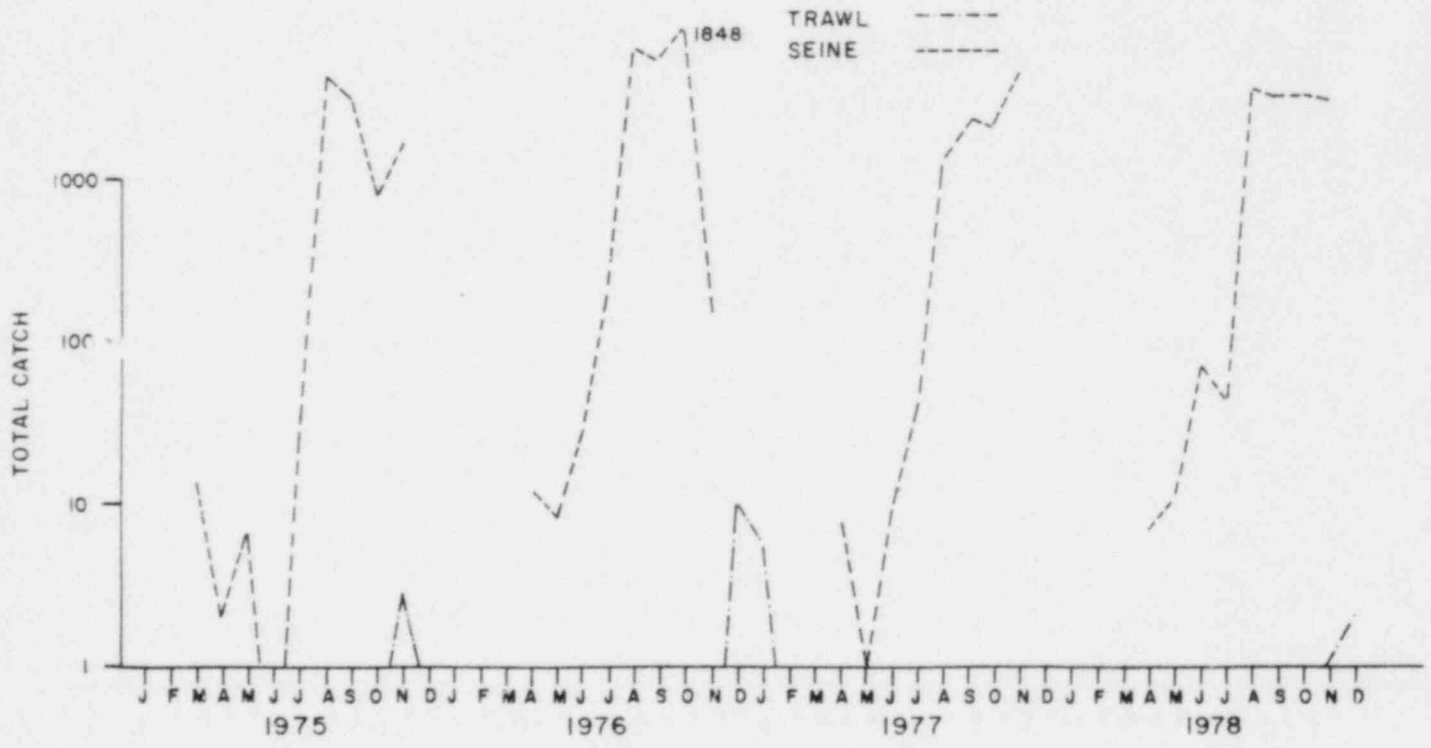


Figure 4.1-8. Total monthly catch of Atlantic silversides, *Menidia menidia*, in otter trawls and beach seines from 1975 through 1978. Seabrook Finfish Studies, 1978.

seining and gill net effort for these species indicates that both populations have generally increased from 1976 through 1978 (Figure 4.1-7), likely reflecting natural population size fluctuations.

4.1.3 Estuarine Species

The more abundant resident finfish of the Hampton-Seabrook estuary are the Atlantic silversides and killifish. Other species that are dependent on the estuary include the American sand lance, winter flounder and rainbow smelt.

The Atlantic silverside is a small, schooling species that inhabits shallow regions with sandy or gravelly substrates either inshore or in brackish water (Bigelow and Schroeder, 1953; Leim and Scott, 1966). In the Hampton-Seabrook estuary this species appears to be most abundant at Station S3 (Table 4.1-3). It is not clear why abundances are higher at S3 (mouth of Seabrook Harbor); the steeper channel profile (and greater water depth) and higher salinities are the only observed differences at this station. Rainbow smelt were also most abundant at Station S3 during all three years although smelt abundance was extremely low in 1978. Killifish, in contrast, tend to be least abundant at Station S3. Although killifish are euryhaline, they prefer brackish water, and are therefore found in greater abundance within the tidal creeks. The spatial distribution of both winter flounder and American sand lance varied among years, suggesting no station preference for either species. Catch per unit of effort was more variable for sand lance than winter flounder, however.

Atlantic silverside was the most abundant estuarine species captured from 1976 through 1978 (Table 4.1-4), although the catch per unit of effort varied considerably among years (Table 4.1-3, Figure 4.1-8). This variation in catch may be due to natural population fluctuation as well as the inherent variability in sampling populations with a heterogeneous distribution. Although silversides are present in the

TABLE 4.1-3. CATCH PE. UNIT OF SEINING EFFORT (TWO HAULS) FOR FIVE FINFISH SPECIES COLLECTED DURING 1976, 1977 AND 1978. SEABROOK FINFISH STUDIES, 1978.

	S1		S2		S3	
	C/E	% TOTAL[a]	C/E	% TOTAL	C/E	% TOTAL
Menidia menidia						
1978	125.6	63.6	338.9	67.5	416.5	87.3
1977	93.2	28.7	162.5	42.8	398.0	80.7
1976	332.6	74.7	185.6	44.4	1049.9	82.8
Ammodytes americanus						
1978	0.0	0.0	87.3	17.4	1.3	0.2
1977	88.4	27.2	13.8	3.6	0.0	0.0
1976	0.1	<0.1	0.0	0.0	53.1	4.2
Fundulus spp.						
1978	47.4	9.9	8.0	1.6	0.1	<0.1
1977	97.6	30.0	175.3	46.2	0.2	<0.1
1976	104.7	23.5	215.3	51.5	0.0	0.0
Pseudopleuronectes americanus						
1978	20.0	1.0	4.8	0.9	13.3	2.8
1977	7.4	2.3	3.8	1.0	11.9	2.4
1976	2.5	0.5	4.3	0.1	5.7	0.4
Osmerus mordax						
1978	0.0	0.0	0.2	<0.1	0.4	<0.1
1977	0.1	<0.1	0.1	<0.1	56.2	11.4
1976	1.9	0.4	3.9	1.0	82.5	6.5

[a]Percent of total catch per station per year

TABLE 4.1-4. SUMMARY OF BIOLOGICAL INDEX VALUES FOR DOMINANT FISH SPECIES COLLECTED IN SEINED, 1976-1978. SEABROOK FINFISH STUDIES, 1978.

	BIOLOGICAL INDEX VALUES*		
	1976	1977	1978
Menidia menidia	68	67	70
Pseudopleuronectes americanus	61	64	64
Fundulus spp.	53	39	38
Gasterosteus aculeatus	28	37	54
Pungitius pungitius	29	25	31
Ammodytes americanus	14	30	39
Osmerus mordax	28	37	15
Alosa aestivalis	13	34	13
Liopsetta putnami	0	26	46
Urophycis spp.	18	26	22
Alosa pseudoharengus	20	14	11
Clupea harengus	3	8	25

*Maximum value is 80

estuary throughout the year, they are most abundant from August through November (Appendix Tables 7.3-1 to 7.3-3). Studies have indicated that silversides inhabit the upper portions of the estuary during the early summer spawning period (NAI, 1979; Jerome *et al.*, 1965; 1968), and move into deeper water throughout the winter (Clayton *et al.*, 1978). A few Atlantic silversides have also been captured inshore each year in the otter trawl samples.

American sand lance abundance was highly variable both spatially and temporally (Table 4.1-3), although the biological index value for sand lance increased each year from 1976 through 1978 (Table 4.1-4). Bigelow and Schroeder (1953) and Leim and Scott (1966) both report that the adults likely move offshore to spawn in deeper water (10 fathoms) during late autumn and winter. Sand lance larvae appear in the inshore regions during the following spring. This temporal movement pattern agrees with that observed along the New Hampshire coast. The adults have been observed in the estuaries during summer and autumn, and at the inshore otter trawling stations from fall through spring (Figure 4.1-9).

Killifish are year-round residents of the Hampton-Seabrook estuary. They have a high biological index value (Table 4.1-4) because they are found during all months from late spring through November, with maximum abundance during the summer (Figure 4.1-10; Appendix Tables 7.3-1 to 7.3-3). The catch per unit of seining effort was stable during 1976 and 1977, but decreased during 1978 (Table 4.1-3).

The winter flounder is an inshore euryhaline species that is seasonally abundant in estuaries. Abundance of flounder along the coast was fairly stable from 1976 through 1978 (Table 4.1-1). Winter flounder were captured year-round in the near-shore regions, with maximum abundance observed during early summer and early fall. High mid-summer water temperatures appear to cause a temporary offshore movement during July and August (Figure 4.1-11). Both mature (>21 cm S.L.) and immature winter flounder inhabit the inshore regions; during 1978 the mean standard length for winter flounder from otter trawl samples was 18.0 cm,

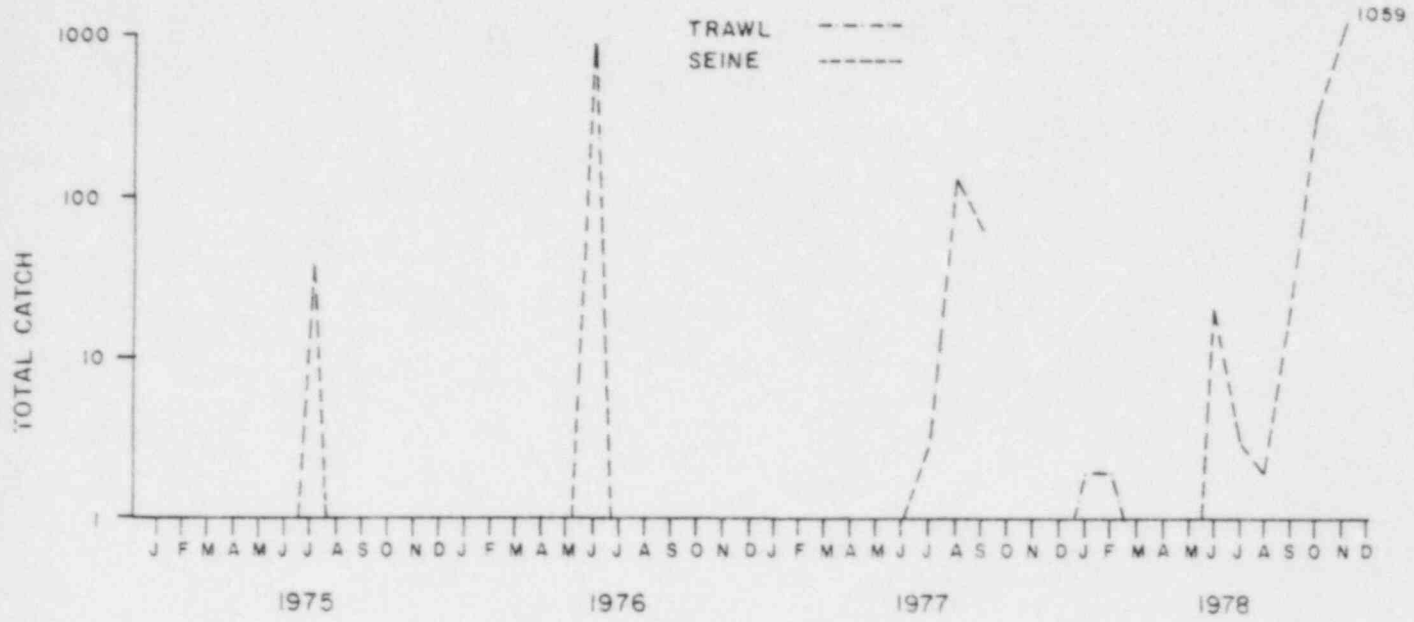


Figure 4.1-9. Total monthly catch of American sand lance, *Ammodytes americanus*, in otter trawls and beach seines from 1975 through 1978. Seabrook Finfish Studies, 1978.

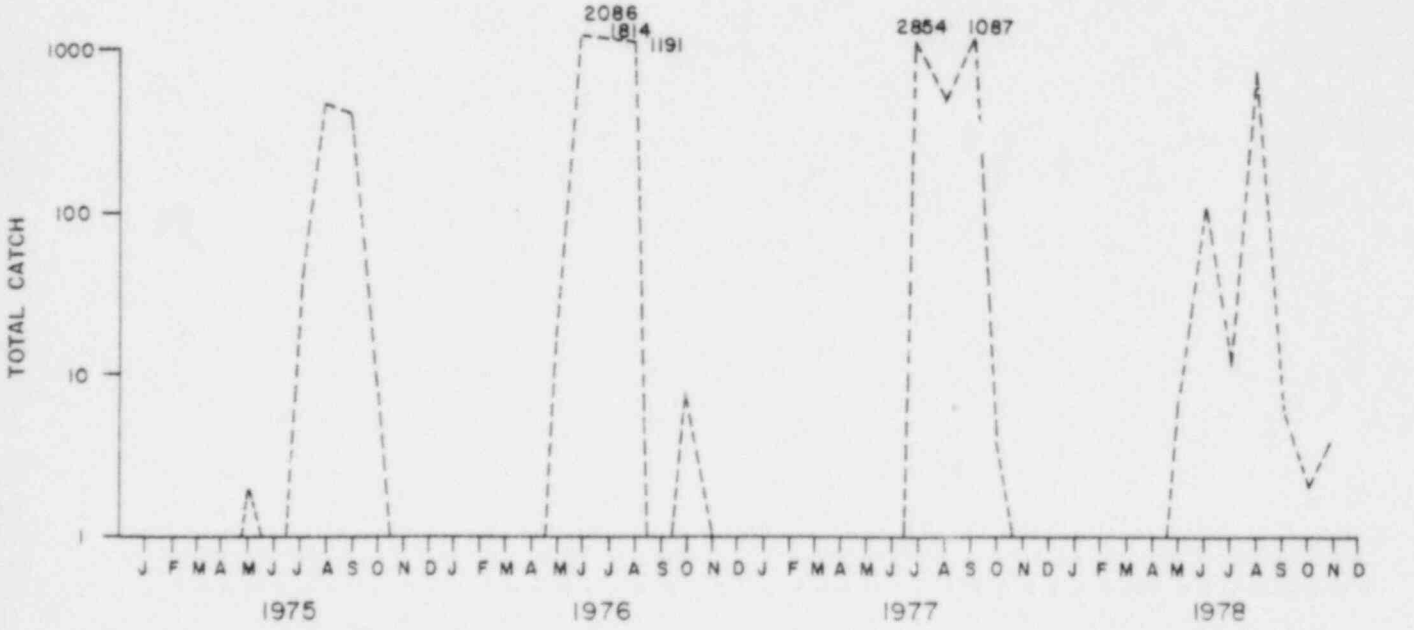


Figure 4.1-10. Total monthly catch of killifish, *Fundulus* spp., in beach seines from 1975 through 1978. Seabrook Finfish Studies, 1978.

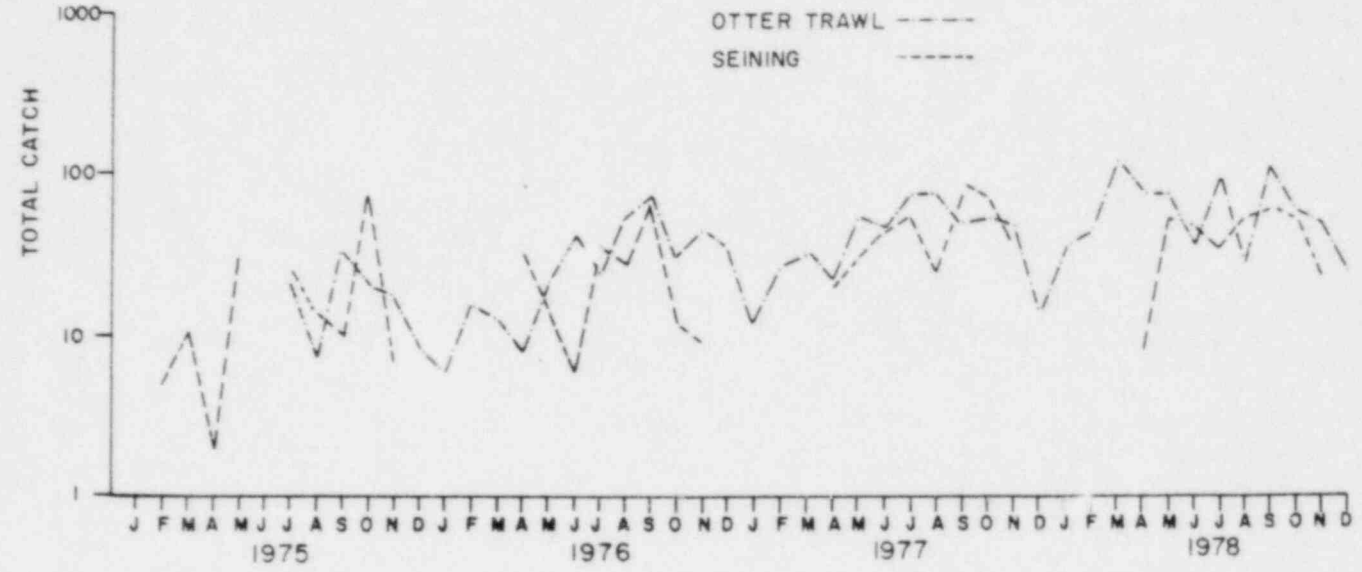


Figure 4.1-11. Total monthly catch of winter flounder, *Pseudopleuronectes americanus*, in otter trawls and beach seines from 1975 through 1978. Seabrook Finfish Studies, 1978.

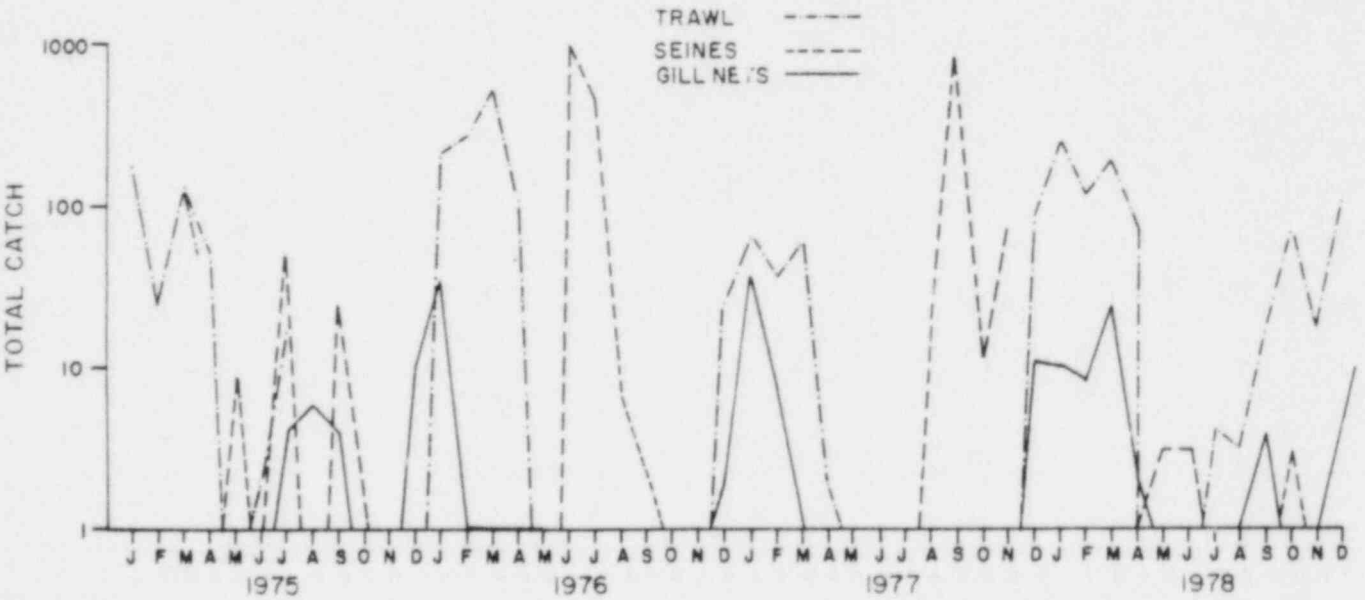


Figure 4.1-12. Total monthly catch of rainbow smelt, *Osmerus mordax*, in otter trawls, gill nets and beach seines from 1975 through 1978. Seabrook Finfish Studies, 1978.

with a range of 2.5 to 40.6 cm. Primarily juveniles are observed within the estuary; mean standard length for flounder from estuarine samples was 6.7 cm, with a range of 1.5 to 26.1 cm. Winter flounder have been seined within the Hampton-Seabrook estuary from April through November. Estuarine sampling in 1973-1974 (NAI, 1974) recovered very few winter flounder from December through March; none were collected in trawls, seven in seines and 13 specimens in fyke nets over this period. Finfish surveys in the Merrimack River estuary and Plum Island Sound (Jerome *et al.*, 1965; 1968) indicate that this species may be present in some estuaries throughout the winter.

The rainbow smelt is an anadromous salmonid that inhabits the inshore coastal waters during most of the year. In summer, adults are found outside the bays and estuaries. Bigelow and Schroeder (1953) report that they remain within a mile of shore in water less than 3 fm (6 m) deep. It is apparent from these studies, however, that in this area, at least, smelt are very low in numbers within a mile of shore and in water up to 5 fm (9 m) during the warmer months (NAI 1974). In late fall and winter they are found in greater numbers in the nearshore areas and in water more than 10 fm (18 m) deep about 2 mi offshore (NAI, 1973, 1979). As the water temperature decreases in the winter, smelt gather in the estuaries, and subsequently ascend to fresh water to spawn during the late winter. The eggs develop within freshwater, but the larvae and juveniles develop within the estuary. Both immature (< 17 cm standard length) and adult smelt are abundant along the New Hampshire coast from late autumn through spring (Figure 4.1-12). In the 1973-1974 survey, only one smelt was captured from January through April within the Hampton-Seabrook estuary. The presence of young-of-the-year within the Hampton-Seabrook Estuary each summer (Figure 4.1-12) indicates successful spawning in the tributaries. The abundance of young-of-the-year within the estuary (Tables 4.1-3 and 4.1-4) as well as immature and adult smelt along the coast (Table 4.1-1) have been variable since 1975. The smelt is well-known for its extreme fluctuation in population size, which in turn influences the annual success of the winter sport fishery (Bigelow and Schroeder, 1953; Jerome *et al.*, 1968).

4.1.4 Indicator Species

Seven finfish species were chosen in conjunction with Region I EPA as indicator species for a FWPCA Section 316(a) demonstration; emphasis during the selection was placed on species with commercial or sport fishery value. The following seven species were chosen:

Coho salmon	*Oncorhynchus kisutch*
Atlantic menhaden	*Brevoortia tyrannus*
Alewife	*Alosa pseudoharengus*
Winter flounder	*Pseudopleuronectes americanus*
Rainbow smelt	*Osmerus mordax*
Atlantic mackerel	*Scomber scombrus*
Pollock	*Pollachius virens*

The cunner, *Tautogolabrus adspersus*, has also been included as an important species; it is a dominant member of the finfish community inhabiting rocky areas, and growth characteristics for this species provide an indicator of sublethal effects that cannot be determined solely from changes in abundance.

Temporal and spatial distributions of these species are summarized in Table 4.1-5. Additional information relevant to the distribution or importance of these species along the New Hampshire coast is discussed below.

The coho salmon is the only indicator species that is not endemic to New Hampshire coastal waters. This species is native to the Pacific Ocean, and was introduced to the Gulf of Maine by the New Hampshire Fish and Game Department during the early 1970's in an attempt to start a coastal salmonid fishery. This program was only marginally successful, and few coho have been collected in the Hampton-Seabrook region during recent years; four were captured in 1976 and two in 1978. Of these, only one was mature; a 6-lb female coho salmon was captured in a gill net during June 1978 (Appendix Table 7-6). The other five were captured within the Hampton-Seabrook estuary by seining and averaged 22 cm total length.

TABLE 4.1-5. TEMPORAL AND SPATIAL ABUNDANCE OF INDICATOR FINFISH SPECIES WITHIN THE HAMPTON-SEABROOK REGION. SEABROOK FINFISH STUDIES, 1978.

TEMPORAL AND SPATIAL ABUNDANCE WITHIN THE HAMPTON-SEABROOK REGION

SPECIES		SPAWNING		EGGS		LARVAE		IMMATURE		ADULTS		COMMENTS
		LOCATION	PERIOD	LOCATION	PERIOD	LOCATION	PERIOD	LOCATION	PERIOD	LOCATION	PERIOD	
Groundfish	*Pseudopleuronectes americanus*	offshore shoal areas & inshore	late winter, spring	N/C, demersal		inshore & esutary	Apr-Jun	inshore; estuary	year-round year-round	inshore	year-round	Resident species; abundant
	Tautogolabrus adspersus	inshore	late spring; early summer	inshore	May-Sep	inshore	Jun-Sep	inshore	year-round	inshore	year-round	Resident species; abundant
Pelagic fish	*Brevoortia tyrannus*	offshore	Jun-Aug	inshore & estuaries	Jun-Aug	inshore & estuaries	Jun-Aug	N/C, south of New England		inshore	May-Nov	Not usually locally abundant; northern range limit
	Scomber scombrus	offshore	late spring, early summer	inshore	Apr-Jul	inshore	Jun-Jul	inshore	Jan-Dec	inshore	Jun-Dec	
	Pollachius virens	inshore	late autumn, early winter	inshore	Oct-Jun	inshore	Oct-Jun	inshore; estuary	Apr-Dec	offshore	year-round	
Anadromous	*Oncorhynchus kisutch*	fresh-water	October	N/C, freshwater		N/C, freshwater		estuary	November	inshore & offshore	winter, spring	Introduced salmonid; not abundant
	Alosa pseudoharengus	fresh-water	spring	N/C; freshwater		N/C, freshwater		inshore; estuary	summer summer	estuary; inshore	spring	
	Osmerus mordax	fresh-water	early spring	N/C; freshwater		estuary	May-Jun	estuary	Jul-Nov	inshore & freshwater	winter	

N/C indicates that this life stage has not been collected in the Hampton-Seabrook study area for the reason listed.

The Atlantic menhaden is a pelagic clupeid that migrates into New Hampshire coastal waters during the late spring and summer and remains inshore through October (Figure 4.1-13). This species prefers warmer waters, and is more common in southern New England. Consequently, the catches of menhaden within the study area have been low, contributing less than 1.5% of the annual gill net catch from 1976 through 1978. The annual abundance of menhaden has fluctuated widely; they were most abundant during 1977 when they were captured continuously from May through October. During 1975, 1976 and 1978, however, menhaden abundance was lower and they were captured only sporadically throughout the summer (Figure 4.1-13). Bigelow and Schroeder (1953) have indicated that the Gulf of Maine is the northern limit for menhaden distribution, and that their abundance in the Gulf of Maine fluctuates tremendously from year to year.

Alewives and blueback herring are anadromous clupeids common along the New Hampshire coast. Alewives ascend into freshwater to spawn in the spring, usually during April and May in New Hampshire. As the alewife migration declines, the blueback herring start migrating into the rivers to spawn so that mixed schools of these species (collectively called river herring) are present in the rivers. The adults return to the ocean soon after spawning. Because both species spawn in freshwater, the eggs are not found within the estuary. Young-of-the-year of both species, however, descend into the estuary during the summer, forming large congeneric schools. These juveniles remain within the estuary until winter when they move out to the inshore coastal waters. Comparison of catch per unit gill net effort suggests that blueback herring were more abundant than alewives along the coast from 1976 through 1978 (Table 4.1-2). In addition, juvenile blueback herring were more abundant than alewives in the estuary (Table 4.1-4); the former represented 11.9% of the 1975-1976 beach seine catch while alewives represented 0.05% of the same catch. These data suggest that blueback may be numerically more important than alewives, and that both species should be considered either combined or separately, as indicator species. The abundance of both species increased from 1976 through 1978, most likely as a result of natural population size fluctuations.

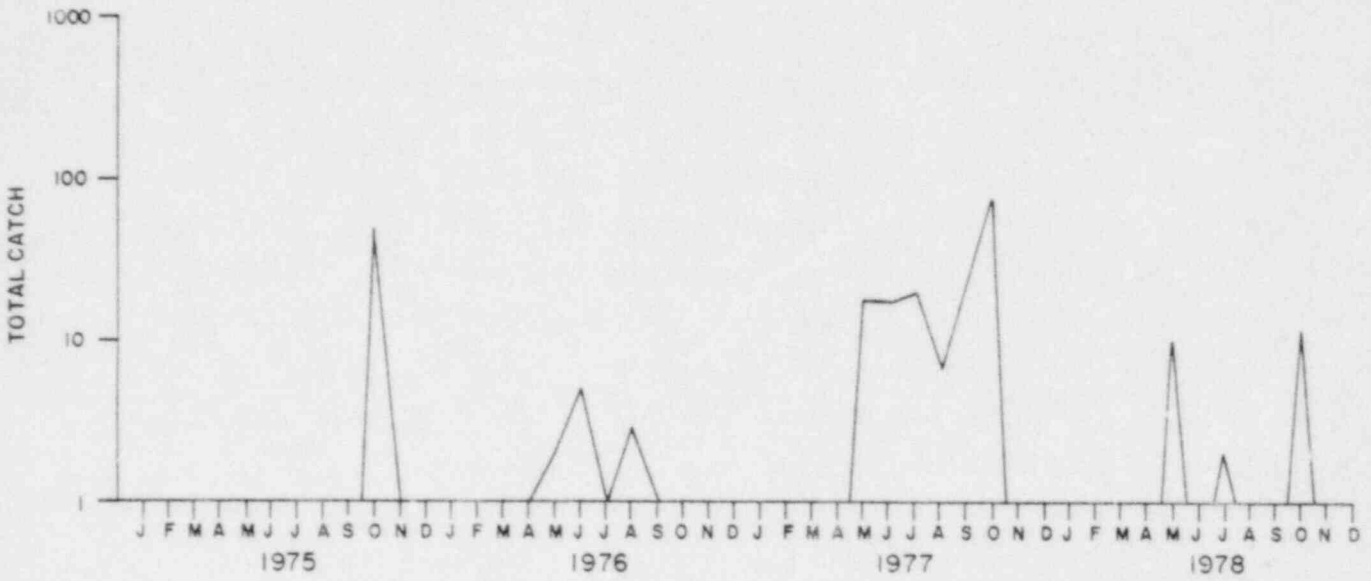


Figure 4.1-13. Total monthly catch of Atlantic menhaden, *Brevoortia tyrannus*, in gill nets from 1975 through 1978. Seabrook Finfish Studies, 1978.

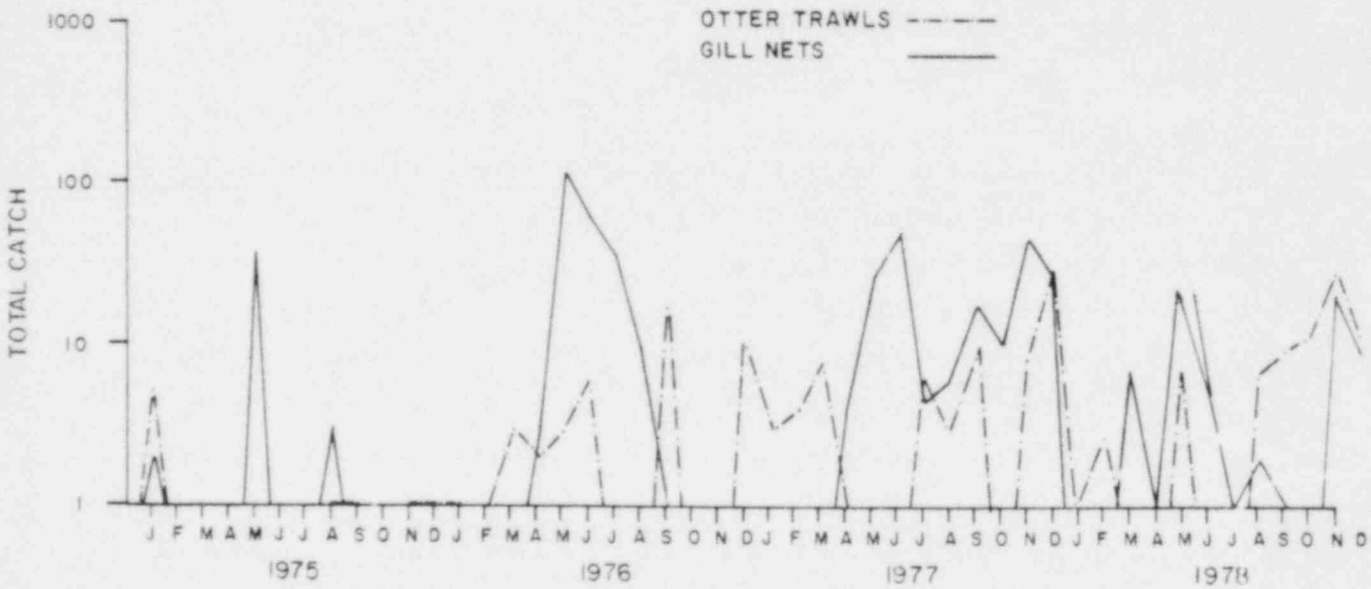


Figure 4.1-14. Total monthly catch of pollock, *Pollachius virens*, in otter trawls and gill nets from 1975 through 1978. Seabrook Finfish Studies, 1978.

The winter flounder was the only resident finfish chosen as an indicator species. It has been abundant in trawls and beach seines during the past three years, and has been collected throughout the year (Table 4.1-1, 4.1-3, 4.1-4; Appendix Tables 7-1 to 7-3 and 7-8 to 7-10). Most of the winter flounder collected in the Hampton-Seabrook Estuary were juveniles of approximately 10 cm standard length (NAI, 1976; 1978). Both immature and adult flounder have been observed at the inshore coastal locations. Winter flounder was the most frequently sought and collected fish during the sport fisheries survey conducted inshore and within the estuary (NAI, 1974; 1975; 1976; 1978); this species is also commercially important.

Rainbow smelt are anadromous, ascending into freshwater to spawn in the early spring at water temperatures of 4.4 to 5.6°C. Adults are first collected offshore during December, and catches decline by late April when the population is largely in freshwater. Catch per unit of trawling effort varied from 1975 through 1978 (Figure 4.1-12), reflecting the cyclic population size fluctuations that are characteristic of rainbow smelt. Smelt are a major food source for salmonids and other piscivorous game fish, and also provide both sport and commercial fisheries along the New Hampshire coast.

The Atlantic mackerel is a pelagic, ocean migrant occurring in New Hampshire waters from late spring through December (Figure 4.1-6). Abundance as indicated by catch per unit of gill net effort varied among years, with lowest abundance in 1978 (Table 4.1-2). This is not unusual, however, because wide yearly fluctuations in population size are characteristic of the mackerel (Bigelow and Schroeder, 1953). The Atlantic mackerel supports a limited sport fishery along the New Hampshire coast.

Pollock have been abundant in the Hampton-Seabrook region from 1975 through 1978, although the catch per unit of effort may not reflect true abundance. This is the result of their low susceptibility to the sampling equipment. Observations by SCUBA divers during 1975 and 1976 indicated that juvenile pollock were common throughout the study area

from April through November, with schools of as many as 800 individuals commonly observed (NAI, 1976). However, gill nets and otter trawls captured fewer pollock than would be expected from the diver observations (Figure 4.1-14). Divers have observed pollock approach and avoid gill nets, sometimes feeding on the previously captured fish. Gill net and otter trawl sampling have shown that pollock are most abundant during the spring and summer, but are present along the coast year-round (Figure 4.4-2). All pollock caught nearshore have been immature, ranging from 7 to 42 cm; individuals captured within the estuary have been even smaller, from 6 to 9 cm. Pollock mature when approximately 55 cm standard length. Bigelow and Schroeder (1953) report that small harbor pollock (20-25 cm) are abundant inshore after early April, while the larger individuals tend to remain farther offshore. This pattern agrees with that observed along the New Hampshire coast. Thus, pollock utilize the Hampton-Seabrook region primarily as a feeding area for juveniles from April through December.

The cunner is an inshore resident species that lives among rocks or sea grasses. For this reason, the cunner is difficult to sample representatively using standard fishing equipment such as trawls and gill nets. Therefore, the condition and age and growth characteristics of the cunner may be a better indicator of sublethal effects or long-term changes within the population than changes in abundance.

Table 4.1-6 presents total length at capture data for cunner sampled from four locations between Connecticut and the Gulf of St. Lawrence. Cunner collected in New Hampshire during 1977 and 1978 were smaller at age than those collected in Massachusetts and Connecticut, and fall within the range given by Johansen (1925) for Ages I and II. The New Hampshire cunner may grow at a slower rate because of a shorter growing season, genetic growth rate differences, or both.

Females from New Hampshire waters tend to be larger than males at Ages II and III, but males are larger throughout the older age classes (Table 3.4-1). Variable growth rates between the sexes have

TABLE 4.1-6. MEAN TOTAL LENGTH (mm) AT CAPTURE FOR CUNNER, *TAUTOGOLABRUS ADSPERSUS*, FROM FOUR LOCATIONS. SEABROOK FINFISH STUDIES, 1978.

AGE	SEABROOK, NH				WEWEANTIC RIVER, MA		FISHER ISLAND SOUND, CT		GULF OF ST. LAWRENCE
	1977		1978						
	LENGTH	N	LENGTH	N	LENGTH	N	LENGTH	N	LENGTH
I	47.2	20	29.4	4	67.0	71	94.9	67	40-60
II	78.3	29	92.0	6	104.0	26	116. .	35	80-110
III	94.3	90	106.0	12	1.1.9	35	146.4	32	120-150
IV	118.4	41	119.1	21	171.6	31	183.4	8	150-180
V	142.4	37	139.0	19	182.1	22			180-220
VI	179.9	33	155.4	15	204.3	3			
SOURCE:	NAI, 1979		Present Study		Serchuk and Cole (1974)		Dew (1976)		Johansen (1925)

also been described for other cunner populations. Johansen (1925) found that males >150 mm (total length) were smaller than females of the same age, while males from Connecticut were larger at age than females (Dew, 1976).

Johansen (1925) reported that onset of maturity in Nova Scotia cunner occurred at Age II; Dew (1976) found 50% of Age 0 and 100% of Age I specimens in Connecticut had attained maturity. New Hampshire cunner mature at Age II (NAI, 1976) suggesting an onset of maturity midway between that determined for Nova Scotia and Connecticut populations. Differences in maturation between Nova Scotia and New Hampshire cunner and those from Connecticut is likely related to the length of the growing season and the observed growth rate. Fish that grow quickly tend to mature earlier than those from slow-growing populations.

Cunner males tended to be longer than the females at all ages (Table 3.4-1). Calculated lengths at age are similar to the observed lengths at capture, which tends to confirm the validity of the back-calculation assumptions. Table 4.1-7 compares calculated lengths for three cunner populations in New England. Coastal New Hampshire cunner were smaller at age than either of the other two populations. In Connecticut (Dew, 1976) and Massachusetts (Serchuk and Cole, 1974), cunner attained 180 mm by Age IV or V, but in New Hampshire Age V fish were 130 mm. This indicates a slow-growing New Hampshire cunner population.

4.2 ICHTHYOPLANKTON

The ichthyoplankton assemblage in the Hampton-Seabrook area during 1978 differed little, in terms of species composition, dominants and general seasonal periodicity, from previous characterizations of the assemblage (NAI, 1979). Groundfish (e.g., sand lance, plaice, cod, hakes) predominated, while pelagic species such as herring and mackerel were transitory. Estuarine-dependent species, such as Atlantic tomcod were rare. Of interest was the reduced numbers of gadids and herring

TABLE 4.1-7. BACK-CALCULATED TOTAL LENGTHS AT ANNULUS FORMATION FOR CUNNER, *TAUTOGOLABRUS ADSPERSUS*, FROM THREE LOCATIONS. SEABROOK FINFISH STUDIES, 1978.

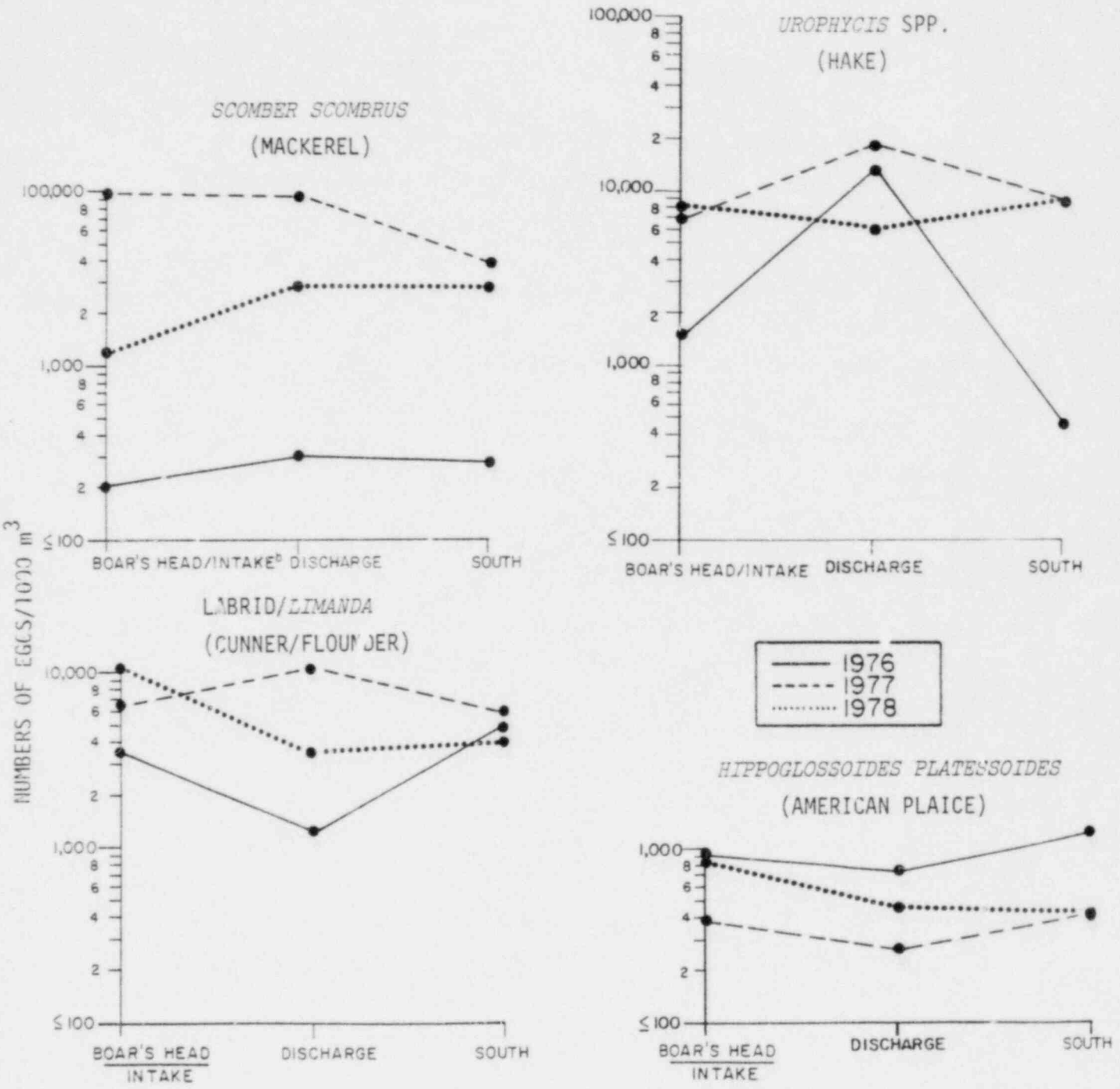
ANNULUS	SEABROOK, NH		WEWEANTIC RIVER, MA	FISHER ISLAND SOUND CT	
	1977	1978		MALES	FEMALES
1	40.9	50.0	46.5	57.4	46.4
2	63.7	72.3	88.3	97.5	87.3
3	84.9	92.3	124.8	135.4	120.6
4	109.0	110.5	153.1	177.9	145.6
5	134.1	129.4	176.5		
6	164.0	145.9			
SOURCE:	NAI, 1979	Present Study	Serchuk and Cole (1974)	Dew (1976)	

collected during the fall of 1978 compared with 1975-1977. Seasonal changes in species richness were also similar to previous years, although 1978, like 1977, saw a fall increase in the number of egg species collected (NAI, 1979).

During 1978, both fish eggs and larvae were generally more abundant at the Intake and South transects than at the Discharge transect. These transect differences varied by species (e.g., Labrid/*Limanda* and *Urophycis* spp. eggs) and, often, by sample period. On an annual basis, species composition was generally similar at all transects, although the Discharge transect was somewhat less similar because of the lower densities of cunner and sand lance larvae.

The spatial and temporal distributions of 14 ichthyoplankton species and groups was evaluated for their periods of occurrence during 1978 and compared with 1975-1977 data. Species selected were indicator species, numerical dominants and those which are of recreational and commercial value. All species showed marked seasonality (Appendix Tables 7-14 and 7-15). Species whose early life stages were most persistent over time were cod/haddock, plaice and Labrid/*Limanda* eggs and sand lance and cod larvae. Seasonal periodicity was generally similar for each species over the years, although start and end dates for presences in samples generally varied from one to two months from year to year.

Changes in spatial distribution between years was suggested for Labrid/*Limanda*, mackerel, plaice and hake eggs and sand lance, yellowtail flounder, silver hake and mackerel larvae (Appendix Tables 7-14 and 7-15). Mean densities of Labrid/*Limanda* eggs were noticeably lower in 1976 at two transects (20 times lower at the south transect) but were more similar between years at the discharge. Densities were lower at the discharge in 1978, a trend different from 1976 and 1977. Mackerel eggs were evenly distributed and occurred in low numbers during 1976; noticeably lower numbers were recorded at the south transect in 1977 and at the intake in 1978 (Figure 4.2-1). Hake eggs were



[a]Average densities (no./1000 m^3) for the number of sample periods each species was present during each year.

[b]Boar's Head transect sampled through 15 Jun 77; Intake transect sampled 6 Jul 77 to present.

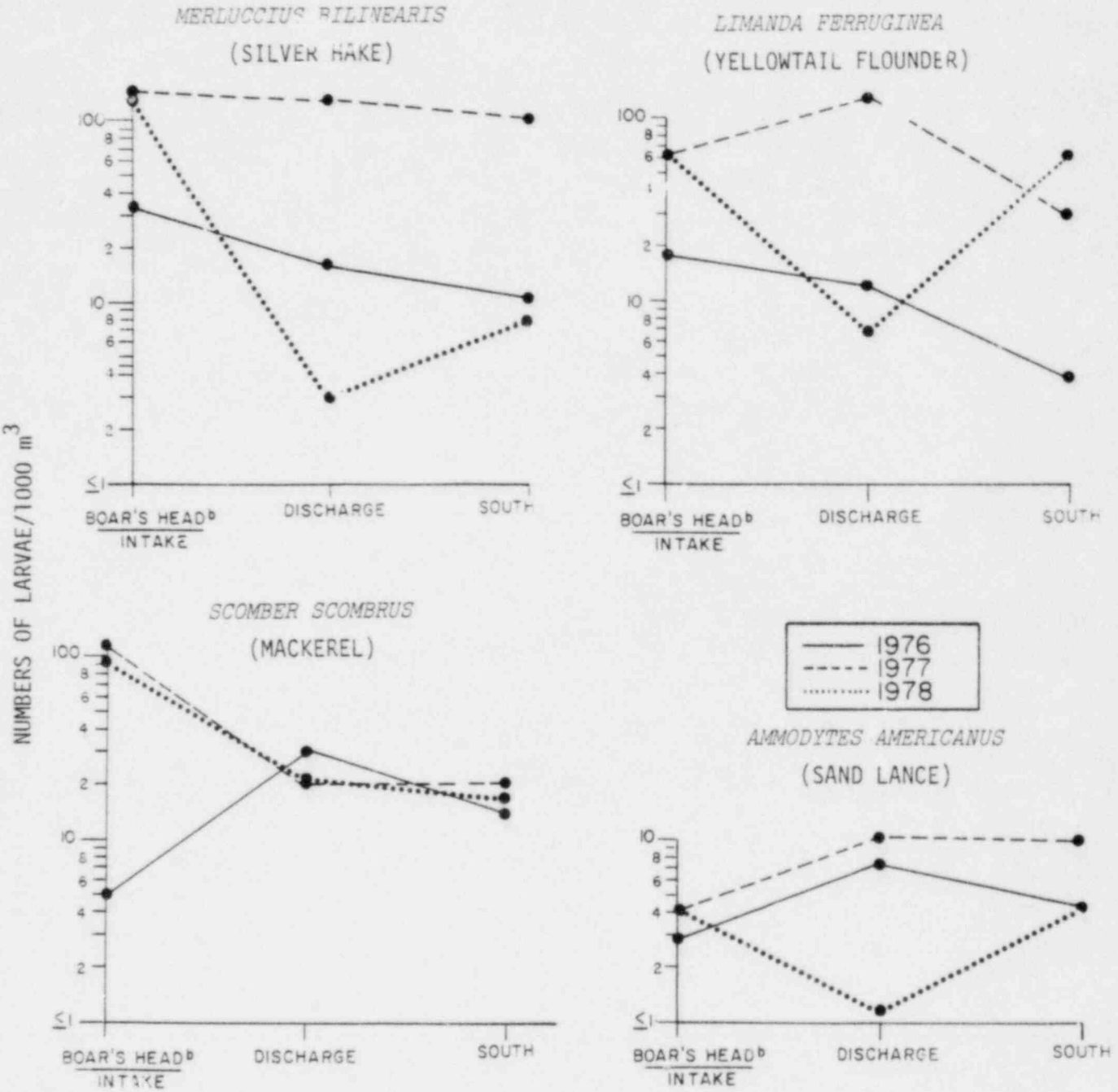
Figure 4.2-1. Mean abundance[a] of selected species of fish eggs by transect,[b] 1976-1978. Seabrook Finfish Studies, 1978.

higher at the discharge site in 1977 while in the other two years they were lowest in abundance at that site.

Sand lance larvae underwent a reduction at the Discharge and South transects in 1978 compared with 1977, with the greatest decrease at the Discharge (Figure 4.2-2). Yellowtail flounder larvae were similar between years at the Discharge and South transects; at Boar's Head abundances were about five times lower in 1976 while they were about five times higher in 1977 and 1978. Silver hake larvae were relatively rare during 1978 at the Discharge and South transects compared with 1977, whereas less dramatic differences were observed among transects during previous years. Mackerel larvae were low in abundance at the Discharge in 1978 (as they were at all sites in 1976), and showed a different spatial relationship compared with the other two years.

Of the indicator species not mentioned in the above discussion (Appendix Tables 7-14 and 7-15), menhaden (eggs and larvae) and smelt larvae were too rare to evaluate. Pollock eggs were generally more abundant at the Boar's Head transect during 1975-1977 and at the Discharge and South transects during 1977-1978; larvae were collected in low densities at all transects during all years. Except for 1978, winter flounder larvae were collected during each year at similar densities at each transect; during 1978 they were somewhat more abundant at the South transect.

At this stage, these trends have only been examined qualitatively. Inclusion of the 1979 studies will yield a four year data base from which appropriate analyses should be able to discern whether any of these changes in spatial distribution are, in fact, significant, or merely attributable to the variability inherent in plankton sampling.



[a]Average densities (no./1000 m^3) for the number of sample periods each species was present during each year.

[b]Boar's Head transect sampled through 15 Jun 77; Intake transect sampled 6 Jul 77 to present.

Figure 4.2-2. Mean abundance[a] of selected species of fish larvae by transect,[b] 1976-1978. Seabrook Finfish Studies, 1978.

4.3 IMPACT OF CONSTRUCTION

Offshore drilling for the discharge structures took place from October 1977 to September 1978 and from October 1978 to March 1979 for the intake structures. The locations of the intake and discharge structures are shown in Figure 2.1-1. The discharge was close to gill net station B and otter trawl transect 2. The intake was between gill net stations B and C and trawl transects 2 and 3. The drilling did not appear to affect the catches of juvenile and adult finfish within the study area. The catch per unit of effort for winter flounder, Atlantic cod, rainbow smelt and hake all increased during 1978 (Table 4.1-1). Gill net catches fluctuated in typical fashion, with increased Atlantic herring and alewife catches during 1978 (Table 4.2-1).

To aid the offshore drilling, a barge facility was constructed during 1977 and 1978 near beach seine station S3 (Figure 2.1-1). The catch per unit of effort at this station increased for most species during 1977 and 1978 (Table 4.3-1). Sand lance catches, however decreased after 1976, but this is most likely due to its extreme spatial heterogeneity within the estuary rather than construction impacts.

Seabrook Station has an on-site settling pond that treats wastewater from the plant and returns it to the Brown's River. The discharged water from this settling pond has been within permit requirements for all parameters except turbidity (Table 4.3-1). During the fall and winter of 1978, turbidity exceeded the 10 JTU allowable maximum, but never exceeded 31 JTU. This level of turbidity would not be expected to exert a detrimental influence on the finfish community of the Brown's River during this season. The closest beach seine station to the settling pond was S2, approximately 0.5 mile down Brown's River from the plant (Figure 2.1-1). The catch per unit of effort for winter flounder, sand lance and Atlantic silversides all increased at S2 over the three years (Table 4.3-1). *Fundulus* spp. catches decreased during 1978, but this occurred at all stations, and was probably the result of typical population fluctuation.

TABLE 4.3-1. WATER QUALITY OF THE SEABROOK WASTEWATER SETTLING POND DURING 1978. SEABROOK FINFISH STUDIES, 1978.

SAMPLING PERIOD		DISCHARGE (THOUSANDS OF GALLONS PER DAY)	TOTAL SUSPENDED SOLIDS (mg/l)	OIL AND GREASE (mg/l)	TURBIDITY (JTU)	pH
May-June	Mean:	201	8.4	4.1	8.0	6.9
	Range:	36-533	6.4-10.4	4.1-4.1	3.5-17	6.9-6.9
July-September	Mean:	16	48.1	6.5	9.2	7.1
	Range:	0-209	28-72	<5-11.7	5.3-14	6.8-7.6
October-December	Mean:	159	76.2	<5	10.2	6.8
	Range:	0-789	13-322	<5-8	2.1-31.0	6.5-7.2
Permit Requirements[a]	Mean:	none	30	15.0	none	6.5-8.0
	Max:	45,000	100	20.0	10.0	

[a] EPA NPDES Permit

At this point, data do not suggest that the ongoing plant construction has adversely influenced the juvenile or adult finfish populations either offshore or in the estuary.

5.0 SUMMARY

5.1 OTTER TRAWLS

Limanda ferruginea continued to be the dominant species (comprising 23% of the total catch). Other major species, *Urophycis* spp., *G. morhua*, *O. mordax*, *P. americanus* and *Myoxocephalus octodecemspinosus* all ranked high during previous years as well. The catch/effort for the major species either remained stable or, in the case of cod and smelt, showed a slight increase from 1977.

5.2 GILL NETS

Gill net catches showed some fluctuations in abundances and dominance over the two year period (July 1975-June 1977). *Clupea harengus* continued to rank first in abundance and *A. aestivalis* ranked second. The remaining 22 species comprised <12% of the total catch. Catch/effort for herring increased during 1978, was essentially unchanged for blueback herring, and declined for mackerel.

5.3 BEACH SEINE

Menidia menidia comprised 75% of the beach seine catch during 1978, a similar percentage as that found during 1975-1977. Catch/effort was somewhat higher than that found during 1977, but was less than 1976. Catch/effort of both *Fundulus* and sand lance declined; smelt showed a marked decline only at S3, a station at which it had historically been abundant.

5.4 ICHTHYOPLANKTON

During 1978, ichthyoplankton assemblages in the vicinity of Seabrook, New Hampshire were found to be quantitatively and qualita-

tively similar to that found during 1975-1977. Fish egg abundance was greatest during summer and late spring when Labrid/*Limanda* were dominant, but Gadid spawning during the fall months showed a decline from earlier years. Fish larvae showed spring and summer maxima due to *A. americanus* (April) and cunner (July). Both the eggs and larval assemblages were affected by season. More species were represented by eggs in spring and fall and larvae in spring and summer with fewer in late fall-early spring. Fish eggs and larvae were generally less abundant at the Discharge transect than the Intake and South transects during 1978. Certain of the more abundant species showed a decline in absolute and relative numbers at the Discharge during 1978 when compared with 1976-1977 data; abundances at the Discharge were still within ranged reported in previous years except for silver hake and sand lance.

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APPENDICES

APPENDIX TABLE 7-1. MONTHLY CATCH (TOTAL OF FOUR REPLICATES) OF FISH COLLECTED BY OTTER TRAWL AT TRANSECT 1 OFF HAMPTON-SEABROOK. SEABROOK FINFISH STUDIES, 1978.

SAMPLING DATE	JAN 23	FEB 16	MAR 23	APR 18	MAY 31	JUL 7	JUL 27	AUG 30	SEP 28	OCT 30	NOV 20	DEC 4	TOTAL
Raja binoculata	2				4						2		8
Raja erinacea	1		3	1	3	2	1						11
Raja radiata			1	2									3
Raja spp.								2	1	4	1		8
Osmerus mordax	134	44	45	5				2	9			21	252
Lophius americanus										1			1
Gadus morhua	4	7	1	2	15	2	32	22	46	47	51	55	284
Merluccius bilinearis					2	8	49	128	5	15			207
Microgadus tomcod	1	2	1										4
Pollachius virens		2			7			4				1	14
Enchelyopus cimbrius							3	1		1	2		7
Urophycis chuss					13	110	106	111	8	2			350
Urophycis tenuis					12	22	3	1					38
Urophycis spp.			3	27				1	107	130	52		320
Macrozoarces americanus	1	1	5	2	27	16	3			3	6	13	77
Menidia menidia												1	1
Archosargus probatocephalus										1			1
Tautogolabrus adspersus					3								3
Pholis gunnellus												1	2
Anarhichas lupus					2								2
Ammodytes americanus	1	2			1								4
Hemitripterus americanus	1	2		1		1		1	3	2	6	1	18
Myoxocephalus aeneus		1										2	3
Myoxocephalus octodecemspinosus	1		9	5	48	32	31	4	14	30	29	12	215
Myoxocephalus scorpius		1		1									2
Aspidophoroides monopterygius			1		1								2
Liparis atlanticus	1	1				1						1	4
Paralichthys oblongus					2	7	2	5	1	1	3		21
Scophthalmus aquosus	3		1		5	9		2		4	8	13	45
Glyptocephalus cynoglossus			2			5	14						21
Hippoglossoides platessoides				1	10								11
Limanda ferruginea	141	23	21	36	155	96	108	64	50	87	137	191	1109
Pseudopleuronectes americanus	15	6	14	6	14	16	16	9	11	18	7	10	142

APPENDIX TABLE 7-2. MONTHLY CATCH (TOTAL OF FOUR REPLICATES) OF FISH COLLECTED BY OTTER TRAWL AT TRANSECT 2 OFF HAMPTON-SEABROOK. SEABROOK FINFISH STUDIES, 1978.

SAMPLING DATE	JAN 23	FEB 16	MAR 23	APR 18	MAY 1	JUL 7	JUL 27	AUG 29	SEP 28	OCT 30	NOV 20	DEC 4	TOTAL
Raja binoculata							1						1
Raja erinacea	1				4	1	2					3	11
Raja radiata		1											1
Raja spp.						5			2		2		9
Alosa pseudoharengus			1							2	4		7
Alosa sapidissima										1			1
Clupea harengus h.								2			1		3
Osmerus mordax	88	69	39	59			4	1	9	67	17	71	424
Gadus morhua	3		3	4	3		5	1	8	20	26	18	91
Merluccius bilinearis							5	5	2		2		14
Microgadus tomcod		3											3
Pollachius virens								2	7	11	28		48
Urophycis chuss				5	35	50	46	6	8				150
Urophycis tenuis				25	4	9	4						42
Urophycis spp.			2						71	33	4		110
Macrozoarces americanus	2	2	1	17	35	7	3			2	9		78
Menidia menidia	1		1								1	1	4
Syngnathus fuscus				1					1				2
Archosargus probatocephalus										4			4
Tautogolabrus adspersus					1		1						2
Lumpenus lumpretaeformis			1										1
Pholis gunnellus				1	7								8
Ammodytes americanus	1											1	2
Hemitripterus americanus			1	3	3	1	2	2	3	4	7		26
Myoxocephalus aeneus	1	6	2										9
Myoxocephalus octodecemspinosus				14	14	2	9		5	7	8	3	62
Myoxocephalus scorpius												3	3
Cyclopterus lumpus								1	1		1		3
Liparis atlanticus		5	1			1						2	9
Liparis liparis			1			1							2
Paralichthys oblongus						1			1				2
Scopthalmus aquosus	2			3	8	9	5		1	3	2	1	34
Limanda ferruginea	10	6		3	9	5	3	1	22	10	14	30	113
Pseudopleuronectes americanus	2	35	69	52	40	18	70	7	85	44	35	8	465

APPENDIX TABLE 7-3. MONTHLY CATCH (TOTAL OF FOUR REPLICATES) OF FISH COLLECTED BY OTTER TRAWL AT TRANSECT 3 OFF HAMPTON-SEABROOK. SEABROOK FINFISH STUDIES, 1978.

SAMPLING DATE	JAN 23	FEB 16	MAR 23	APR 18	MAY 30	JUL 6	JUL 26	AUG 29	SEP 28	OCT 30	NOV 20	DEC 4	TOTAL
Raja binoculata	2		2			1		2		2		3	12
Raja erinacea	12	6		3	7	1	9	5		10		17	70
Raja radiata					3	3	6		1			7	20
Raja spp.									12	4	20		36
Osmerus mordax	45	8	96	8								10	167
Lophius americanus								1	1	1	1		4
Gadus morhua	7	6	4	11	60	35	23	134	226	116	93	116	831
Melanogrammus aeglefinis					1						1		2
Merluccius bilinearis						16	41	2	12	14	5		90
Microgaddus tomcod	2	2	45										49
Pollachius virens	1	1						1	2				5
Enchelyopus cimbrius					1		1					1	3
Urophycis chuss						119	83	20	1				223
Urophycis tenuis				2	6	15	3	1	1				28
Urophycis spp.				113	7		96		34	77	40	4	371
Macrozoarces americanus	2	5	3	11	66	22	11		2		7	5	134
Sygnathus fuscus	1		1										2
Centropristis striata											1		1
Archosargus probatocephalus										1			1
Ulvaria subbifurcata					1								1
Hemitripterus americanus	1				1			2	3	3	1	1	12
Myoxocephalus octodecemspinosus	4			43	90	34	44	52	50	54	93	24	488
Triglops murrayi											1		1
Aspidophoroides monopterygius	3			4	6							7	20
Liparis atlanticus	2	1											3
Liparis liparis	1												1
Paralacthys oblongus						3		1	1	1	1		7
Scophthalmus aquosus	4		1	3	4		1			6	8	5	32
Glyptocephalus cynoglossus						6	5						11
Hippoglossus hippoglossus				1									1
Hippoglossoides platesscides				5	1	3	1			1		3	14
Limanda ferruginea	62	19	70	26	108	58	43	25	54	52	77	122	716
Pseudopleuronectes americanus	19	5	44	12	21	9	13	12	13	8	12	7	175

APPENDIX TABLE 7-4. VOLUME (LITERS) OF ALGAE COLLECTED IN OTTER TRAWL TOWS DURING 1978. SEABROOK FINFISH STUDIES, 1978.

DATE	TRANSECT 1 REPLICATES				TRANSECT 2 REPLICATES				TRANSECT 3 REPLICATES			
	A	B	C	D	A	B	C	D	A	B	C	D
January 23	18.9	9.5	9.5	6.2	9.5	85.2	14.2	14.2	0.0	3.8	0.0	6.2
February 16	127.8	18.9	108.8	37.9	73.8	37.9	18.9	4.7	0.0	0.0	6.2	6.2
March 23	0.0	0.0	0.0	0.0	56.8	47.3	80.4	18.9	0.0	0.0	0.0	0.0
April 18	*	*	*	*	*	*	*	*	*	*	*	*
May 31	0.0	0.0	0.0	0.0	298.1	331.2	42.6	118.3	0.0	0.0	0.0	0.0
July 7	9.5	0.0	0.0	0.0	[illegible]	25.2	44.1	37.9	0.0	0.0	0.0	2.3
July 27	0.0	0.0	0.0	0.0	[illegible]	107.3	47.3	37.9	0.0	0.0	0.0	0.0
August 29	0.0	0.0	0.0	0.0	18.9	28.4	28.4	9.5	0.0	0.0	0.0	0.0
September 28	0.0	0.0	0.0	0.0	94.6	66.2	37.9	164.1	0.0	0.0	0.0	0.0
October 31	0.0	0.0	0.0	0.0	96.8	47.3	75.7	18.9	0.0	0.0	0.0	0.0
November 20	0.0	0.0	0.0	0.0	18.9	37.9	18.9	18.9	0.0	0.0	0.0	0.0
January 4	18.9	0.0	0.0	0.0	23.7	9.5	21.2	9.5	0.0	0.0	0.0	0.0

* Algal volume not recorded

APPENDIX TABLE 7-5. FISH SPECIES COLLECTED IN GILL NETS AT TRANSECT A. SEABROOK FINFISH STUDIES, 1978.

		JAN 24*	FEB 22	MAR 30	APR 18	MAY 23	JUN 13	JUL 11	AUG 15	SEP 12	OCT 10	NOV 14	DEC 6	TOTAL
Alosa aestivalis	S	16		11	2	2		20			15	5		71
	B	1		1				1			13	2	1	19
Alosa pseudoharengus	S			1		6		5	4	4		1		21
	B							1				1		2
Alosa sapidissima	S										2			2
	B													
Brevoortia tyrannus	S					2		1			5			8
	B													
Clupea harengus	S	30		6	102	10	12			707	176	30	16	1089
	B	10		1	54	6				385	7	218	50	731
Gadus morhua	S													
	B										1	2		3
Merluccius bilinearis	S							82						82
	B							5						5
Myoxocephalus octodecemspinosus	S													
	B				1							1		2
Osmerus mordax	S	1	1	6									2	10
	B		1						1					2
Peprilus triacanthus	S							3		1	3			7
	B									1				
Pollachius virens	S													
	B					1						1		2
Pomatomus saltatrix	S							1	1	5				7
	B										1	1		2
Prionotus carolinus	S						1							1
	B													
Pseudopleuronectes americanus	S													
	B			1										1
Scomber scombrus	S			1				9	1			8		19
	B					1					1	11		13
Urophycis chuss	S													
	B							4	7			1		12
Urophycis sp.	S													
	B								1		4			5

* Sampling date is the first of three consecutive sampling days

APPENDIX TABLE 7-6. FISH SPECIES COLLECTED IN GILL NETS AT TRANSECT B. SEABROOK FINFISH STUDIES, 1978.

		JAN 24	FEB 22	MAR 30	APR 18	MAY 23	JUN 13	JUL 11	AUG 15	SEP 12	OCT 10	NOV 14	DEC 6	TOTAL
Alosa aestivalis	S	4		19		2	1	3	9	7	12	6	1	64
	B	1		6					3	2	205		1	218
Alosa mediocris	S										1			1
	B													
Alosa pseudoharengus	S					9		4	6	1	1	2		23
	B										1			1
Alosa sapidissima	S								1					1
	B											1		1
Brevoortia tyrannus	S					3					2			5
	B										2			2
Clupea harengus	S	41		4	70	25	5			49	18	56	65	333
	B	10		88	149	16	2			311	32	189	8	805
Gadus morhua	S													
	B	1		5					1			1		8
Hemitripterus americanus	S							1						1
	B					1								1
Merluccius bilinearis	S								36					36
	B							4		2				6
Myoxocephalus octodecemspinosus	S						1					1		2
	B								2					2
Oncorhynchus kisutch	S						1				1			2
	B													
Osmerus mordax	S		1	1										2
	B	8	3	1						4		1	6	23
Peprilus triacanthus	S								1					1
	B													
Pollachius virens	S					1						4		6
	B					4	1	1	2	1		4	4	19
Pomatomus saltatrix	S									19				19
	B									2				2
Pseudopleuronectes americanus	S													
	B									1				1
Scomber scombrus	S							22		1		12		35
	B							3	2	1	6	8		20
Scophthalmus aquosus	S						1							1
	B													
Squalus acanthias	S													
	B									1				1
Syngnathus fuscus	S			1										1
	B													
Tautogolabrus adspersus	S													
	B									1				1
Urophycis chuss	S													
	B							4	3	13				20
Urophycis tenuis	S													
	B							1						1
Urophycis spp.	S													
	B								1					1

* Sample date is the first of three consecutive sampling days.

APPENDIX TABLE 7-7. FISH SPECIES COLLECTED IN GILL NETS AT TRANSECT C. SEABROOK FINFISH STUDIES, 1978.

		JAN 24	FEB 22	MAR 30	APR 18	MAY 23	JUN 13	JUL 11	AUG 15	SEP 12	OCT 10	NOV 14	DEC 6	TOTAL
Alosa aestivalis	S	22		99	238	4		6	5	4	37	9	1	425
	B	6		28			4	6			58	8	1	113
Alosa pseudoharengus	S					14		6	42	1				63
	B					3				2	1	3		9
Alosa sapidissima	S							1	1		1	1		4
	B													
Brevoortia tyrannus	S					4		1			4		1	10
	B					1								1
Clupea harengus	S	14		71	424	59	2	1		127	30	87	94	909
	B	17	2	75	83	8	2			342	129	174	37	869
Gadus morhua	S													
	B	1		7						1	1	5		15
Macrozoarces americanus	S													
	B			1										1
Merluccius bilinearis	S							11						11
	B							4			5	2		11
Myoxocephalus octodecemspinosus	S													
	B			1		1					1	1		4
Osmerus mordax	S			12	2									14
	B	1	2	4									2	9
Pollachius virens	S					1						2		3
	B			7	1	19	1					9	5	42
Pomatomus saltatrix	S									3	1			4
	B													
Peprilus triacanthus	S								1		5			6
	B								1					1
Pseudopleuronectes americanus	S													
	B			1										1
Scomber scombrus	S							7	1	1		5		14
	B							9	1	1	2	5		18
Squalus acanthias	S													
	B						1			10				11
Tautogolabrus adspersus	S													
	B										1	4		5
Urophycis chuss	S													
	B							3		2				5
Clupeidae	S			1										1
	B			8							1			9

* Sample date is the first of three consecutive sampling days.

APPENDIX TABLE 7-8. TOTAL MONTHLY FINFISH CATCH AT BEACH SEINING STATION 1. SEABROOK FINFISH STUDIES, 1978.

	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
Alosa aestivalis			17			133			150
Alosa pseudoharengus						1			1
Clupea harengus			1			5			6
Salmo gairdneri			2			1			3
Salvelinus fontinalis			1						1
Urophycis chuss			1						1
Fundulus heteroclitus			1	7	525			1	534
Fundulus majalis		2	1		218				221
Fundulus spp.				1				2	3
Menidia menidia	6	1	34	22	333	873	554	187	2010
Gasterosteus aculeatus	2	4	17	3					26
Pungitius pungitius			20		52	44	11		127
Syngnathus fuscus	1			1					2
Liopsetta putnami	5	4	8	6	14	3		1	41
Pseudopleuronectes americanus	1	9	6	1	6	6	2	1	32

Sampling dates: April 4,28; May 11,26; June 8,23; July 17,31; August 11,24; September 11,22; October 6,20; November 3,17

APPENDIX TABLE 7-9. TOTAL MONTHLY FINFISH CATCH AT BEACH SEINING STATION 2. SEABROOK FINFISH STUDIES, 1978.

	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
Alosa aestivalis			1			5	1		7
Alosa pseudoharengus							1		1
Clupea harengus			839						839
Salmo gairdneri			3						3
Osmerus mordax							2	2	4
Urophycis chuss			2	1					3
Urophycis spp.						4	1	1	6
Fundulus heteroclitus			16	2	9	1		1	29
Fundulus majalis		5	85		1				91
Fundulus spp.				1		5	2		8
Menidia menidia	1	10	38	23	448	1315	1717	1871	5423
Gasterosteus aculeatus	7	23	54	5				2	91
Pungitius pungitius			4		1	1	1	1	8
Syngnathus fuscus			1	1					2
Ammodytes americanus				3	2	23	311	1058	1397
Myoxocephalus aenaeus								1	1
Myoxocephalus octodecemspinosus		15							15
Scophthalmus aquosus						1			1
Liopsetta putnami	2	10	6	2				1	21
Pseudopleuronectes americanus	1	28	8	9	5	6	12	8	77

Sampling dates: April 4,28; May 11,26; June 8,23; July 17,31; August 11,24; September 11,22; October 6,20; November 3,17

APPENDIX TABLE 7-10. TOTAL MONTHLY FINFISH CATCH AT BEACH SEINING STATION 3. SEABROOK FINFISH STUDIES, 1978.

	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
Alosa aestivalis						1			1
Alosa pseudoharengus		1	2					1	4
Clupea harengus		159				18			177
Anchoa hepsetus					1				1
Oncorhynchus kisutch				1					1
Salmo trutta				30	27				57
Osmerus mordax		1	3				3		7
Microgadus tomcod			4						4
Pollachius virens		218	1						219
Urophycis chuss			5	2					7
Urophycis tenuis			1						1
Urophycis spp.						17	3	1	21
Fundulus majalis			1		1				2
Menidia menidia			3	1	3141	1269	1299	951	6664
Gasterosteus aculeatus	1	11	90	1	2	8	7		120
Pungitius pungitius			65	1		1	2		69
Syngnathus fuscus		1	1						2
Tautogolabrus adspersus						1	3		4
Ammodytes americanus			20					1	21
Myoxocephalus octodecemspinosus		5						1	6
Scophthalmus aquosus					1	1			2
Liopsetta putnami	3	7	4	4	2	2	3	2	27
Pseudopleuronectes americanus	6	15	34	24	42	48	31	13	213

Sampling dates: April 11, 28; May 11, 26; June 8, 23; July 17, 31; August 11, 24; September 11, 22; October 6, 20; November 3, 17.

APPENDIX TABLE 7-11. BRAY-CURTIS SIMILARITY OF ICHTHYOPLANKTON TRANSECTS BASED UPON MEAN ANNUAL (1978) ABUNDANCE[a] OF ALL SPECIES. SEABROOK FINFISH STUDIES, 1978.

	SIMILARITY			
	FISH EGGS		FISH LARVAE	
	TRANSFORMED[b]	NOT TRANSFORMED	TRANSFORMED	NOT TRANSFORMED
Intake vs. Discharge	96	86	84	51
Intake vs. South	94	78	85	70
South vs. Discharge	95	71	77	44

[a] Based upon 15 comparable sample periods

[b] log n + 1 transformation

APPENDIX 7-12. MEAN ABUNDANCE[a] (NO./100 m^3) OF FISH EGGS IN COASTAL NEW HAMPSHIRE ICHTHYOPLANKTON COLLECTIONS. SEABROOK FINFISH STUDIES, 1978.

SPECIES NAME	16 JAN 12 REPS	13 FEB 12 REPS	8 MAR 4 REPS	20 MAR 12 REPS	29 MAR 4 REPS	16 APR 12 REPS
BREVOORTIA TYRANNUS	0.000	0.000	0.000	0.000	0.000	0.000
EGGS UNIDENTIFIED	0.000	0.000	0.000	0.000	0.000	3.584
BROSME BROSME	0.000	0.000	0.000	0.000	0.000	0.000
POLLACHIUS VIRENS	18.099	0.000	0.000	0.167	0.000	2.465
PEPRILUS TRIACANTHUS	0.000	0.000	0.000	0.000	0.000	0.000
GLYPTOCEPHALUS CYNOGLOSSUS	0.000	0.000	0.000	0.000	0.000	0.000
ENCHELOPUS CIMBRIUS	0.000	0.000	0.000	0.000	0.000	0.000
SCOPHTHALMUS AQUOSUS	0.000	0.000	0.000	0.000	0.000	0.000
GADUS/MELANOGRAMMUS	15.645	11.043	13.383	65.305	90.227	831.462
HIPPOGLOSSOIDES PLATESSOIDES	0.272	6.407	12.876	226.725	174.481	3217.555
MERLUCCIUS BILINEARIS	0.000	0.000	0.000	0.000	0.000	0.000
SCOMBER SCOMBRUS	0.000	0.000	0.000	0.000	0.000	0.000
UROPHYCIS SP.	0.000	0.000	0.000	0.000	0.000	0.000
LABRID/LIMANDA	0.000	0.000	0.000	0.782	1.044	183.959
COL. TOTALS	34.016	17.450	26.260	292.980	265.751	4238.023

	26 APR 12 REPS	10 MAY 12 REPS	24 MAY 12 REPS	8 JUN 12 REPS	22 JUN 12 REPS	13 JUL 12 REPS
BREVOORTIA TYRANNUS	0.000	0.000	0.000	0.000	0.000	0.000
EGGS UNIDENTIFIED	2.286	2.338	4.377	1.873	0.000	9.357
BROSME BROSME	0.000	0.660	7.742	46.961	47.507	0.000
POLLACHIUS VIRENS	0.000	0.000	0.000	0.000	0.000	0.000
PEPRILUS TRIACANTHUS	0.000	0.000	0.000	0.000	134.198	37.950
GLYPTOCEPHALUS CYNOGLOSSUS	0.000	0.000	27.626	13.985	569.582	347.712
ENCHELOPUS CIMBRIUS	139.391	3.030	295.471	40.586	773.348	37.109
SCOPHTHALMUS AQUOSUS	0.000	0.864	194.210	498.575	508.531	1003.982
GADUS/MELANOGRAMMUS	75.800	279.713	173.721	1010.775	350.406	75.330
HIPPOGLOSSOIDES PLATESSOIDES	361.461	934.268	260.939	482.326	101.229	43.877
MERLUCCIUS BILINEARIS	0.000	0.546	1.062	0.913	70.239	1170.623
SCOMBER SCOMBRUS	0.000	0.000	97.753	430.782	8773.484	75.660
UROPHYCIS SP.	0.000	0.000	4.728	1018.483	10108.145	18557.930
LABRID/LIMANDA	258.556	116.456	1481.148	16223.563	52042.039	19121.773
COL. TOTALS	837.894	1827.874	2543.760	19787.922	73458.668	40521.313

	26 JUL 4 REPS	3 AUG 12 REPS	23 AUG 4 REPS	6 SEP 12 REPS	5 OCT 12 REPS	2 NOV 12 REPS
BREVOORTIA TYRANNUS	0.000	0.000	0.000	0.000	0.899	0.000
EGGS UNIDENTIFIED	57.348	0.000	9.569	0.419	0.894	0.000
LIMANDA FERRUGINEA	0.000	0.000	0.000	0.000	0.000	0.000
BROSME BROSME	0.000	0.000	0.000	0.000	0.000	0.000
POLLACHIUS VIRENS	0.000	0.000	0.000	0.000	3.831	7.165
PEPRILUS TRIACANTHUS	0.000	0.000	0.000	2.720	0.714	0.000
GLYPTOCEPHALUS CYNOGLOSSUS	228.644	10.733	0.000	3.514	7.350	0.902
ENCHELOPUS CIMBRIUS	391.469	50.811	16.842	10.666	102.290	0.282
SCOPHTHALMUS AQUOSUS	2444.627	136.190	1271.473	75.611	27.334	0.000
GADUS/MELANOGRAMMUS	338.471	11.523	13.209	3.458	20.345	64.076
HIPPOGLOSSOIDES PLATESSOIDES	0.000	0.000	0.000	0.160	0.640	0.000
MERLUCCIUS BILINEARIS	12985.125	34.462	0.000	0.319	208.811	0.681
SCOMBER SCOMBRUS	21193.172	0.000	0.000	0.000	0.000	0.000
UROPHYCIS SP.	40533.469	17827.086	8717.375	887.683	674.364	0.784
LABRID/LIMANDA	27752.125	3693.081	135.981	61.443	139.591	0.772
COL. TOTALS	105924.438	21763.879	10164.445	1045.993	1187.084	74.641

	3 DEC 12 REPS	26 DEC 4 REPS
BREVOORTIA TYRANNUS	0.000	0.000
EGGS UNIDENTIFIED	0.268	0.000
LIMANDA FERRUGINEA	0.000	0.000
BROSME BROSME	0.000	0.000
POLLACHIUS VIRENS	136.380	1.805
PEPRILUS TRIACANTHUS	0.000	0.000
GLYPTOCEPHALUS CYNOGLOSSUS	0.000	0.000
ENCHELOPUS CIMBRIUS	0.000	0.000
SCOPHTHALMUS AQUOSUS	0.000	0.000
GADUS/MELANOGRAMMUS	53.556	6.200
HIPPOGLOSSOIDES PLATESSOIDES	0.970	0.000
MERLUCCIUS BILINEARIS	0.703	0.000
SCOMBER SCOMBRUS	0.000	0.000
UROPHYCIS SP.	0.104	0.000
LABRID/LIMANDA	0.000	0.000
COL. TOTALS	191.981	8.005

[a]Mean of all transects: Transect 2 (Intake) only analyzed on 8, 29 March, 26 Jul, 23 Aug, 26 Dec.

APPENDIX 7-13. MEAN ABUNDANCE[a] (NO./1000 m^3) OF FISH LARVAE IN COASTAL NEW HAMPSHIRE ICHTHYOPLANKTON COLLECTIONS. SEABROOK FINFISH STUDIES, 1978.

	26 JUL 4 REPS	9 AUG 12 REPS	23 AUG 4 REPS	6 SEP 12 REPS	5 OCT 12 REPS	2 NOV 12 REPS
MENIDIA MENIDIA	0.000	0.000	0.000	0.030	0.000	0.000
GASTEROSTEUS ACULEATUS	0.000	0.000	0.000	0.000	0.000	0.000
MICROGADUS TOMCOD	0.000	0.000	0.000	0.000	0.000	0.000
TAUTOGA ONITIS	0.000	0.000	1.124	0.000	0.000	0.000
MACROZOARCES AMERICANUS	0.000	0.000	0.000	0.000	0.000	0.000
BROSME BROSME	0.000	0.180	0.000	0.000	0.000	0.000
MYOXOCEPHALUS OCTODECEMSPINOSUS	0.000	0.000	0.000	0.000	0.000	0.000
LOPHIUS AMERICANUS	0.000	3.995	1.015	0.000	0.000	0.000
OSMERUS MORDAX	0.000	0.306	0.000	0.000	0.000	0.000
SYNGNATHUS FUSCUS	1.948	0.834	9.062	0.404	0.288	0.000
CYCLOPTERUS LUMPUS	0.474	0.000	0.488	0.000	0.000	0.000
UROPHYCIS SP.	0.462	9.094	2.122	0.000	1.489	0.000
CLUPEA HARENGUS	0.000	0.000	0.000	0.000	0.000	0.000
MYOXOCEPHALUS AENAEUS	0.000	0.000	0.000	0.000	0.000	0.000
ASPIDOPHOROIDES MONOPTERYGIUS	0.000	0.000	0.000	0.000	0.000	0.000
SEBASTES MARINUS	0.000	33.891	0.000	0.000	0.000	0.000
SCOPHTHALMUS AQUOSUS	1.786	15.023	0.599	2.608	0.562	0.000
LARVAE UNIDENTIFIED-MUTILATED	4.458	1.512	0.000	0.000	0.288	0.282
POLLACHIUS VIRENS	0.000	0.000	0.000	0.000	0.000	0.776
MELANOGRAMMUS AEGLEFINUS	0.000	0.425	0.000	0.000	0.000	0.000
SCOMBER SCOMBRUS	2.048	33.693	0.000	0.000	0.000	0.000
PHOLIS GUNNELLUS	0.000	0.000	0.000	0.000	0.000	0.000
MERLUCCIUS BILINEARIS	13.432	344.657	0.000	0.000	0.748	0.565
LIMANDA FERRUGINEA	0.362	18.100	0.000	0.000	0.321	0.260
ENCHELOPUS CIMBRIUS	101.203	85.815	0.488	0.159	7.305	0.423
GLYPTOCEPHALUS CYNOGLOSSUS	53.350	325.447	0.526	1.314	3.011	0.282
ULVARIA SUBBIFURCATA	117.346	42.800	1.053	1.406	0.352	0.000
PSEUDOPLEURONECTES AMERICANUS	0.000	0.000	0.000	0.000	0.000	0.000
GADUS MORHUA	11.503	3.645	0.000	0.000	0.000	0.260
LIPARIS SP.	0.924	2.610	0.488	0.000	0.000	0.000
HIPPOGLOSSOIDES PLATESSOIDES	0.000	0.531	0.000	0.000	0.000	0.000
TAUTOGOLABRUS ADSPERSUS	150.164	136.242	123.232	4.212	0.000	0.000
AMMODYTES AMERICANUS	0.000	0.000	0.000	0.000	0.000	0.000
COL. TOTALS	461.730	1081.970	140.197	10.103	14.365	2.848

	5 DEC 12 REPS	26 DEC 4 REPS
MENIDIA MENIDIA	0.000	0.440
GASTEROSTEUS ACULEATUS	0.000	0.000
MICROGADUS TOMCOD	0.000	0.000
TAUTOGA ONITIS	0.000	0.000
MACROZOARCES AMERICANUS	0.000	0.440
BROSME BROSME	0.000	0.000
MYOXOCEPHALUS OCTODECEMSPINOSUS	0.000	0.000
LOPHIUS AMERICANUS	0.000	0.000
OSMERUS MORDAX	0.000	0.000
SYNGNATHUS FUSCUS	0.000	0.000
CYCLOPTERUS LUMPUS	0.000	0.000
UROPHYCIS SP.	0.000	0.000
CLUPEA HARENGUS	15.141	4.485
MYOXOCEPHALUS AENAEUS	0.000	0.000
ASPIDOPHOROIDES MONOPTERYGIUS	0.000	0.000
SEBASTES MARINUS	0.000	0.000
SCOPHTHALMUS AQUOSUS	0.000	0.000
LARVAE UNIDENTIFIED-MUTILATED	0.000	0.468
POLLACHIUS VIRENS	12.628	3.528
MELANOGRAMMUS AEGLEFINUS	0.000	0.000
SCOMBER SCOMBRUS	0.000	0.000
PHOLIS GUNNELLUS	0.000	1.336
MERLUCCIUS BILINEARIS	0.000	0.000
LIMANDA FERRUGINEA	0.000	0.000
ENCHELOPUS CIMBRIUS	0.943	0.000
GLYPTOCEPHALUS CYNOGLOSSUS	0.000	0.000
ULVARIA SUBBIFURCATA	0.000	0.000
PSEUDOPLEURONECTES AMERICANUS	0.000	0.000
GADUS MORHUA	0.306	0.000
LIPARIS SP.	0.000	0.890
HIPPOGLOSSOIDES PLATESSOIDES	0.000	0.000
TAUTOGOLABRUS ADSPERSUS	0.000	0.000
AMMODYTES AMERICANUS	1.375	107.797
COL. TOTALS	30.393	119.375

[a]Mean of all transects; Transect 2 (Intake) only analyzed on 8, 29 March, 26 Jul, 23 Aug, 26 Dec.

APPENDIX 7-13. (Continued)

SPECIES NAME	16 JAN 12 REPS	15 FEB 12 REPS	6 MAR 4 REPS	20 MAR 12 REPS	29 MAR 4 REPS	16 APR 12 REPS
MENIDIA MENIDIA	0.000	0.000	0.000	0.000	0.000	0.000
GASTEROSTEUS ACULEATUS	0.000	0.000	0.000	0.000	0.000	0.000
MICROGADUS TOMCOD	0.000	0.000	0.000	0.000	0.000	0.000
TAUTOGA ONITIS	0.000	0.000	0.000	0.000	0.000	0.000
MACROZOARCES AMERICANUS	0.000	0.000	0.000	0.000	0.000	0.000
ORTHOPRISTIS CHRYSOPTERA	0.000	0.000	0.000	0.000	0.000	0.000
MYOXOCEPHALUS OCTODECEMSPINOSUS	0.000	0.000	0.000	0.000	0.000	0.000
LOPHIUS AMERICANUS	0.000	0.000	0.000	0.000	0.000	0.000
OSMERUS MORDAX	0.000	0.000	0.000	0.000	0.000	0.000
SYNGNATHUS FUSCUS	0.000	0.000	0.000	0.000	0.000	0.000
CYCLOPTERUS LUMPUS	0.000	0.000	0.000	0.000	0.000	0.000
UROPHYCIS SP.	0.000	0.000	0.000	0.000	0.000	0.000
CLUPEA HARENGUS	0.000	0.000	0.000	0.000	0.000	0.000
MYOXOCEPHALUS AENAEUS	0.000	0.000	3.279	0.327	1.905	8.289
ASPIDOPHOROIDES MONOPTERYGIUS	0.000	0.000	0.000	0.000	4.184	21.923
SEBASTES MARINUS	0.000	0.000	0.000	0.000	0.000	0.000
SCOPHTHALMUS AQUOSUS	0.000	0.000	0.000	0.000	0.000	0.000
LARVAE UNIDENTIFIED-MUTILATED	0.000	0.000	0.000	0.000	0.000	0.661
POLLACHIUS VIRENS	0.570	0.000	0.000	0.000	0.000	0.000
MELANOGRAMMUS AEGLEFINUS	0.000	0.000	0.000	0.000	0.000	0.000
SCOMBER SCOMBRUS	0.000	0.000	0.000	0.000	0.000	0.000
PHOLIS GUNNELLUS	0.000	0.000	47.860	6.651	238.149	33.849
MERLUCCIUS BILINEARIS	0.000	0.000	0.000	0.000	0.000	0.000
LIMANDA FERRUGINEA	0.000	0.000	0.000	0.000	0.000	0.000
ENCHELOPUS CIMBRIUS	0.000	0.000	0.000	0.000	0.000	0.000
GLYPTOCEPHALUS CYNOGLOSSUS	0.000	0.000	0.000	0.000	0.000	0.000
ULVARIA SUBBIFURCATA	0.000	0.000	0.000	0.000	0.000	0.000
PSEUDOPLEURONECTES AMERICANUS	0.000	0.000	0.000	0.000	0.000	0.000
GADUS MORHUA	0.304	0.000	0.000	0.000	0.000	4.566
LIPARIS SP.	4.412	9.526	23.728	5.190	60.671	18.412
HIPPOGLOSSOIDES PLATESSOIDES	0.000	0.000	0.000	0.000	0.000	13.325
TAUTOGOLABRUS ADSPERSUS	0.000	0.000	0.000	0.000	0.000	0.000
AMMODYTES AMERICANUS	10.117	42.380	2649.534	556.603	780.809	1793.002
COL. TOTALS	15.403	51.906	2724.401	568.915	1095.902	1894.118

SPECIES NAME	26 APR 12 REPS	10 MAY 12 REPS	24 MAY 12 REPS	8 JUN 12 REPS	22 JUN 12 REPS	13 JUL 12 REPS
MENIDIA MENIDIA	0.000	0.000	0.000	0.000	0.000	0.000
GASTEROSTEUS ACULEATUS	0.000	0.000	0.000	0.000	0.156	0.000
MICROGADUS TOMCOD	0.216	0.000	0.000	0.000	0.000	0.000
TAUTOGA ONITIS	0.000	0.000	0.000	0.000	0.000	0.000
MACROZOARCES AMERICANUS	0.000	0.000	0.000	0.000	0.000	0.000
ORTHOPRISTIS CHRYSOPTERA	0.000	0.000	0.000	0.000	0.000	0.000
MYOXOCEPHALUS OCTODECEMSPINOSUS	1.140	0.356	0.477	0.000	0.320	0.569
LOPHIUS AMERICANUS	0.000	0.000	0.000	0.000	0.000	0.000
OSMERUS MORDAX	0.000	0.888	5.177	0.000	0.000	0.000
SYNGNATHUS FUSCUS	0.000	0.000	0.000	0.000	0.000	0.305
CYCLOPTERUS LUMPUS	0.000	0.000	1.811	2.250	3.332	1.170
UROPHYCIS SP.	0.000	0.000	0.000	0.000	0.000	5.370
CLUPEA HARENGUS	1.228	0.000	0.000	0.000	0.000	0.000
MYOXOCEPHALUS AENAEUS	1.114	1.516	4.838	1.598	0.000	0.000
ASPIDOPHOROIDES MONOPTERYGIUS	0.000	4.480	0.000	0.000	0.000	0.000
SEBASTES MARINUS	0.000	0.300	0.000	0.000	0.000	0.000
SCOPHTHALMUS AQUOSUS	0.000	0.000	0.000	0.000	0.257	28.264
LARVAE UNIDENTIFIED-MUTILATED	0.714	1.852	1.756	31.943	7.995	2.032
POLLACHIUS VIRENS	0.000	0.000	0.000	0.000	0.000	0.000
MELANOGRAMMUS AEGLEFINUS	0.112	0.000	0.000	79.407	2.818	0.000
SCOMBER SCOMBRUS	0.000	0.000	0.000	0.000	0.156	97.554
PHOLIS GUNNELLUS	4.941	2.797	0.849	0.000	0.000	0.000
MERLUCCIUS BILINEARIS	0.000	0.000	1.955	0.000	0.000	22.143
LIMANDA FERRUGINEA	0.139	1.881	5.304	32.574	206.161	132.373
ENCHELOPUS CIMBRIUS	0.000	0.000	0.941	2.152	16.908	257.242
GLYPTOCEPHALUS CYNOGLOSSUS	0.000	0.000	0.000	1.426	3.790	147.663
ULVARIA SUBBIFURCATA	3.204	3.317	156.680	96.436	117.684	73.453
PSEUDOPLEURONECTES AMERICANUS	1.542	81.079	247.847	231.167	22.818	9.986
GADUS MORHUA	3.214	9.579	7.670	915.691	18.022	53.243
LIPARIS SP.	28.724	83.578	149.671	405.579	14.789	6.429
HIPPOGLOSSOIDES PLATESSOIDES	22.740	197.474	55.440	1060.283	19.193	31.659
TAUTOGOLABRUS ADSPERSUS	0.000	0.000	0.000	0.000	0.000	1926.235
AMMODYTES AMERICANUS	1109.748	75.234	150.984	22.694	6.460	1.170
COL. TOTALS	1194.547	474.151	1017.335	2596.615	441.274	2353.760

APPENDIX TABLE 7-14. MEAN ABUNDANCE (NO./1000 m^3), BY TRANSECT AND SAMPLE PERIOD[a], OF SELECTED SPECIES OF FISH EGGS, 1975-1978. SEABROOK FINFISH STUDIES, 1978.

SPECIES	DATES PRESENT	BOAR'S HEAD[d]	INTAKE[d]	DISCHARGE	SOUTH
Indicator Species					
Brevoortia tyrannus (Menhaden)	28 Oct 75	0	---	2	0
	3 Aug-7 Sep 77	---	13	0	16
	1 Oct 78	---	2	4	0
Labrid/*Limanda* (Cunner/Yellowtail)	24 Jul-28 Oct 75[b]	1,121	---	849	1,351
	5 Feb-29 Sep 76	1,532	---	13,507	457
	26 Jan-4 Oct 77	7,181	---	18,057	9,271
	20 Mar-2 Nov 78	---	8,128	6,152	9,045
Pollachius virens[c] (Pollock)	28 Oct-15 Dec 75	129	---	85	54
	27 Oct 76-26 Jan 77	182	---	59	69
	15 Dec 77-16 Jan 78	---	30	123	112
Scomber scombrus (Mackerel)	24 Jul 75[b]	0	---	7	0
	18 May-20 Jul 76	208	---	313	286
	3 May-23 Aug 77	9,872	---	9,194	3,996
	24 May-13 Jul 78	---	1,223	2,944	2,857
Groundfish					
Gadus/Melanogrammus[c] (Cod/Haddock)	27 Aug 75-15 Jun 76	460	---	373	444
	18 Aug 76-23 Aug 77	191	---	376	171
	7 Sep 77-23 Aug 78	---	170	172	333
	6 Sep 78-5 Dec 78	---	18	41	46
Hippoglossoides platessoides (Plaice)	5 Feb-20 Jul 76	933	---	720	1,224
	2 Mar-23 Aug 77	394	---	264	433
	16 Mar-13 Jul 78	---	847	455	398

(Continued)

APPENDIX TABLE 7-14. (Continued)

SPECIES	DATES PRESENT	BOAR'S HEAD[d]	INTAKE[d]	DISCHARGE	SOUTH
Groundfish (Continued)					
Urophycis spp. (Hake)	24 Jul[b]-28 Oct 75	429	---	238	523
	15 Jun-27 Sep 76	3,606	---	1,259	4,984
	3 May-1 Nov 77	---	6,661	10,587	6,096
	24 May-2 Nov 78	---	10,812	3,531	4,062
Pelagic Species					
Merluccius bilinearis (Silver Hake)	27 Aug-28 Oct 75	12	---	221	164
	15 Jun-27 Sep 76	1,070	---	986	1,339
	15 Jun-15 Dec 77	---	5,303	4,843	5,723
	10 May-5 Dec 78	---	217	102	128

[a] Mean based on number of consecutive sample periods a species was present at one or more transects

[b] Sampling commenced on this date at these transects

[c] *Pollachius virens* eggs collected during spring months of 1976-1978 have been reexamined and found to be *Gadus/Melanogrammus*

[d] Boar's Head transect sampled through 15 Jun 77; Intake sampling commenced 6 Jul 77. Where sample periods overlap these dates, means are listed in the column for the transect at which the majority of the eggs were collected even though means are over both transects.

APPENDIX TABLE 7-15. MEAN ABUNDANCE (NO./1000 m^3) BY TRANSECT AND SAMPLE PERIOD[a], OF SELECTED SPECIES/GROUPS OF FISH LARVAE, 1975-1978. SEABROOK FINFISH STUDIES, 1978.

SPECIES	DATES PRESENT	BOAR'S HEAD[d]	INTAKE[d]	DISCHARGE	SOUTH
Indicator Species					
Brevoortia tyrannus (Menhaden)	24 Jul 75[b]	76	---	99	66
	20 Jul 76	20	---	5	0
Osmerus mordax (Smelt)	19 Nov-15 Dec 75	0	---	0	14
	18 May-5 Jun 76	0	---	5	5
	3 May-24 May 77	4	---	16	90
	10 May-9 Aug 78	---	2	1	<1
Pollachius virens[c] (Pollock)	19 Nov 75-23 Mar 76	11	---	29	70
	27 Oct 76-26 Jan 77	20	---	14	18
	1 Nov 77-16 Jan 78	---	39	43	19
Pseudopleuronectes americanus (Winter flounder)	24 Jul 75[b]	0	---	2	0
	20 Apr-15 Jun 76	48	---	67	32
	7 Apr-6 Jul 77	55	---	62	30
	26 Apr-13 Jul 78	---	58	62	191
Scomber scombrus (Mackerel)	15 Jun-20 Jul 76	18	---	[illegible]	4
	15 Jun-7 Sep 77	---	63	134	31
	22 Jun-9 Aug 78	---	62	7	62
Tautogolabrus adspersus (Cunner)	24 Jul[b]-29 Sep 75	476	---	80	49
	5 Jun-29 Sep 76	133	---	68	36
	15 Jun-4 Oct 77	---	295	160	330
	13 Jul-6 Sep 78	---	591	96	982

(Continued)

APPENDIX TABLE 7-15. (Continued)

SPECIES	DATES PRESENT	BOAR'S HEAD[d]	INTAKE[d]	DISCHARGE	SOUTH
Groundfish					
Ammodytes americanus	5 Feb-15 Jun 76	288	---	725	444
(Sand lance)	2 Jan-3 Aug 77	401	---	1050	1028
	15 Dec 77-13 Jul 78	---	429	113	418
Gadus morhua[c]	19 Nov 75-23 Mar 76	3	---	2	3
(Cod)	16 Nov 76-26 Jan 77	1	---	2	2
	1 Nov 77-16 Jan 78	---	3	6	2
	20 Apr-15 Jun 76	10	---	19	30
	24 May-23 Aug 77	24	---	20	24
	12 Apr-9 Aug 78	---	109	106	41
Hippoglossoides platessoides	24 Jul 75[b]	14	---	4	2
(Plaice)	25 Feb-15 Jun 76	98	---	77	180
	3 May-23 Aug 77	711	---	60	384
	12 Apr-9 Aug 78	---	330	132	59
Limanda ferruginea	24 Jul[b]-29 Sep 75	1	---	3	2
(Yellowtail flounder)	18 May-29 Sep 76	5	---	30	14
	24 May-7 Sep 77	116	---	20	22
	10 May-2 Nov 78	---	95	21	17
Melanogrammus aeglefinis	23 Mar-15 Jun 76	11	---	6	4
(Haddock)	24 May-6 Jul 77	4	---	6	5
	26 Apr-9 Aug 78	---	10	20	9
Urophycis spp.	27 Aug-29 Sep 75	22	---	23	17
(Hake)	20 Jul-27 Oct 76	1	---	<1	2
	20 Jul-1 Nov 77	---	46	28	29
	13 Jul-5 Oct 78	---	5	2	6

(Continued)

APPENDIX TABLE 7-15. (Continued)

SPECIES	DATES PRESENT	BOAR'S HEAD[d]	INTAKE[d]	DISCHARGE	SOUTH
Pelagic Species					
Clupea harengus (Herring)	28 Oct 75-23 Mar 76	332	---	93	214
	29 Sep 76-26 Jan 77	78	---	184	82
	4 Oct-27 Dec 77	---	355	206	124
	5 Dec 78	---	16	19	10
	7 Apr-24 May 77	<1	---	2	1
	26 Apr 78	---	3	1	0
Merluccius bilinearis (Silver hake)	24 Jul[b]-28 Oct 75	12	---	23	35
	15 Jun-27 Oct 76	34	---	16	11
	6 Jul-4 Oct 77	---	146	128	102
	24 May-2 Nov 78	---	131	3	8

--- = Transect not sampled

[a] Mean based on number of consecutive sample periods a species was present at one or more transects.

[b] Sampling commenced on this date at these transects

[c] *P. virens* larvae collected during May/June 1976 have been reexamined and found to be *Gadus morhua*

[d] Boar's Head transect sampled through 15 Jun 77; Intake sampling commenced 6 Jul 77. Where sample periods overlap, mean is of both transects, but placed under transect at which the majority of larvae were collected.