SEABROOK ENVIRONMENTAL STUDIES 1976-1977
FINFISH ECOLOGY INVESTIGATIONS IN HAMPTON-SEABROOK ESTUARY AND ADJOINING COASTAL WATERS
TECHNICAL REPORT VIII-4

Prepared for

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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 year-round study of the eggs, larvae and adults utilizing the nearshore region was initiated in 1973 (NAI, 1974). This latter 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 silversides (Conover and Ross, 1978).

The purpose of the present study is to continue to build a historical data base which characterizes the temporal and spatial distribution of finfish that utilize the Hampton-Seabrook nearshore region and estuary. This program is a continuation of the one initiated in the summer of 1975 which addresses distribution of pelagic, benthic and estuarine fishes, as well as their egg and larval forms. Special programs, such as age and growth of a resident benthic species (*Tauto-*

golabrus adspersus) and spawning run identification of a local anadromous species (*Alosa pseudoharengus*) were also continued. The age and growth study of *T. adspersus* was initiated in 1975 because it was chosen as an indicator species by the Nuclear Regulatory Commission, Normandeau Associates, Inc., and Public Service Company of New Hampshire. This report presents information collected during the second year (1976-1977) of preoperational monitoring for Seabrook Nuclear Station and compares these data and conclusions with those from the previous year (1975-1976). Between 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 STATION DESCRIPTIONS

2.1 OTTER TRAWL TRANSECTS

Three offshore transects (Figure 2.0-1) were established for otter trawling. Two of the transects (1 and 3) were relocated to deeper water in the 1975-1976 study. These transects remained unchanged during the present study. Transect 1 is off Seabrook Beach in an area with a clean sandy bottom some distance from rocky outcroppings. Tow depths ranged from 20 to 28 meters. Transect 2 is in an area scoured by tidal currents and directly offshore from Hampton Harbor and is near the Inner Sunk Rocks. Large quantities of drift algae are generally common in this area following storms. Tow depths ranged from 17 to 20 meters. Transect 3 is off Great Boars Head and just seaward of a cobble area (rocks 15-50 cm in diameter). The sampling area is characterized by a sandy bottom littered with shell debris. Tow depths ranged from 22 to 30 meters.

2.2 GILL NET STATIONS

Station A is located over a soft bottom substrate in 20 meters of water and seaward from rocky outcroppings off Seabrook Beach (Figure 2.0-1). It is in the tidal plume flushing from Hampton Harbor during ebb tide. Station B is also over soft bottom and seaward of the inner sunk rocks in 17 meters of water. It is in the path of water entering Hampton Harbor during flood tide. Station C is located over rocky bottom substrate in 17 meters of water, offshore from Boars Head, Hampton.

2.3 BEACH SEINE STATIONS

Station S1 is located in the Hampton River (Figure 2.0-1). Station S2 is near the mouth of the Browns River, approximately 200 meters upriver, whereas Station S-3 is in Seabrook Harbor, approximately

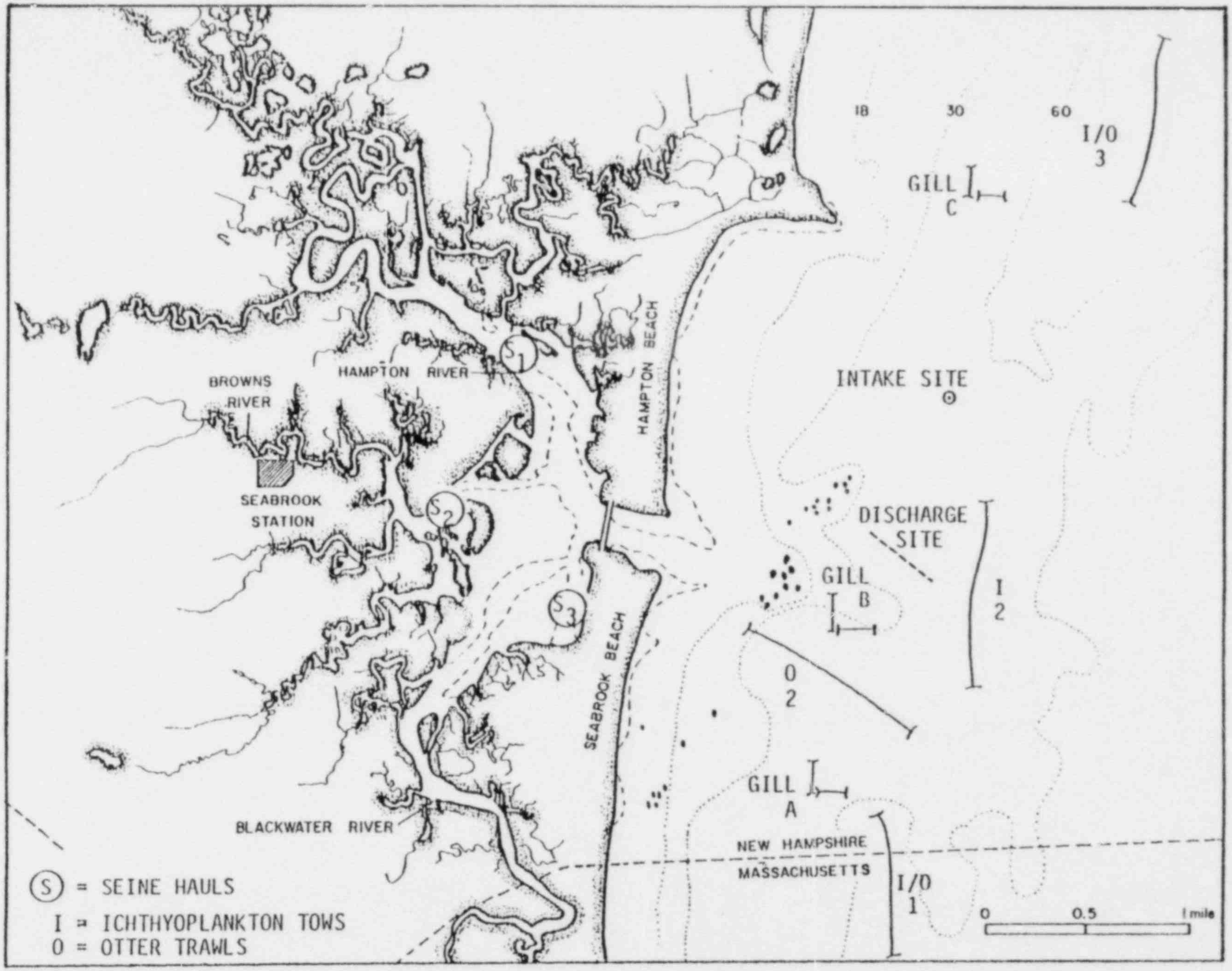

Figure 2.0-1. Finfish sampling stations. Seabrook Finfish Studies, 1976-1977.

400 meters inland from the Hampton Harbor bridge. The substrate at all stations is scoured by tidal currents and is composed of medium sand.

2.4 ICHTHYOPLANKTON TRANSECTS

Transect 1 (Figure 2.0-1) is located off Seabrook Beach on an area of clean sandy bottom several hundred meters from rocky outcroppings, and is located in the same zone as the Transect 1 otter trawl. Depth at this transect ranged from 20 to 28 meters. Transect 2 is located parallel to the shoreline outside the Inner Sunk Rocks and tows were made just beyond the discharge site in 20 to 24 meters. Transect 3 is located off Great Boars Head in an area of sandy bottom with some shell debris; depth ranged from 22 to 30 meters.

3.0 METHODS

The offshore sampling program consisted of monthly otter trawls, gill net sets, ichthyoplankton tows and biweekly surveys of sport fishermen. The estuarine program consisted of monthly beach seines, biweekly surveys of sport fishermen and a survey of freshwater tributaries for alewife (*Alosa pseudoharengus*) runs.

3.1 OTTER TRAWLS

Four (4) replicate otter trawls were taken at night along Transects 1, 2 and 3 (Figure 2.0-1) with a 9.2 m shrimp trawl (3.8 cm nylon mesh body; 1.3 cm mesh cod end liner). The net was deployed and towed at approximately 3 kn (engine operating at 900 rpm) for 10 minutes; replicate tows were taken in opposite directions. Periodically, tows at Transect 2 were reduced to 5 minutes due to large amounts of algae clogging the net. Specific information on all otter trawl tows is given in Table 3.1-1.

Catch data for 1976/77 were not statistically compared among transects and years because the large amounts of algae at Transect 2 reduced the efficiency of the net. Data for the 1976/77 season were reduced to catch per unit effort (C/E) of the major species at each transect and compared with values for the same species in the 1975/76 study. These analyses provided a description of relative abundance among transects and years.

3.2 GILL NETS

Nets were set for three consecutive 24-hr periods per month at all three stations (Figure 2.0-1). Two nets, assembled as shown in

TABLE 3.1-1. NUMBER AND DURATION OF OTTER TRAWL TOWS TAKEN IN 1975-1976 AND 1976-1977. SEABROOK FINFISH STUDIES, 1976-1977.

	1975-1976 TRANSECTS						1976-1977 TRANSECTS					
	1		2		3		1		2		3	
Month	# Of Tows	Minutes	# Of Tows	Minutes	# Of Tows	Minutes	# Of Tows	Minutes	# Of Tows	Minutes	# Of Tows	Minutes
Jul	4	10	3 1	10 7	3 1	10 NT[a]	4	10	4	10	4	10
Aug	4	10	3 1	10 7	4	10	4	10	1 3	10 5[b]	4	10
Sep	4	10	4	10	4	10	4	10	1 3	10 5[b]	4	10
Oct	4	10	4	10	4	10	4	10	4	10	4	10
Nov	4	10	4	10	4	10	4	10	4	10	4	10
Dec	4	10	4	10	3 1	10 6	4	10	4	10	4	10
Jan	4	10	4	10	4	10	4	10	2 2	10 NT[c]	4	10
Feb	4	10	4	10	4	10	4	10	3 1	10 5[b]	4	10
Mar	4	10	3 1	10 NT[c]	4	10	4	10	4	10	4	10
Apr	3 1	10 7	4	10	4	10	4	10	4	10	4	10
May	4	10	2 1	10 5[b]	4	10	4	10	1 3	10 5[b]	4	10
Jun	4	10	3 1	10 5[b]	4	10	4	10	1 3	10 5[b]	4	10

a = Not Taken (net snagged)

b = Reduced to 5 min., algae clogging

c = Not Taken (algae clogging)

Figure 3.2-1, were permanently set for the three days at each station, one parallel to and one perpendicular to the isobath. The nets were positioned on permanent buoys, set and tended by SCUBA divers.

Gill net data for the 1976/77 period were compared with the 1975/76 data, using a type of split-plot analysis of variance (Kirk, 1968). The model used $\log_{n+1}$ abundances, where blocks consist of days, depth and stations are within block effects, and year and month are between block effects. Because the $\log_{n+1}$ transformation did not eliminate heterogeneity of variance, F-tests of main effects and interactions contain biases. Contrasts among means were not tested for this reason but graphs of means for the major species are given from which inferences were made.

3.3 BEACH SEINE

Four (4) replicate seine hauls were taken with a 30.7 x 0.9 m bag seine. The outer wings of the seine were composed of 2.5 cm mesh (bar measure). The nylon bag was 2.5 meters square and composed of 1.2 cm mesh (stretch measure). Seine samples were taken monthly from April-November at Stations S1, S2 and S3 (Figure 2.0-1). Species rank and numerical abundances between years were compared for major species.

3.4 SPORTFISHERMEN SURVEY -- ALEWIFE (*ALOSA PSEUDOHARENGUS*) SURVEY

Censuses were conducted from July through September to record the sport fish catch from shore and boat fishermen, in Hampton Harbor and the local near-shore area. Fishermen were asked what species they had caught, how long they had been fishing, and what they preferred to catch. The census data for the 1976/77 season for offshore and estuarine fishermen was pooled and presented by species in catch per fishing hour.

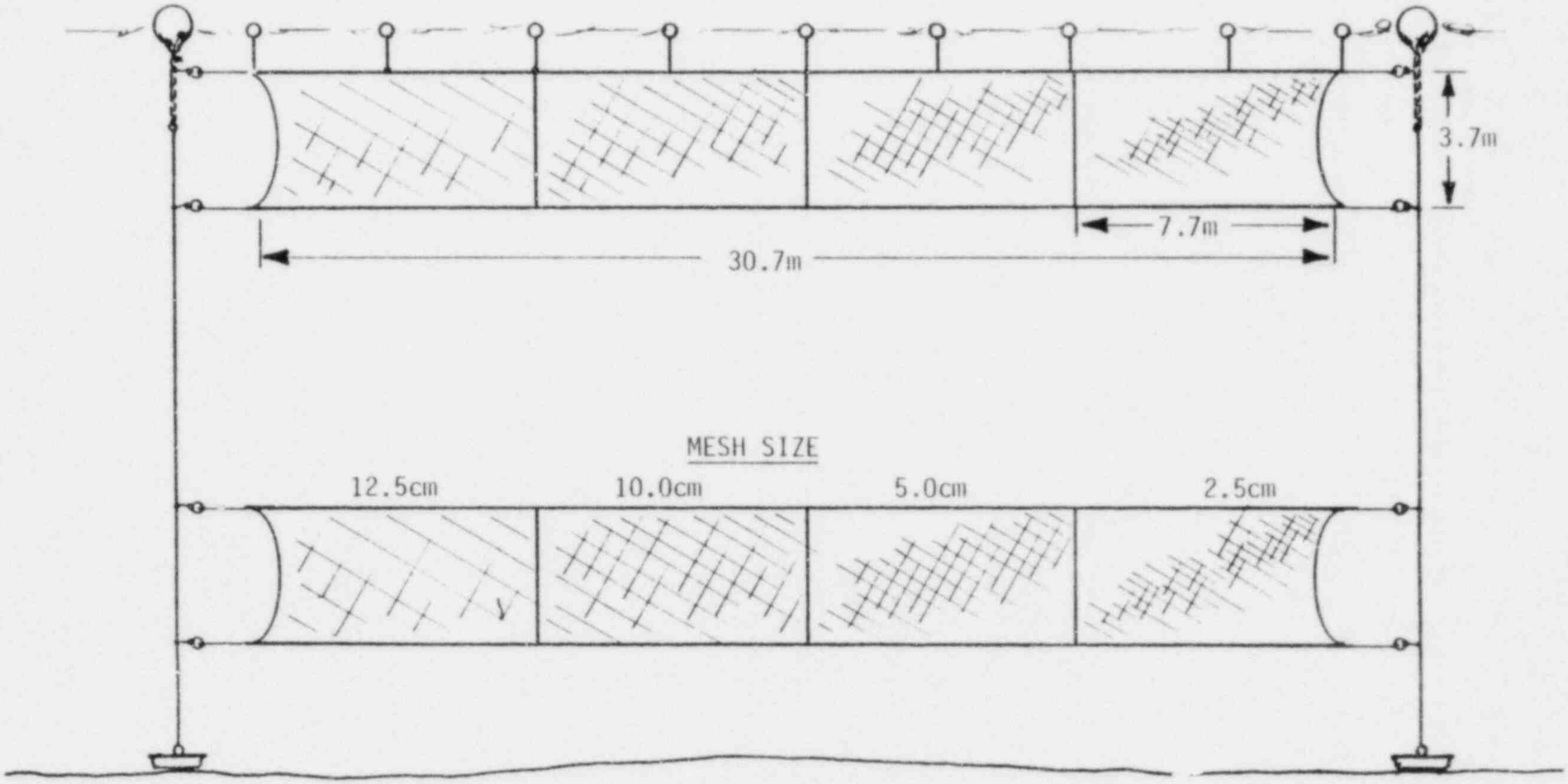

Figure 3.2-1. Gill net array. Seabrook Finfish Investigations, 1976-1977.

An alewife survey was conducted by the New Hampshire Fish and Game Department. During April and May several Hampton Harbor tributaries were examined for the presence of alewife in an attempt to evaluate the timing and size of the run. The average number of fish per minute was tabulated for days when counts were made. During the peak run in May, counts were made for one minute with four minute intervals between counts. When the run was slow, counts were made for three minutes with seven minute intervals between counts.

3.5 ICHTHYOPLANKTON

Four (4) replicate mid-water plankton tows for fish eggs and larvae were conducted at night along Transects 1, 2 and 3 (Figure 2.0-1) using a 1-m diameter 505 μ mesh net. The net was lowered with an attached depressor to a depth approximately half that of the bottom depth and towed at 2-3 kn. Speed was varied at two minute intervals to sample a range of midwater levels. 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 pre-sorted for eggs and larvae. 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*]). Subsamples were obtained using a Folsom plankton splitter when sample densities were relatively high.

Sanders' (1960) Biological Index was calculated to measure community dominance during 1975-1976 and 1976-1977. This index weighted each sampling period equally by assigning a rank to the ten most abundant species during a given sampling period and assigning a point value to each rank (e.g., 10 points for first, 9 points for second...1 point for tenth). These scores were summed over the entire study period to

give the Biological Index value. The maximum potential score was 120 points assuming 12 sampling dates per year.

Two additional techniques were used to evaluate structure of fish egg and larvae assemblages: numerical classification and species richness (number of species). Numerical classification proceeded in three steps:

1. all transect-date elements were compared using a similarity coefficient. For this investigation, Euclidean distance was calculated using $\log_{n+1}$ abundance data (Boesch, 1977).

2. group associations are determined based on the above analysis; the clustering strategy adopted was the "unweighted pair-group method using arithmetic averages, UPGMA" (Boesch, 1977);

3. the results of the clustering strategy were then presented as a dendrogram.

A variable stopping rule (Boesch, 1977) was applied to assist in interpretation of these analyses. Groups defined by the variable stopping rule were evaluated by nodal analysis for constancy which, in this case, is essentially an assessment of frequency of occurrence of a species within a transect-date group (Boesch, 1974). In addition, the mean abundance of each species of egg and dominant fish larvae (by biological index) within an operational cluster were calculated.

Species richness (number of species) was calculated for both eggs and larvae to compare seasons and years for this parameter. Data for selected species were reduced to comparable time periods to allow direct comparison between years of temporal and spatial distributions.

3.6 CUNNER (*TAUTOGOLABRUS ADSPERSUS*) AGE AND GROWTH

Most *T. adspersus* were captured in lobster traps set in the discharge area during the summer and fall. The remainder were collected by SCUBA divers using a seine. Individuals were measured (± 1 mm standard length), weighed (± 0.1 g) and sexed by dissection and gonad examination. Scales were removed from the left side, posterior to the insertion of the dorsal fin and just below the lateral line. Prior to reading, scales were washed and mounted between glass slides. Scales were projected at 92X magnification and scale radius and annular distance determined.

Age and growth was determined using a computer program which analyzed growth parameters for males and females separately and for all fish combined:

3.6.1 Back-Calculation of Length at Age

The relationship between scale radius and standard length at capture for males, females, juveniles and all sexes combined was calculated using linear regression. This yielded the constants in the Lee equation (Lagler, 1956; Miller, 1966):

Standard length = a + cs   where a and c are constants
s is 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 age for each specimen (Tesch, 1968; Lagler, 1956):

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

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

3.6.2 Length-Weight

The relationship between growth in length and weight was calculated according to the equation:

$$W = cL^n \text{ or } \log W = \log c + n \log L$$

where: W = weight (g)
L = standard length (mm)
c, n = constants

The value of n usually approximates 3.0 since the weight of an object ideally varies as the cube of its length when shape and specific gravity remain constant (Carlander, 1969; Lagler, 1956). A value for $n > 3.0$, for example, implies that a fish becomes relatively more robust as it grows. The importance of the length-weight relationship lies in its ability to predict with reasonable accuracy weights of fish when only length is known.

3.6.3 Growth/Body-Scale Relationship

When the scales on a fish grow proportionately faster than the fish, and the scales are used to calculate fish length at annulus formation there are two results. First, the linear relationship between scale radius and total length does not pass through the origin, but intersects the y-axis at a point designated as the "a value" for the linear equation:

scale radius = a + b (standard length)

This "a value" is then used as a correction factor in the calculation of length at annulus formation. The second effect is called the "Lee phenomenon" and results in back-calculated lengths at a given annulus that decrease with increasing fish size.

4.0 RESULTS

A total of 64 species[a] representing 54 genera were collected in the Hampton-Seabrook area from July 1976-June 1977. Of these, 58 species were juveniles and adults, 30 species were earlier life stages (Appendix Table 8.0-1).

4.1 OTTER TRAWLS

A total of 38 species was collected in trawls during the sampling year (Table 4.1-1). Five species accounted for 78% of the catch and eleven species accounted for 96.5% of the catch. *Limanda ferruginea* was the most abundant species (36.8%) followed by *Urophycis* spp. (white and squirrel hake) 22.9% and *Merluccius bilinearis* 6.1%. The number of species collected was similar for all transects, although Transect 1 had the greater number of individuals followed by Transect 3 and Transect 2.

Total number of species collected at the three transects over the year was similar (Table 4.1-2). Seasonal trends in number of species collected was difficult to assess among the transects. The number of species was low at transects 1 and 2 in January and February, but this trend was not apparent at Transect 3, where number of species remained similar throughout the year (Table 4.1-2).

Species rank differed among the 3 transects (Table 4.1-3). Catches of *L. ferruginea*, *Urophycis* spp., *Myoxocephalus octodecemspinosus* and *Gadus morhua* were greater at the offshore transects (1 and 3) while catches of *Pseudopleuronectes americanus* were greater at Transect 2, closest to shore. Numbers of fish collected per unit of effort were lower at Transect 2 due to the abbreviated (5 minute) tows (Table 4.1-4).

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[a] Common names are listed in Appendix Table 8.0-1.

TABLE 4.1-1. SPECIES RANK FOR FISHES COLLECTED IN OTTER TRAWLS. SEABROOK FINFISH STUDIES, 1976-1977.

SPECIES	TOTAL NUMBER	%
Limanda ferruginea	2,664	36.8
Urophycis spp.	1,656	22.9
Pseudopleuronectes americanus	468	6.5
Merluccius bilinearis	442	6.1
Myoxocephalus octodecemspinosus	428	5.9
Melanogrammus aeglefinus	267	3.7
Raja spp.	252	3.5
Macrozoarces americanus	246	3.4
Gadus morhua	220	3.0
Osmerus mordax	186	2.6
Scophthalmus aquosus	147	2.0
Pollachius virens	46	<1.0
Syngnathus fuscus	23	<1.0
Liparis atlanticus	18	<1.0
Menidia menidia	18	<1.0
Paralichthys oblongus	16	<1.0
Aspidophoroides monopterygius	15	<1.0
Ulvaria subbifurcata	14	<1.0
Myoxocephalus aenaeus	13	<1.0
Hemitripterus americanus	12	<1.0
Lophius americanus	12	<1.0
Enchelyopus cimbrius	10	<1.0
Alosa pseudoharengus	9	<1.0
Hippoglossoides platessoides	8	<1.0
Stenotomus chrysops	8	<1.0
Pholis gunnellus	8	<1.0
Prionotus carolinus	7	<1.0
Myoxocephalus scorpius	4	<1.0
Alosa aestivalis	3	<1.0
Ammodytes americanus	3	<1.0
Tautogolabrus adspersus	3	<1.0
Peprilus triacanthus	2	<1.0
Centropristis striata	1	<1.0
Clupea harengus	1	<1.0
Cyclopterus lumpus	1	<1.0
Hippoglossus hippoglossus	1	<1.0
Liparis liparis	1	<1.0
Microgadus tomcod		<1.0
TOTAL	7,234	

TABLE 4.1-2. NUMBER OF SPECIES AND INDIVIDUALS COLLECTED PER MONTH AT EACH OTTER TRAWL TRANSECT (1, 2 AND 3). SEABROOK FINFISH STUDIES, 1976-1977.

Month	Transect 1		Transect 2		Transect 3	
	# Species	# Individuals	# Species	# Individuals	# Species	# Individuals
Jul 1976	9	287	9	46	14	217
Aug	11	383	5	97	11	483
Sep	12	377	9	187	12	402
Oct	13	438	12	76	13	220
Nov	14	447	9	71	14	295
Dec	15	291	10	65	18	195
Jan 1977	7	172	6	27	12	119
Feb	8	104	7	47	11	92
Mar	11	198	13	111	13	106
Apr	11	165	12	43	13	201
May	12	299	8	100	9	204
Jun	11	390	8	169	12	173
TOTAL	27[a]	3,551	26[a]	979	29[a]	2,707

[a] Total no. of different species collected

TABLE 4.1-3. SPECIES RANK FOR FISHES COLLECTED IN OTTER TRAWLS AT EACH TRANSECT (1, 2 AND 3). SEABROOK FINFISH STUDIES, 1976-1977.

TRANSECT 1

Species	TOTAL NUMBER	PERCENT COMPOSITION
Limanda ferruginea	1,712	49
Urophycis spp.	889	25
Merluccius bilinearis	260	8
Myoxocephalus octodecemspinosus	156	4
Pseudopleuronectes americanus	126	3
Scophthalmus aquosus	88	2
Gadus morhua	84	2
Others	236	7
TOTAL	3,551	

TRANSECT 3

Species	TOTAL NUMBER	PERCENT COMPOSITION
Limanda ferruginea	773	25
Urophycis spp.	563	21
Melanogrammus aeglefinus	230	18
Myoxocephalus octodecemspinosus	238	7
Raja spp.	165	4
Macrozoarces americanus	172	4
Merluccius bilinearis	143	4
Others	420	17
TOTAL	2,704	

TRANSECT 2

Species	TOTAL NUMBER	PERCENT COMPOSITION
Pseudopleuronectes americanus	249	29
Urophycis spp.	204	20
Limanda ferruginea	179	9
Osmerus mordax	64	9
Raja spp.	41	6
Macrozoarces americanus	40	6
Merluccius bilinearis	39	5
Others	163	16
TOTAL	979	

TABLE 4.1-4. CATCH PER UNIT EFFORT (10 MIN.) AT EACH TRANSECT OF ABUNDANT SPECIES COLLECTED IN TRAWLS IN 1975-1976 AND 1976-1977. MONTHS WHEN EACH SPECIES WAS NOT COLLECTED HAVE BEEN EXCLUDED. SEABROOK FINFISH STUDIES, 1976-1977.

		TRANSECTS		
		1	2[a]	3
Limanda ferruginea	75-76	30.5	4.8	18.7
	76-77	35.7	4.4	16.1
Osmerus mordax	75-76	15.5	26.6	17.3
	76-77	3.4	3.9	3.3
Urophycis spp.	75-76	14.1	4.4	11.7
	76-77	20.9	9.5	14.4
Merluccius bilinearis	75-76	5.6	0.6	4.8
	76-77	8.4	1.9	4.4
Gadus morhua	75-76	2.8	0.6	3.4
	76-77	2.3	0.3	2.6
Pseudopleuronectes	75-76	0.9	2.4	1.3
americanus	76-77	2.8	7.3	2.0
Myoxocephalus	75-76	1.9	0.5	3.7
octodecemspinosus	76-77	3.9	1.3	4.3

[a] Some tows only 5 minutes (See Table 3.1-1), but all data converted to catch per 10 minutes.

4.2 GILL NETS

A total of 25 species was collected in gill nets during the 1976/77 sample period (Table 4.2-1). *Clupea harengus* was the most abundant species and *M. bilinearis* ranked second. Three species accounted for 81% of the total catch, while the nine top ranked species accounted for 97.4% of the catch. The number of individuals collected was lowest in December but remained fairly equal in numbers throughout the other months. Overall, total number of species collected was high May through October and low in the winter when the catch was almost exclusively *C. harengus*. The total number of species was greatest at Station B while the largest number of individuals collected was at Station C (Table 4.2-2).

Results of statistical tests on the catch per effort for important species is given in Table 4.2-3. The month x year interaction was significant ($p \leq .001$) for all species tested. Catch per effort of *Scomber scombrus* and *M. bilinearis* changed over years. Depth effects were significant for four of the five species listed. The between station effects were significant ($.05 \geq P > .01$) for *M. bilinearis* only, but three way interactions involving stations with depth, year and months were significant for *C. harengus, S. scombrus* and *Alosa aestivalis*. Each species will be discussed in more detail in Section 5.0. In that discussion, graphic data presentation for each species is somewhat different in order to best illustrate the factors that showed significant interaction.

4.3 BEACH SEINE

A total of 26 species was collected during 1976/77. *Menidia menidia* were the most abundant species. Six species accounted for 97.6% of the total (Table 4.3-1).

TABLE 4.2-1. SPECIES RANK FOR FISHES COLLECTED IN GILL NETS. SEABROOK FINFISH STUDIES, 1976-1977.

SPECIES	TOTAL NUMBER	%
Clupea harengus	1,846	51.6
Merluccius bilinearis	671	18.8
Scomber scombrus	380	10.6
Alosa aestivalis	249	7.0
Pollachius virens	120	3.4
Urophycis spp.	65	1.8
Alosa pseudoharengus	64	1.8
Osmerus mordax	49	1.4
Brevoortia tyrannus	43	1.2
Gadus morhua	33	<1.0
Tautogolabrus adspersus	18	<1.0
Alosa sapidissima	7	<1.0
Myoxocephalus octodecemspinosus	6	<1.0
Alosa mediocris	5	<1.0
Peprilus triacanthus	5	<1.0
Pseudopleuronectes americanus	5	<1.0
Mustelus canis	2	<1.0
Ammodytes americanus	1	<1.0
Centropristis striata	1	<1.0
Pholis gunnellus	1	<1.0
Pomatomus saltatrix	1	<1.0
Scophthalmus aquosus	1	<1.0
Squalus acanthias	1	<1.0
Stenotomus chrysops	1	<1.0
Syngathus fuscus	1	<1.0
TOTAL	3,576	

TABLE 4.2-2. NUMBER OF SPECIES AND INDIVIDUALS COLLECTED PER MONTH AT EACH GILL NET STATION (A, B AND C). SEABROOK FINFISH STUDIES, 1976-1977.

Month	Station A		Station B		Station C	
	# Species	# Individuals	# Species	# Individuals	# Species	# Individuals
Jul 1976	8	81	5	110	8	139
Aug	7	139	9	109	9	107
Sep	8	72	7	128	5	154
Oct	7	42	8	73	7	211
Nov	4	67	5	78	4	202
Dec	4	36	3	35	4	29
Jan 1977	2	80	2	119	2	111
Feb	2	186	2	60	2	161
Mar	0[a]	0	3[a]	3	2[a]	23
Apr	4	144	5	111	3	69
May	6	109	8	76	6	130
Jun	9	111	12	120	12	131
TOTAL	15[b]	1,067	20[b]	1,022	17[b]	1,467

[a] only one 24 hour set

[b] total no. of different species collected

TABLE 4.2-3. RESULTS OF SPLIT-PLOT ANALYSIS OF VARIANCE ON CATCH PER EFFORT [TRANSFORMED LOG $_{10}$ (CATCH + 1)] FOR MAJOR SPECIES COLLECTED IN GILL NETS. SEABROOK FINFISH STUDIES, 1976-1977

	Months	Years	Months X Years	Depth	Months X Depth	Years X Depth	Months X Years X Depth	Stations	Months X Stations	Years X Stations	Years X Months X Stations	Depth X Stations	Months X Depth X Stations	Years X Depth X Stations
Alosa aestivalis	**	–	***	**	–	–	–	–	*	–	–	–	–	–
Alosa pseudoharengus	–	–	***	–	**	–	***	–	–	–	–	–	–	–
Clupea harengus	***	–	***	***	***	*	–	–	–	–	–	–	*	–
Scomber scombrus	*	*	***	***	*	**	***	–	–	–	*	–	*	–
Merluccius bilinearis	***	***	***	***	**	*	*	***	**	–	*	–	–	–

* = $.05 \geq p > .01$

** = $.01 \geq p > .001$

*** = $p \leq .001$

TABLE 4.3-1. SPECIES RANK FOR FISHES COLLECTED IN BEACH SEINE. SEABROOK FINFISH STUDIES, 1976-1977.

SPECIES	TOTAL NUMBER	%
Menidia menidia	25,056	79.6
Fundulus spp.	3,015	9.6
Ammodytes americanus	1,417	4.5
Pungitius pungitius	510	1.6
Osmerus mordax	419	1.3
Microgadus tomcod	320	1.0
Pseudopleuronectes americanus	244	<1.0
Pollachius virens	226	<1.0
Gasterosteus aculeatus	94	<1.0
Alosa aestivalis	62	<1.0
Urophycis spp.	43	<1.0
Clupea harengus	34	<1.0
Alosa pseudoharengus	16	<1.0
Limanda ferruginea	15	<1.0
Salmo gairdneri	5	<1.0
Oncorhynchus kisutch	4	<1.0
Liopsetta putnami	3	<1.0
Salmo trutta	3	<1.0
Cyclopterus lumpus	2	<1.0
Myoxocephalus aenaeus	2	<1.0
M. scorpius	2	<1.0
Scophthalmus aquosus	2	<1.0
Apeltes quadracus	1	<1.0
Hemitripterus americanus	1	<1.0
Morone saxatilis	1	<1.0
Syngnathus fuscus	1	<1.0
Tautogolabrus adspersus	1	<1.0
TOTAL	31,499	

Total number of species for all stations combined was high June through August and typically low in late Fall and early spring (Table 4.3-2). Station S3 had the greater number of species collected. One reason was that Station S3 was located closest to the ocean and more ocean species such as *P. virens*, *Urophycis* spp. and *O. mordax* were collected. The number of individuals collected was greatest June through October due to large numbers of *M. menidia*. Catch was highest in October at Station S3 (Table 4.3-2) when *M. menidia* were extremely abundant.

4.4 ALEWIFE SURVEY

The alewife run in the Taylor River was the earliest recorded in several years; it began on April 13 and essentially ended the last week in May. During the run, water temperatures ranged from 6.5°C to 16.5°C. During the peak of the run on May 17, 40 fish/minute passed the fish ladder (Table 4.4-1). Counts taken May 16 and May 17 may not have been entirely alewives since a sample of 77 fish examined on May 18 showed 82% blueback herring, indicating the run consisted largely of bluebacks in late May. Local fishermen stated that the 1977 run was better than average.

TABLE 4.4-1. NUMBER OF *ALOSA* SPP. PER MINUTE COUNTED ASCENDING THE TAYLOR FISH LADDER, APRIL-MAY 1977. SEABROOK FINFISH STUDIES, 1976-1977.

DATE	TIME	TIDE STAGE	# FISH/MINUTE
April 13, 1977	0730-0830	High tide	0.1
April 17	1045-1200	High tide	0
April 22	1230-1325	Flooding	2.4
April 26[a]	1900-1910	Ebbing	0
April 28	1422-1432	Flooding	0.2
May 2	1900-1910	Flooding	5.2
May 4	1430-1510	Ebbing	17.4
May 5	1245-1430	Ebbing	12.8
May 16	1010-1030	High tide	36.0
May 17	1100-1145	High tide	40.0
May 18[b]	1130-1330	High tide-Ebbing	8.8

[a] 4 days of heavy rain, run temporarily stopped because of high water

[b] 77 fish sampled and 18% were alewives, remainder were blueback herring

TABLE 4.3-2. NUMBER OF SPECIES AND INDIVIDUALS COLLECTED PER MONTH AT EACH SEINE STATION (S1, S2 AND S3). SEABROOK FINFISH STUDIES, 1976-1977.

Month	Station S1		Station S2		Station S3	
	# Species	# Individuals	# Species	# Individuals	# Species	# Individuals
Jul 1976	5	1,545	3	452	11	1,539
Aug	6	2,988	6	1,722	7	3,419
Sep	6	1,637	5	1,146	5	3,227
Oct	3	861	3	1,006	1	10,002
Nov	4	9	2	31	6	142
Apr 1977	3	13	6	34	6	16
May	4	17	3	63	6	12
Jun	10	1,446	10	48	6	122
TOTAL	16[a]	8,516	17[a]	4,502	20[a]	18,481

[a] Total no. of different species collected

4.5 SPORT FISHERMEN SURVEY

Pseudopleuronectes americanus was the most common species caught and was recorded in every census, with the largest catches made in June and July (Table 4.5-1). *Pollachius virens* was recorded in every census except 1 August, and was very abundant in September censuses. *Osmerus mordax* were caught in late August and September and were very abundant on 5 September. Catches of *G. morhua* and *S. scombrus* were also recorded in low numbers during the surveys. Most fishermen thought fishing was fair.

4.6 ICHTHYOPLANKTON

4.6.1 Species Composition

Eleven fish egg taxa and 25 species of fish larvae were identified from ichthyoplankton collections in the vicinity of the Hampton-Seabrook estuary between July 1976 and June 1977 (Appendix Table 8.0-1). This compares with 14 egg taxon and 31 species of larvae identified during the 1975-1976 program (NAI, 1977). There were more species of larvae than eggs because: some eggs are demersal (e.g., *Clupea harengus* and *Ammodytes americanus*), spawning occurs in areas of reduced salinity (e.g., *Osmerus mordax*), the species broods the young (*Syngnathus fuscus*), there is migration of post larva from other areas (*Anguilla rostrata*) or the eggs are combined into categories of similar morphology (e.g., Labrid/*Limanda* and *Gadus*/*Melanogrammus*).

During 1976-1977, eggs of *Gadus*/*Melanogrammus*, Labrid/*Limanda*, *Enchelyopus cimbrius*, *Pollachius virens* and *Hippoglossoides platessoides* were dominant; this same assemblage was also dominant during 1975-1976 (Table 4.6-1, Appendix 8.0-11). Dominant fish larvae during 1976-1977 included *E. cimbrius*, *A. americanus*, *G. morhua* and *P. virens* (Table 4.6-1, Appendix 8.0-12). This assemblage differed from the 1975-1976 dominants which included *Liparis* sp., *C. harengus* and *H. platessoides* and excluded *G. morhua* and *P. virens*.

TABLE 4.5-1. HAMPTON-SEABROOK SPORT FISHERY CATCH BY SPECIES, NUMBER PER HOUR OF FISHING EFFORT. SEABROOK FINFISH STUDIES, 1976-1977.

DATE	*Pseudopleuronectes americanus*	*Gadus morhua*	*Pollachius virens*	*Scomber scombrus*	*Tautogolabrus adspersus*	*Osmerus mordax*	*Centropristes striatus*	*Prionotus carolinus*	*Brosme brosme*	*Urophycis* sp.
3 Jul 76	1.36	.16	.95		1.75		.20			
27 Jul 76	.62		.52					.15		
1 Aug 76	.37									
22 Aug 76	.88	.91	.52	1.73		.33			.14	
5 Sep 76	.44	.08	3.21			9.51				
19 Sep 76	.66	2.26				3.19				.25
12 Jun 77	2.02	1.0	.5							1.0
25 Jun 77	.43		1.74							

TABLE 4.6-1. SUMMARY OF BIOLOGICAL INDEX VALUES OF DOMINANT FISH EGGS AND LARVAE IN THE HAMPTON-SEABROOK AREA 1975-1977. SEABROOK FINFISH STUDIES, 1976 - 1977

EGGS

Species	Biological Index Value 1975-1976	1976-1977
Gadus/Melanogrammus	91	90
Labrid/Limanda	73	69
Enchelyopus cimbrius	59	63
Pollachius virens	58	52
Hippoglossoides platessoides	57	50
Urophycis sp.	32	46
Scophthalmus aquosus	34	35
Merluccius bilinearis	25	37
Glyptocephalus cynoglossus	26	28
Scomber scombrus	13	20
Brosme brosme	17	5
Peprilus triacanthus	4	-
Brevoortia tyrannus	3	-
Prionotus carolinas	3	-

LARVAE

Species	Biological Index Value 1975-1976	1976-1977
Enchelyopus cimbrius	52	52
Ammodytes americanus	46	97
Gadus morhua	43	48
Pollachius virens	37	42
Clupea harengus	47	31
Hippoglossoides platessoides	43	23
Tautogolabrus adspersus	26	32
Ulvaria subbifurcata	27	29
Liparis sp.	52	NR
Glyptocephalus cynoglossus	31	NR
Scophthalmus aquosus	NR	31
Melluccius bilinearis	NR	31

- = not collected

NR = not ranked by biological index

4.6.2 Temporal Distribution

Fish egg abundance was greatest during summer 1976 and late spring 1977 when Labrid/*Limanda* eggs were dominant (Figure 4.6-1). A smaller secondary peak, a result of Gadid spawning, occurred between November and early February. Egg densities were lowest during late January and February. The general succession of species during 1976-1977 was:

Summer: Labrid/*Limanda*, *Urophycis* spp.
Fall: *E. cimbrius*, *Gadus/Melanogrammus*
Winter: *Gadus/Melanogrammus*, *P. virens*
Spring: *H. platessoides*, *E. cimbrius*, Labrid/*Limanda*

Fish larvae showed a bimodal cycle of abundance with a March peak dominated by *A. americanus* and a May peak dominated by *H. platessoides* and *Ulvaria subbifurcata*, (Figure 4.6-2).

The general seasonal succession was

Summer: *Tautogolabrus adspersus*, *E. cimbrius*
Fall: *E. cimbrius*, *Liparis* sp., *P. virens*
Winter: *P. virens*, *A. americanus*
Spring: *A. americanus*, *H. platessoides*

The spatial distribution of eggs and larvae indicated that, within any month, the greatest abundances were found more often at Transect 3 than at the other two transects. However, over the year, the greatest mean abundances were recorded at Transect 2 for eggs ($23.7/m^3$) and Transects 1 and 2 for larvae ($1.3/m^3$). These yearly mean abundances reflected a maximum egg density of almost 200 eggs/m^3 (mostly Labrid/*Limanda*) at Transect [illegible] June 1977 and a large pulse of *A. americanus* larvae at Transect [illegible] on 2 March 1977.

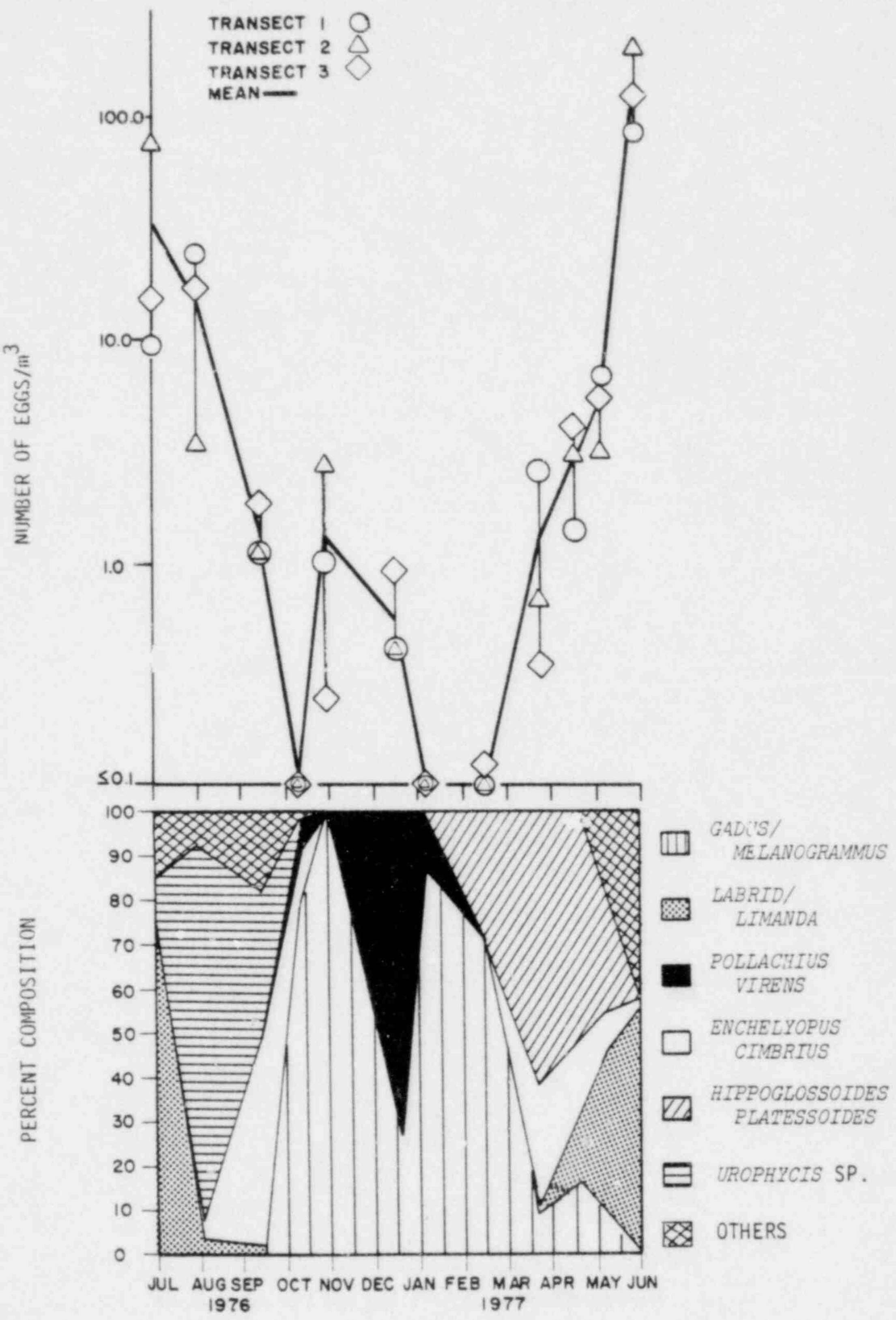


Figure 4.6-1. Abundance (no./m^3) and percent composition of fish eggs in ichthyoplankton collections, Hampton-Seabrook area. Seabrook Finfish Studies, 1976-1977.

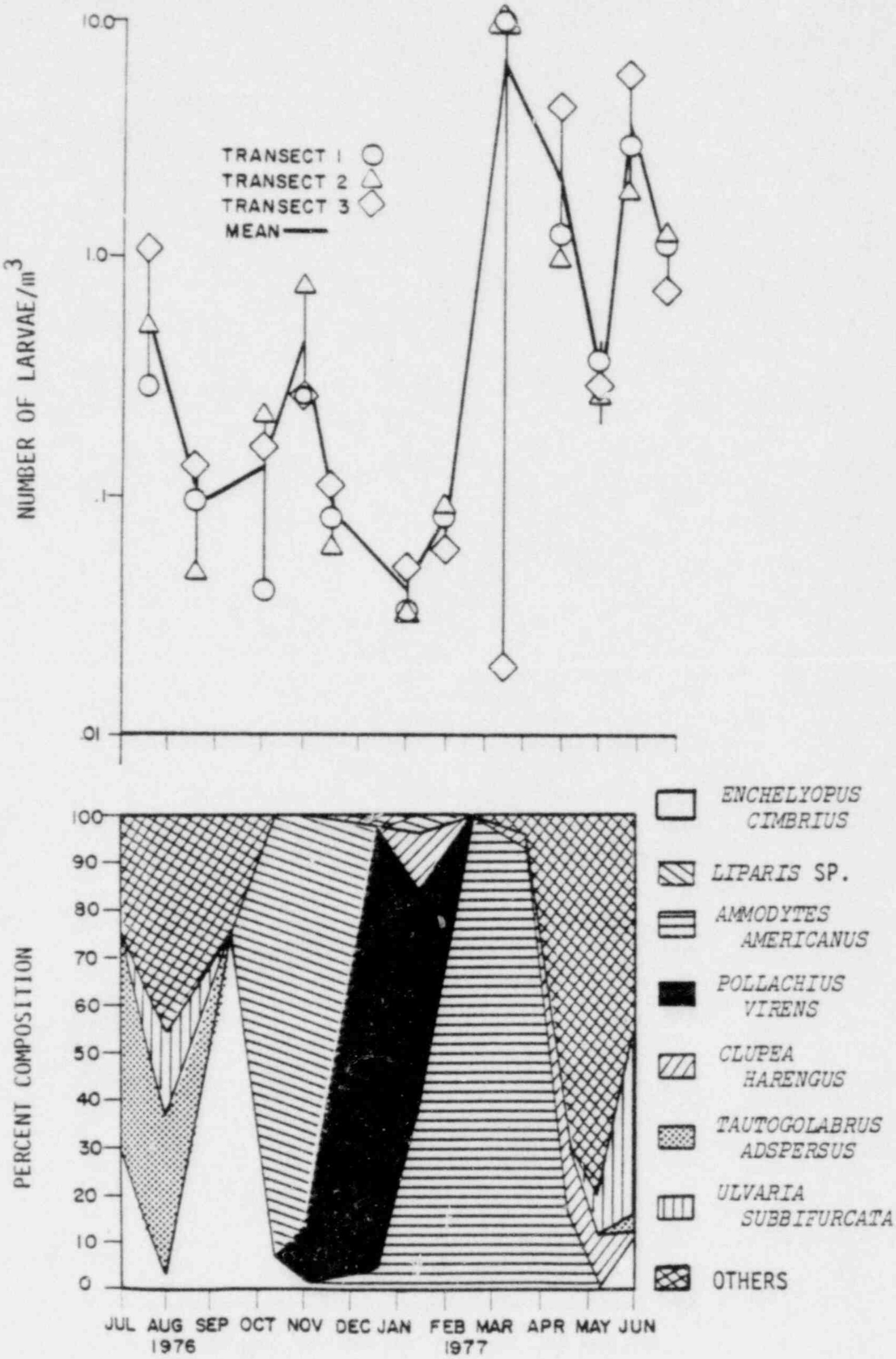


Figure 4.6-2. Abundance (no./m^3) and percent composition of fish larvae in ichthyoplankton collections, Hampton-Seabrook area. Seabrook Finfish Studies, 1976-1977.

4.6.3 Cluster Analysis

Cluster analysis was applied to the 1975-1977 data to assist in evaluating whether the near-field ichthyoplankton assemblage showed evidence of spatial heterogeneity during preoperational years, thereby providing basis for pre-and post-operational comparisons. Additionally, the importance of seasonal factors (see Section 4.6.2) in affecting community structure was investigated.

Seven and eight transect-date clusters were discerned at varying sums of squared differences for eggs and larvae, respectively during 1975-1977 (Appendix Figures 8.0-1,2). Working clusters in each case were distinguishable by season, abundance, species richness and constancy (Tables 4.6-2,3; Appendix Tables 8.0-13,14 and Appendix Figures 8.0-3,4).

Cluster analysis of the fish egg assemblage in the Hampton-Seabrook area showed that transects aggregated primarily by season, with little evidence of spatial heterogeneity or of differences between years. The analysis of fish larvae, however, did not show as clear a seasonal pattern.

Eggs represented fewer taxa and generally showed 1-2 dates of pronounced abundance. Such a pattern would be expected to show strong seasonality. Fish larvae were less abundant than their eggs or their eggs were not collected; their seasonal periodicity was generally not characterized by a single date of overwhelming abundance. Such a trend would be expected to suggest a more subtle seasonal pattern as evident from these data.

4.6.4 Species Richness

Numbers of species of both fish eggs and larvae showed a general cycle of fewer species present during winter months followed by

TABLE 4.6-2. SUMMARY OF CLUSTER ANALYSIS OF FISH EGG DISTRIBUTION, HAMPTON-SEABROOK AREA JULY 1975 - JUNE 1977. SEABROOK FINFISH STUDIES, 1976 - 1977.

Cluster	General Cluster Characteristics						
Station/Date Cluster	Transect	Months	Seasonal Assemblage	Mean Total Abundance	Species Richness	Numerical Dominants	Constancy >.75
I (2)	2	Jun-Jul 76	summer	2	11	*Labrid/Limanda* *Urophycis* sp.	*Labrid/Limanda* *E. cimbrius* *Urophycis* sp. *S. aquosus* *M. bilinearis* *S. scombrus*
II (3)	1,2,3	June 77	summer	1	11	*Labrid/Limanda* *S. scrombrus*	*Gadus/Melanogrammus* *Labrid/Limanda* *E. cimbrius* *H. platessoides* *Urophycis* sp. *S. aquosus* *M. bilinearis* *G. cynoglossus* *S. scombrus* *B. brosme*
III (5)	1,2,3	July 75,76	summer	4	10	*Labrid/Limanda* *Urophycis* sp.	*Labrid/Limanda* *E. cimbrius* *Urophycis* sp. *S. aquosus* *G. cynoglossus*
IV (14)	1,2,3	Apr-Jun 76	spring	5	12	*H. platessoides* *Labrid/Limanda*	*Gadus/Melanogrammus* *Labrid/Limanda* *E. cimbrius* *P. virens* *H. platessoides*

TABLE 4.6-2 (Continued)

Cluster		General Cluster Characteristics					
Station/Date Cluster	Transect	Months	Assemblage	Abundance	Richness	Dominants	Constancy .75
V (44)	1,2,3	Aug 9-Dec 75 Feb, Aug - Nov 76 Jan - May, Nov 77	variable	7	14	*Gadus/Melanogrammus* *P. virens*	*Gadus/Melanogrammus*
VI (1)	2	Nov 75	late fall	6	2	*Gadus/Melanogrammus* *P. virens*	*Gadus/Melanogrammus* *P. virens*
VII (2)	1,3	Aug 76	summer	3	6	*Urophycis* sp. *M. bilinearis*	*Labrid/Limanda* *E. cimbrius* *Urophycis* sp. *S. aquosus* *M. bilinearis*

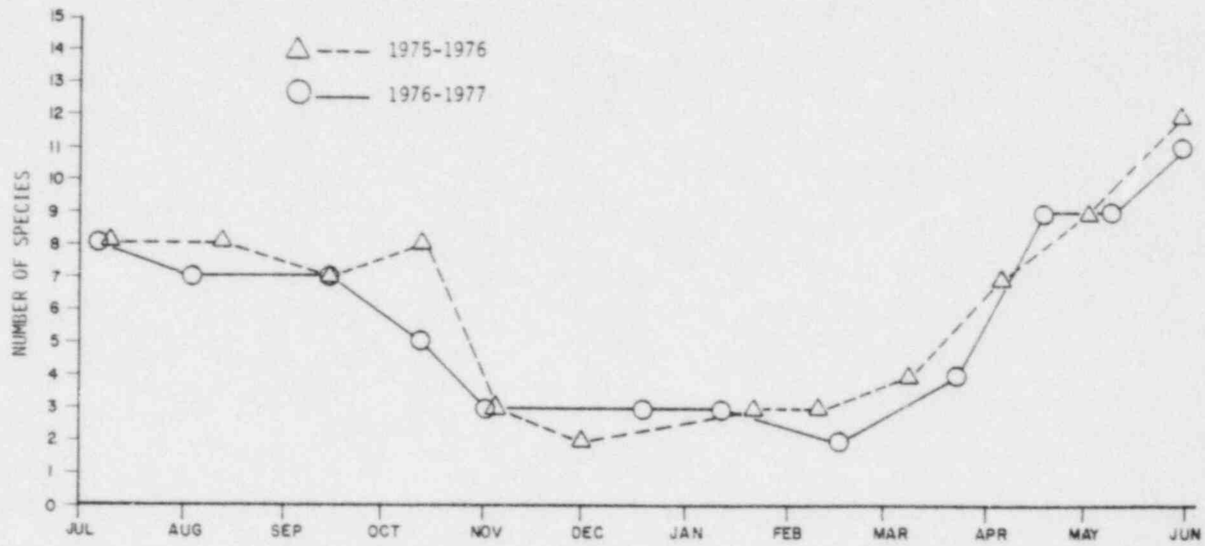
( ) = number of elements in cluster

TABLE 4.6-3. SUMMARY OF CLUSTER ANALYSIS OF FISH LARVAE DISTRIBUTION, HAMPTON-SEABROOK AREA. JULY 1975 - JUNE 1977. SEABROOK FINFISH STUDIES, 1976 - 1977

Cluster	General Cluster Characteristics						
Station/Date Cluster	Transect	Months	Assemblage	Abundance	Richness	Dominants	Constancy .75
I (51)	1,2,3	Jul 75-Dec 75 Feb,Apr-Nov 76 Jan,Mar,May,Jun 77	None	8	28	*E. cimbrius* *H. platessoides*	None
II (9)	1,2,3	Feb 76-Apr 76 Apr 77	winter-spring	7	17	*A. americanus* *Liparis* sp.	*A. americanus* *Liparis* sp.
III (1)	2	May 76	spring	4	11	*Liparis* sp. *H. platessoides*	*A. americanus* *G. morhua* *H. platessoides* *U. subbifurcata* *Liparis* sp.
IV (3)	2,3	Aug 75 Oct 76 May 77	None	5	20	*T. adspersus* *U. subbifurcata*	None
V (2)	1,3	Nov 75	fall	6	4	*C. harengus* *P. virens*	*E. cimbrius* *P. virens* *C. harengus*
VI (2)	1,3	May 77	spring	2	11	*H. platessoides* *U. subbifurcata*	*A. americanus* *G. morhua* *H. platessoides* *Liparis* sp.
VII (2)	2,3	Feb 76 April 77	winter-spring	3	9	*A. americanus* *Liparis* sp.	*A. americanus* *Liparis* sp.
VIII (2)	1,2	March 77	winter	1	4	*A. americanus* *Liparis* sp.	*A. americanus* *Liparis* sp.

( ) = number of elements in cluster

a spring-summer increase during both study years (Figure 4.6-3). A comparison of larval species richness suggested that there were differences in the community between spring 1976 and spring 1977. However, based on both species richness and cluster analysis, the structure of the ichthyoplankton assemblage in the Hampton-Seabrook area is primarily a result of seasonality and associated abiotic factors (e.g., temperature, photoperiod) which influence the reproductive cycles of the individual species.



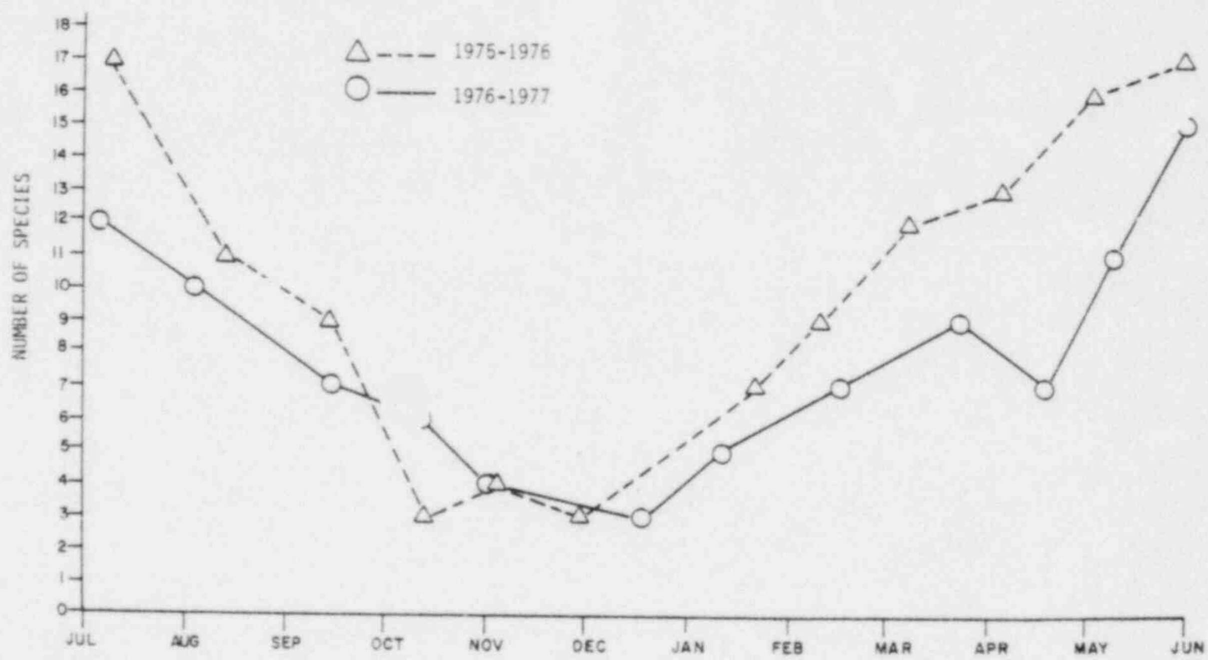


Figure 4 6-3. Fish eggs and larvae in ichthyoplankton collections, Hampton-Seabrook area. Seabrook Finfish Studies, 1976-1977.

5.0 DISCUSSION OF MAJOR SPECIES

5.1 CUNNER, *TAUTOGOLABRUS ADSPERSUS*

5.1.1 Spatial and Temporal Abundance

Although *T. adspersus* have been documented to be one of the most abundant species in the nearshore zone (NAI, 1977), few are captured in the nets used in the sampling program. They typically congregate at the bottom around rock ledge areas and therefore are generally not subject to capture by trawling. Trawling is conducted in areas where the bottom is unobstructed by rocks. Bottom gill nets are set approximately 3 m above the substrate, far enough above bottom so that most *T. adspersus* would not come in contact with them. All the individuals collected for this study were captured in lobster pots set in the discharge area and by SCUBA divers using a seine. It is reported by Olla *et al.* (1975) and Dew (1976) that *T. adspersus* overwinter in a torpid non-feeding state. Few individuals were observed in previous studies during the winter, supporting these observations.

5.1.2 Age and Growth

5.1.2.1 Length and Weight at Capture

The 389 *T. adspersus* collected in 1976 ranged from 31.7 to 317.5 mm SL. Mean lengths of males at capture appeared slightly larger than females for all ages (Table 5.1-1). However, the number of individuals in male year classes was too small for definite determination of the effect of sex on body size. Mean weight of males similarly appeared heavier than that of females, except at Age V. In 1975 (NAI, 1977), mean lengths were similar for both sexes but males weighed slightly more than females.

TABLE 5.1-1. AVERAGE CALCULATED STANDARD LENGTH AT ANNULUS FORMATION FOR *TAUTOGOLABRUS ADSPERSUS*, (FEMALES, MALES AND ALL FISH) CAPTURED IN 1976. SEABROOK FINFISH STUDIES, 1976-1977.

	YEAR CLASS	# OF FISH	MEAN (MM) S. L. AT CAPTURE FOR AGE GROUPS (I-VIII)	AVERAGE WEIGHT AT CAPTURE (g)	CALCULATED STANDARD LENGTH AT FORMATION OF ANNULUS							
					I	2	3	4	5	6	7	8
FEMALES	1975	0	- (I)	-	-							
	1974	11	69.3 (II)	8.2	34.4	57.1						
	1973	18	80.8 (III)	11.2	33.1	54.2	70.7					
	1972	23	100.8 (IV)	23.3	34.4	54.2	73.6	90.1				
	1971	31	120.0 (V)	37.9	32.8	52.4	72.7	90.3	106.0			
	1970	24	144.7 (VI)	67.2	33.3	51.7	73.6	95.4	115.8	132.1		
	1969	13	152.9 (VII)	83.6	31.8	49.2	69.1	88.1	105.5	123.1	138.9	
	1968	6	183.1 (VIII)	135.5	31.5	48.7	67.5	85.5	106.5	127.8	148.0	166.2
	GRAND AVERAGE				33.2	52.8	72.1	90.9	109.1	128.8	141.8	166.2
	SAMPLE SIZE (N)				126	126	115	97	74	43	19	6
	CONFIDENCE INTERVAL (α = .05)				32.5-33.9	51.5-54.1	70.2-74.0	88.3-93.5	105.8-112.4	124.2-133.4	134.8-148.8	159.7-172.7
	AVERAGE ANNUAL INCREMENT				33.2	19.6	19.3	18.8	18.2	19.7	13.0	24.4
MALES	1975	0	- (I)	-	-							
	1974	0	- (II)	-	-	-						
	1973	12	88.4 (III)	15.4	36.5	60.2	76.3					
	1972	9	108.7 (IV)	27.3	34.3	56.3	75.1	95.7				
	1971	6	118.5 (V)	37.4	31.8	50.2	67.7	86.7	104.0			
	1970	9	170.0 (VI)	94.1	34.6	56.7	85.2	103.9	135.4	154.4		
	1969											
	GRAND AVERAGE				34.7	56.7	76.8	96.5	122.9	154.4		
	SAMPLE SIZE				36	36	36	24	15	9		
	CONFIDENCE INTERVAL (α = .05)				33.4-36.0	54.3-59.1	73.4-80.2	88.7-104.3	112.8-132.9	146.5-162.4		
	AVERAGE ANNUAL INCREMENT				34.7	22.0	20.1	19.7	26.4	31.5		
ALL FISH (INCL. JUV.)	1975	20	39.7	1.4	32.3							
	1974	29	65.9	6.9	33.4	54.8						
	1973	90	79.4	11.8	33.6	54.2	69.2					
	1972	41	99.7	22.3	34.0	53.7	72.0	88.8				
	1971	37	119.8	37.8	32.7	52.1	71.9	89.7	105.7			
	1970	33	151.6	74.6	33.6	53.1	76.8	97.7	121.2	138.2		
	GRAND AVERAGE				34.4	53.6	71.5	91.8	113.0	138.2		
	SAMPLE SIZE (N)				250	230	201	111	70	33		
	CONFIDENCE INTERVAL (α = .05)				32.9-33.9	52.7-54.6	70.1-72.9	89.0-94.6	109.0-116.9	132.2-144.2		
	AVERAGE ANNUAL INCREMENT				34.4	19.2	17.9	20.3	21.2	25.2		

5.1.2.2 Length-Weight Relationships

Length-weight relationships were used as indices of the relationship between growth in length and weight. The length-weight equation for 63 males ranging from 76.2 to 317.5 mm is:

$$\text{Log } W = -4.6098 + 2.9691 \text{ Log } L \quad (r = .9885)$$

The equation for 215 females ranging from 63.5 to 292.1 mm is:

$$\text{Log } W = -4.4999 + 2.9287 \text{ Log } L \quad (r = .9676)$$

The equation for all fish combined is:

$$\text{Log } W = -4.6423 + 2.9890 \text{ Log } L \quad (r = .9801)$$

Slope and y intersect differences were not significant.

5.1.2.3 Growth/Body-Scale Relationship

The body-scale relationship for *T. adspersus* collected in 1976 was derived from 291 individuals, ranging from 31.7 to 196.8 mm. A total of 98 fish was eliminated from the sample because of regenerated scales.

The calculated (a) value for New Hampshire *T. adspersus* was 16.02, which was lower than the value of 29.40 derived in 1975. The primary reason for this difference was attributed to the small sample size of only four juveniles captures in 1975, which attributed to the higher (a) value. During 1976, 111 of the 389 *T. adspersus* collected were juveniles which resulted in a lower calculated (a) value. This (a) value may be more realistic for the New Hampshire *T. adspersus* population, due to the diverse and less biased sample size.

Mean back-calculations for lengths at annulus formation were performed for each sex and for total fish (Table 5.1-1). A 95% confidence interval on the back calculations was computed for both sexes and all fish combined. Back calculation for males could only be validated through Age Class VI, females through Age Class VIII and all fish combined through Age Class VI. Serchuck and Cole (1974) reported they could only back calculate to Age VI and Dew (1976) reported Age Class IV. The older fish exhibit less overall annular scale growth than younger groups due to decreasing scale growth with age. Thus, as older fish are more difficult to age the validity of the parameter is decreased.

Calculated lengths for all ages were similar (Table 5.1-1). The differences in growth between year classes was small. There was also reasonable agreement between the calculated lengths and the actual lengths of fish of corresponding age. This is illustrated in Table 5.1-1 in which the average standard length for each age group at capture is greater than the average calculated length but less than the calculated average length for the succeeding annulus. These findings validated the use of scales in determining age and growth of *T. adspersus* up to Age Class VI for all fish combined.

5.1.2.4 Sex Ratio

The female:male sex ratio was 3.2:1 for 278 *T. adspersus* whose sex could be determined. This observed ratio was disproportionate at the 95% confidence interval (x^2 = .36). Males comprised only 22% of *T. adspersus* captured Dew (1976) reported the opposite with a male:female ratio of 2.2:1. The reason for the difference was not determined, but could have been due to the location or selectivity of the lobster pots. Dew (1976), used eel pots, minnow traps, angling and selective spear fishing to obtain samples. He also utilized a longer sampling period, February through December, as opposed to our sampling period from July through October.

5.1.2.5 Eggs and Larvae

Tautogolabrus adspersus, *Tautoga onitis* and *Limanda ferruginea* which comprise the labrid/*Limanda* egg group have overlapping spawning periods (Bigelow and Schroeder, 1953; Leim and Scott, 1966), this limits the ability to discriminate the temporal and spatial distributions of the component species. *Limanda ferruginea* commences spawning between March and April while the Labrids commence spawning in June, thus eggs present until May can be assumed to be *L. ferruginea*; from May-September interpretation is more difficult. The Labrids are more inshore species while *L. ferruginea* spawning is concentrated more offshore (Bigelow and Schroeder, 1953).

Labrid/*Limanda* eggs were present between January and October over the 1975-1977 study period. Greatest abundance occurred in June 1976 and 1977 (Table 5.1-2). Mean egg abundance was generally greatest at Transect 2 due primarily to the large abundance of eggs at this station during 15 June 1976, 1977 and 20 July 1976. *Tautogolabrus adspersus* larvae were much more abundant than *L. ferruginea* larvae (see Section 5.3.3). Labrid/*Limanda* eggs were generally more abundant during the summer-fall of 1976 and spring 1977 relative to comparable periods in 1975 and 1976 (Table 5.1-2).

Tautogolabrus adspersus larvae were present from June-September and most abundant during August 1975 and July 1976 (Table 5.1-2). Transect 3 showed the greatest mean abundance for the July-September period, reflecting the distribution on the date of maximum abundance. Mean abundance for the July-September period experienced a 50% reduction between 1975 and 1976.

TABLE 5.1-2. ABUNDANCE[a] OF LABRID/*LIMANDA* EGGS AND *TAUTOGOLABRUS ADSPERSUS* LARVAE IN THE ICHTHYOPLANKTON COLLECTIONS OF HAMPTON-SEABROOK AREA 1975-1977. SEABROOK FINFISH STUDIES, 1976-1977.

Labrid/*Limanda* EGGS

DATE	TRANSECTS 1	2	3	x̄ [b]	DATE	TRANSECTS 1	2	3	x̄
24 Jul 75	4.360	3.156	5.305	4.240	20 Jul 76	1.648	66.295	6.372	24.772
27 Aug 75	0.050	0.074	0.108	0.077	18 Aug 76	0.246	0.435	0.858	0.513
29 Aug 75	0.074	0.163	0.083	0.107	29 Sep 76	0.032	0.016	0.022	0.023
28 Oct 75	0.000	0.002	0.009	0.004	27 Oct 76	0.000	0.000	0.000	0.000
x̄ [b]	1.121	0.849	1.351	1.107	x̄	0.482	16.689	1.813	6.328
DATE	1	2	3	x̄	DATE	1	2	3	x̄
5 Feb 76	0.000	0.000	0.001	<0.001	26 Jan 77	0.000	0.000	0.001	<0.001
25 Feb 76	0.000	0.000	0.000	0.000	2 Mar 77	0.000	0.000	0.000	0.000
23 Mar 76	0.013	0.001	0.015	0.010	7 Apr 77	0.030	0.017	0.003	0.017
20 Apr 76	1.230	1.486	1.105	1.274	3 May 77	0.503	0.392	0.384	0.426
18 May 76	0.647	0.934	2.955	1.512	24 May 77	2.367	1.016	2.291	1.891
15 Jun 76	0.295	52.398	3.570	18.574	15 Jun 77	52.835	127.842	43.610	74.762
x̄	0.364	9.137	1.247	3.562	x̄	9.289	21.545	7.715	12.849

Tautogolabrus adspersus LARVAE

DATE	1	2	3	x̄	DATE	1	2	3	x̄
24 Jul 75	0.017	0.195	0.042	0.085	20 Jul 76	0.114	0.239	0.473	0.275
27 Aug 75	0.130	0.031	1.373	0.511	18 Aug 76	0.022	0.019	0.052	0.031
29 Sep 75	0.001	0.013	0.014	0.009	29 Sep 76	0.004	0.000	0.000	0.001
x̄	0.049	0.080	0.476	0.202	x̄	0.047	0.086	0.175	0.103
DATE	1	2	3	x̄	DATE	1	2	3	x̄
15 Jun 76	0.003	0.012	0.008	0.008	15 Jun 77	0.023	0.077	0.047	0.049

[a] no./m^3 [b] x̄ =Transect mean (columns) and date mean (rows)

5.2 SILVER HAKE, *MERLUCCIUS BILINEARIS*

5.2.1 Spatial and Temporal Abundances

M. bilinearis ranked second in gill net catches and third in trawl catches. They were more abundant in 1976/77 in both gill nets and trawl catches than the previous year. Individuals were captured from early spring through December in trawls, with the majority being captured during early summer and late fall (Appendix Tables 8.0-2, 8.0-3, 8.0-4). Individuals were captured in gill nets from April-November and were most abundant during June, July and September, agreeing with the otter trawl results (Figure 5.2-1). None were collected January-April with any gear type, agreeing with the results from the previous year (NAI, 1977). The low catches in late August suggest that they move offshore during the warmest months, which has been previously documented for nearshore Gulf of Maine waters (Bigelow and Schroeder, 1953; NAI, 1977). The offshore movement is probably temperature dependent. Richards (1963) reported that *M. bilinearis* were seasonally abundant in Long Island Sound, being absent in mid-winter and mid-summer when water temperatures were too cold or too warm.

Merluccius bilinearis showed significant ($p \leq .001$) differences in gill net C/E between months, years, depth, stations and months x years (Table 4.2-3). The majority were collected at Station C, though none were caught there during July and August 1975. The peak abundance for 1975/76 occurred in October for all stations, with catches in July and August being very low (Figure 5.2-2b). The peak for 1976/77 occurred in July with a smaller peak in September, but during October there was a drop in abundance at all stations. Bottom gill nets captured the majority of *M. bilinearis* during both sample years (Figure 5.2-2a).

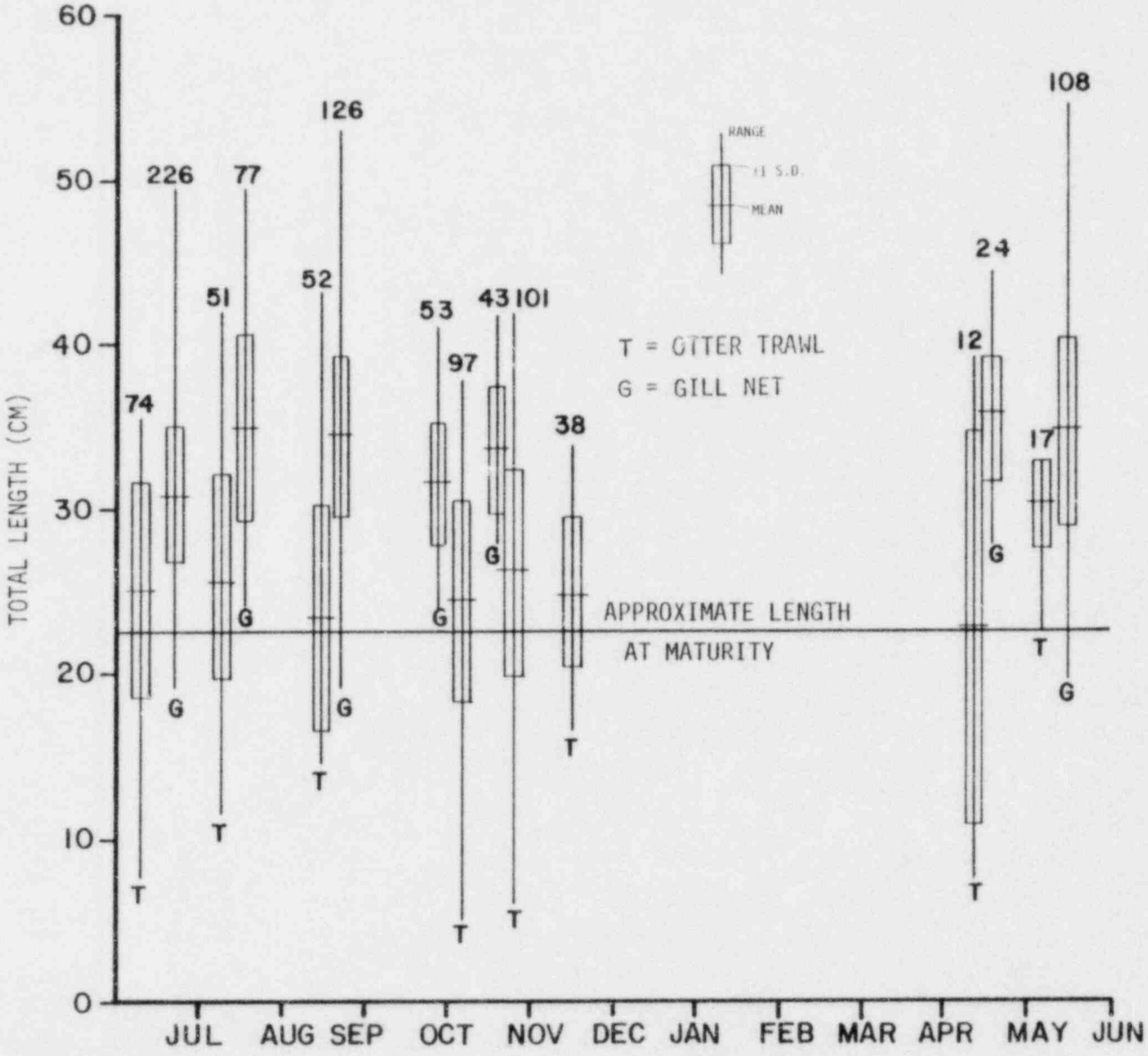


Figure 5.2-1. Standard length, means ranges and standard deviations of *Merluccius bilinearis* captured near the Hampton-Seabrook estuary. Seabrook Finfish Studies, 1976-1977.

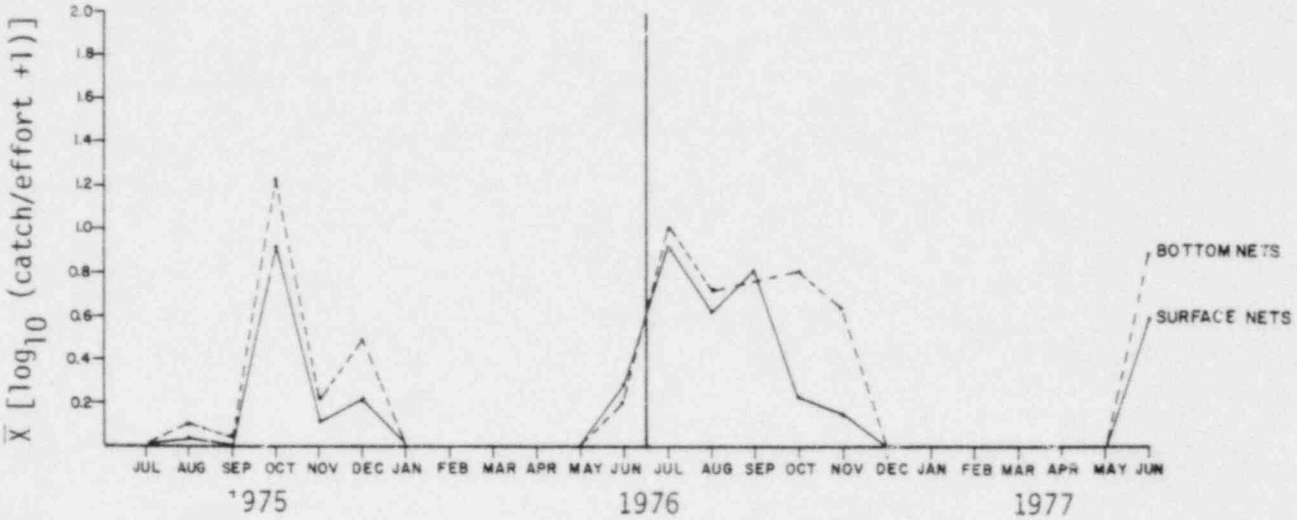


Figure 5.2-2a. Mean [$\log_{10}$(catch/effort +1)] of *Merluccius bilinearis* for surface and bottom gill nets. Depths averaged over all stations and days. Seabrook Environmental Studies 1976-1977.

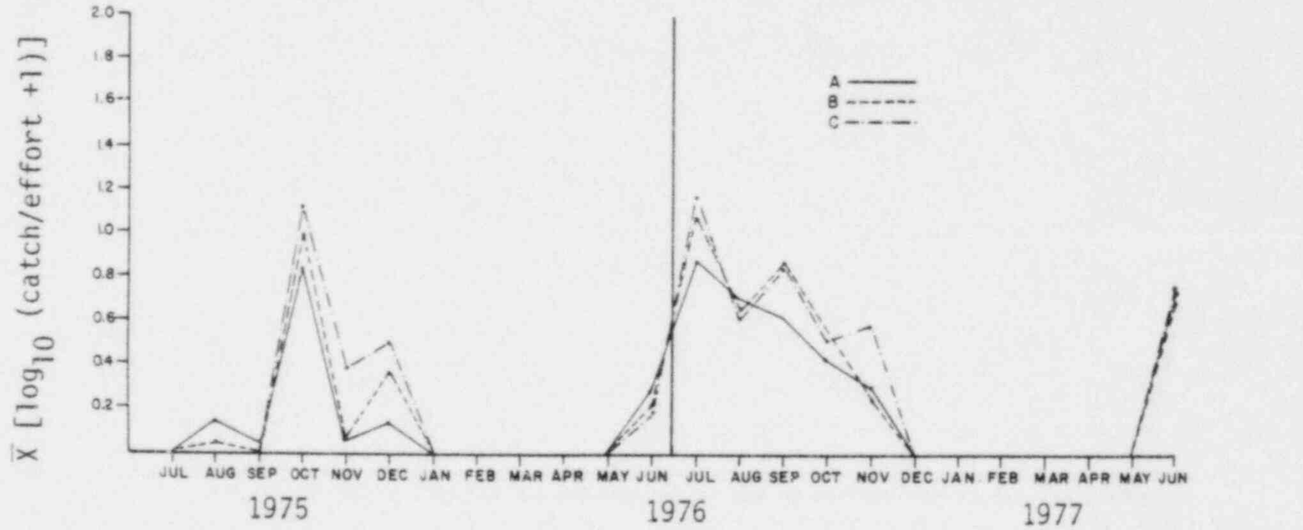


Figure 5.2-2b. Mean [$\log_{10}$(catch/effort +1)] of *Merluccius bilinearis* for gill net Stations A,B and C. Stations averaged over depths and days. Seabrook Environmental Studies 1976-1977.

5.2.2 Length of Specimens

Merluccius bilinearis ranging from 5.1 to 54.6 cm were captured in gill nets and trawls (Figure 5.2-1). Juveniles were present in low numbers in all months sampled with the majority captured in trawls. Mature fish were abundant in summer and fall, with larger individuals captured in gill nets. More mature fish were collected in July and August 1976 than the previous year. The fish collected in trawls during 1975/76 were primarily juveniles, but in 1976/77 they were mostly adults (mean length > 22.5 cm).

5.2.3 Eggs and Larvae

Both eggs and larvae of *M. bilinearis* were present in the Seabrook vicinity between June and October (Table 5.2-1). Egg and larval densities peaked during September 1975 and July 1976.

M. bilinearis eggs were most abundant at Transects 2 and 1 during July-October 1975 while during July-October 1976 mean abundances were similar at all transects (Table 5.2-1). Mean egg density increased 1300% between 1975 (mean = $0.107/m^3$) and 1976 (mean = $1.402/m^3$) (Table 5.2-1).

M. bilinearis larvae were most abundant at Transects 1 and 2 during 1975 whereas during 1976 larvae were less abundant at these transects (Table 5.2-1). Mean annual (July-October) abundances were similar during both years (Table 5.2-1).

Egg:larvae ratios provide a gross estimate of egg mortality. Marked differences were noted between 1975 (4.6:1) and 1976 (56.1:1), suggesting higher attrition during 1976; alternately, sampling variability due to patchiness and/or timing of sample collection may also be reflected in these ratios.

TABLE 5.2-1. ABUNDANCE[a] OF *MERLUCCIUS BILINEARIS* EGGS AND LARVAE IN ICHTHYOPLANKTON COLLECTIONS, HAMPTON-SEABROOK AREA, 1975-1977. SEABROOK FINFISH STUDIES, 1976-1977.

EGGS

DATE	TRANSECTS 1	TRANSECTS 2	TRANSECTS 3	$\bar{x}$ [b]	DATE	TRANSECTS 1	TRANSECTS 2	TRANSECTS 3	$\bar{x}$
24 Jul 75	0.000	0.000	0.000	0.000	20 Jul 76	5.724	4.555	3.221	4.500
27 Aug 75	0.001	0.018	0.017	0.012	18 Aug 76	0.792	0.105	1.715	0.871
29 Sep 75	0.476	0.618	0.018	0.401	29 Sep 76	0.143	0.157	0.416	0.239
28 Oct 75	0.015	0.026	0.002	0.014	27 Sep 76	0.002	0.000	0.000	<0.001
$\bar{x}$ [b]	0.123	0.166	0.032	0.107	$\bar{x}$	1.665	1.204	1.338	1.402
DATE	1	2	3	$\bar{x}$	DATE	1	2	3	$\bar{x}$
15 Jun 76	0.036	0.115	0.106	0.086	15 Jun 76	0.194	0.143	0.515	0.284

LARVAE

DATE	1	2	3	$\bar{x}$	DATE	1	2	3	$\bar{x}$
24 Jul 75	0.000	0.002	0.000	<0.001	20 Jul 76	0.007	0.064	0.129	0.067
27 Aug 75	0.002	0.056	0.041	0.033	18 Aug 76	0.031	0.000	0.011	0.014
29 Aug 75	0.137	0.033	0.005	0.058	29 Sep 76	0.017	0.012	0.031	0.020
28 Oct 75	0.002	0.000	0.000	<0.001	27 Oct 76	0.000	0.000	0.001	<0.001
$\bar{x}$	0.035	0.023	0.012	0.023	$\bar{x}$	0.014	0.019	0.043	0.025
DATE	1	2	3	$\bar{x}$	DATE	1	2	3	$\bar{x}$
15 Jun 76	0.000	0.006	0.000	0.002	15 Jun 77	0.005	0.006	0.014	0.008

[a] no./m^3 [b] $\bar{x}$ = transect means (columns) and date means (rows)

5.2.4 Utilization

New Hampshire coastal waters are utilized by adults and juvenile *M. bilinearis* as a feeding ground from spring to early winter, with greatest numbers present from early summer through fall. Spawning occurs in the study area, but egg and larvae abundance had large fluctuations between years (NAI, 1976, 1977). Bigelow and Schroeder (1953) reported that major spawning grounds were located further offshore.

5.3 YELLOWTAIL FLOUNDER (*LIMANDA FERRUGINEA*)

5.3.1 Spatial and Temporal Abundance

Limanda ferruginea was the most abundant species collected in otter trawls during 1976/77. Individuals were collected every sampling period at all transects. Catch was lowest in January and February, although they were still abundant during these months (Appendix Tables 8.0-2, 8.0-3, 8.0-4). These data agree with the 1975/76 results (NAI, 1977). Catch per effort (C/E) at Transect 1 was highest, while Transect 2 was much lower than 1 or 3 (Table 4.1-4). Catches of *L. ferruginea* from 1975-1977 have remained similar and the differences among transects over the years have not changed (Table 4.1-4). Prior to 1975, all transects were in depths equal to Transect 2 and C/E for *L. ferruginea* was low. Since moving transects 1 and 3 to deeper locations, the C/E has increased while catches at Transect 2 remain similar to previous years.

5.3.2 Length of Specimens

Limanda ferruginea ranging from 2.4 to 43.2 cm were collected by trawls (Figure 5.3-1). Adults were collected in all months, but the majority was immature. Young-of-the-year (YOY) were abundant from November-April, which agrees with previous results (NAI, 1977).

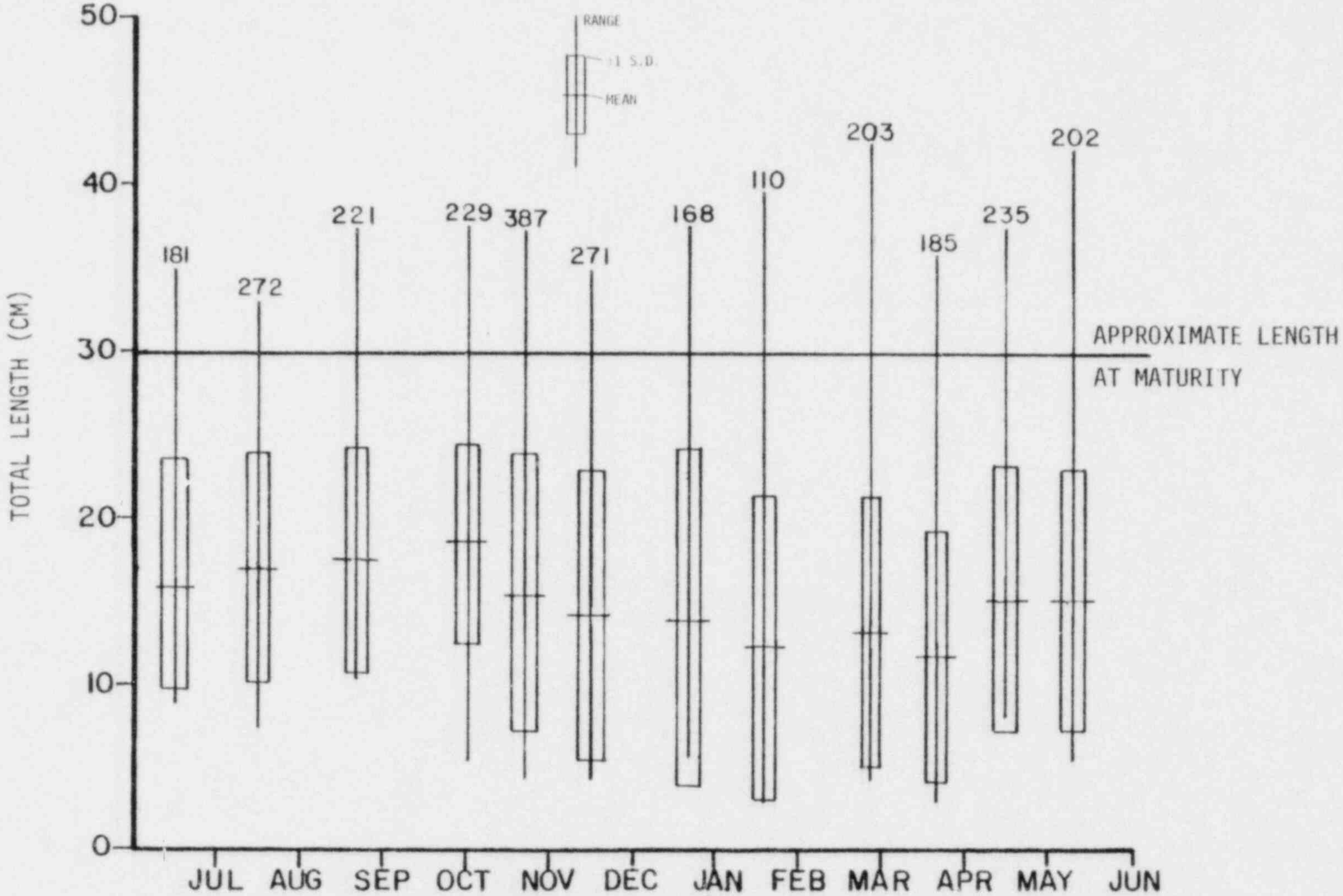


Figure 5.3-1. Standard length, means, ranges and standard deviations of *Limanda ferruginea* captured near the Hampton-Seabrook estuary. Seabrook Finfish Studies, 1978

5.3.3 Eggs and Larvae

Limanda ferruginea larvae were present between May and September with a June peak (Table 5.3-1). Abundances were generally low July-September with little evidence of spatial segregation. During June, larvae were more abundant at Transect 2 (1976) and Transect 1 (1977). Mean annual abundances were similar between years.

L. ferruginea eggs are discussed in Section 5.1.2.5.

5.3.4 Utilization

New Hampshire coastal waters are used by all age groups of *L. ferruginea* and limited spawning may occur. The majority of individuals were juveniles with few adults captured. Bigelow and Schroeder (1953) indicate that adults in this area prefer deeper water (40-60 meters) both for general habitat and as a spawning ground.

5.4 ATLANTIC HERRING, *CLUPEA HARENGUS*

5.4.1 Spatial and Temporal Abundance

Clupea harengus was the most abundant species collected in gill nets (51.6% of total) and ranked 12th in beach seine catches. They were collected during all months, with the majority captured from October-June (Appendix Tables 8.0-5, 8.0-6, 8.0-7). Lowest abundance was from July through September when water temperature was the highest (Figure 5.4-1).

A significant 2-way interaction ($p \leq .001$) of gill net C/E with months x years, months x depth and a significant ($.05 \geq p > .01$) months x stations interaction (Table 4.2-3) was found. The C/E for 1976 showed a large peak in November, but in 1975 C/E was low (Figures 5.4-2a, 5.4-2b).

TABLE 5.3-1. ABUNDANCE[a] OF *LIMANDA FERRUGINEA* LARVAE IN ICHTHYOPLANKTON COLLECTIONS HAMPTON-SEABROOK AREA, 1975 - 1977. SEABROOK FINFISH STUDIES, 1976-1977.

	TRANSECTS					TRANSECTS			
DATE	1	2	3	$\bar{x}$ [b]	DATE	1	2	3	$\bar{x}$
24 Jul 75	0.000	0.009	0.002	0.004	20 Jul 76	0.008	0.039	0.004	0.017
27 Aug 75	0.000	0.000	0.002	0.001	18 Aug 76	0.000	0.000	0.001	0.001
29 Sep 75	0.007	0.001	0.000	0.003	29 Sep 76	0.004	0.000	0.004	0.003
$\bar{x}$ [b]	0.002	0.003	0.001	0.002	$\bar{x}$	0.004	0.013	0.003	0.007

DATE	1	2	3	$\bar{x}$	DATE	1	2	3	$\bar{x}$
18 May 76	0.012	0.002	0.011	0.005	24 May 77	0.000	0.000	0.015	0.005
15 Jun 76	0.047	0.109	0.003	0.053	15 Jun 77	0.104	0.027	0.022	0.051
$\bar{x}$	0.030	0.056	0.007	0.031	$\bar{x}$	0.052	0.014	0.019	0.028

[a] no./m^3

[b] $\bar{x}$ = transect means (columns) and date means (rows)

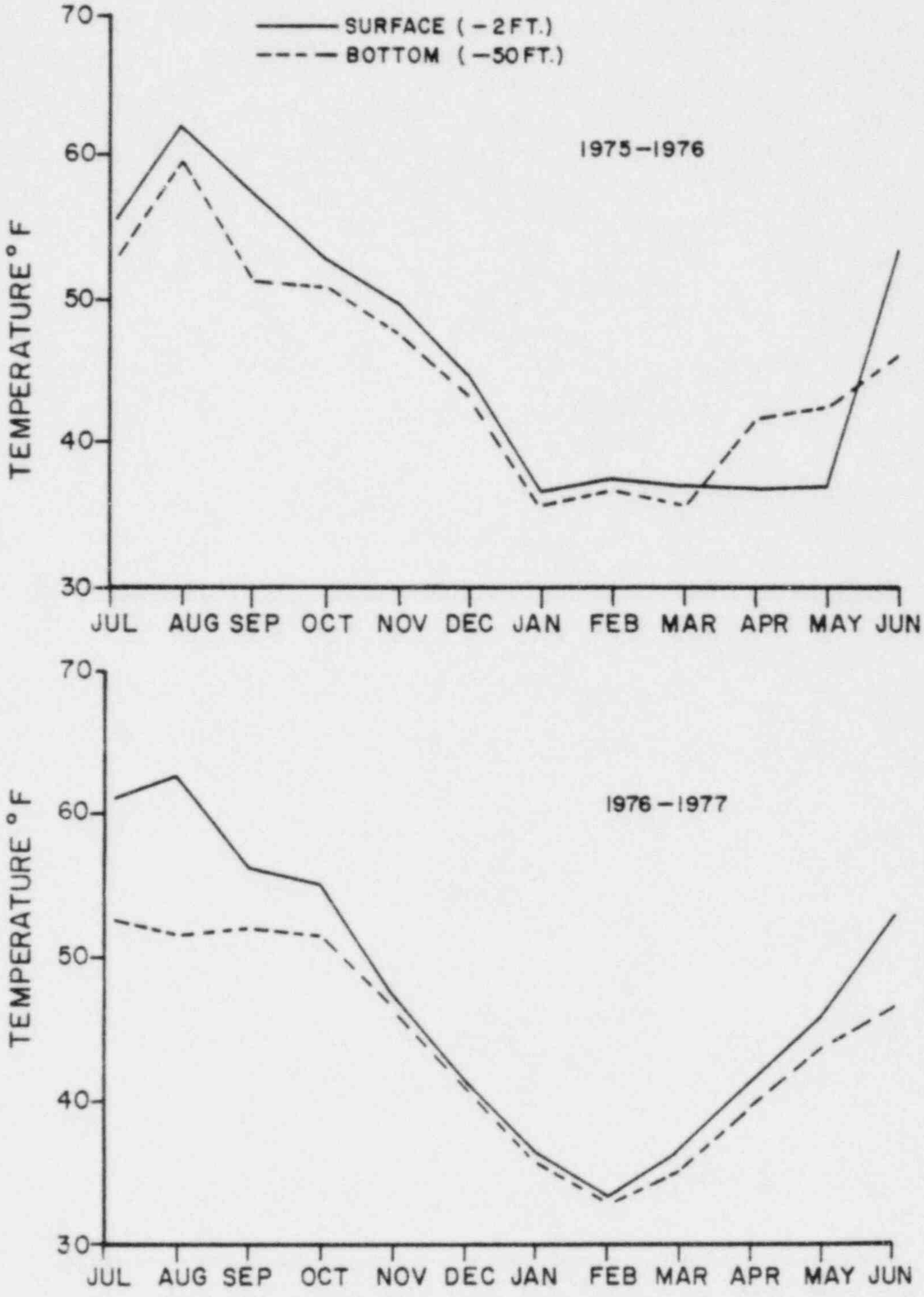


Figure 5.4-1. Monthly mean of daily average temperature recorded by *in-situ* continuous monitors off Hampton Beach, New Hampshire, 1975-1977. Seabrook Finfish Studies, 1978.

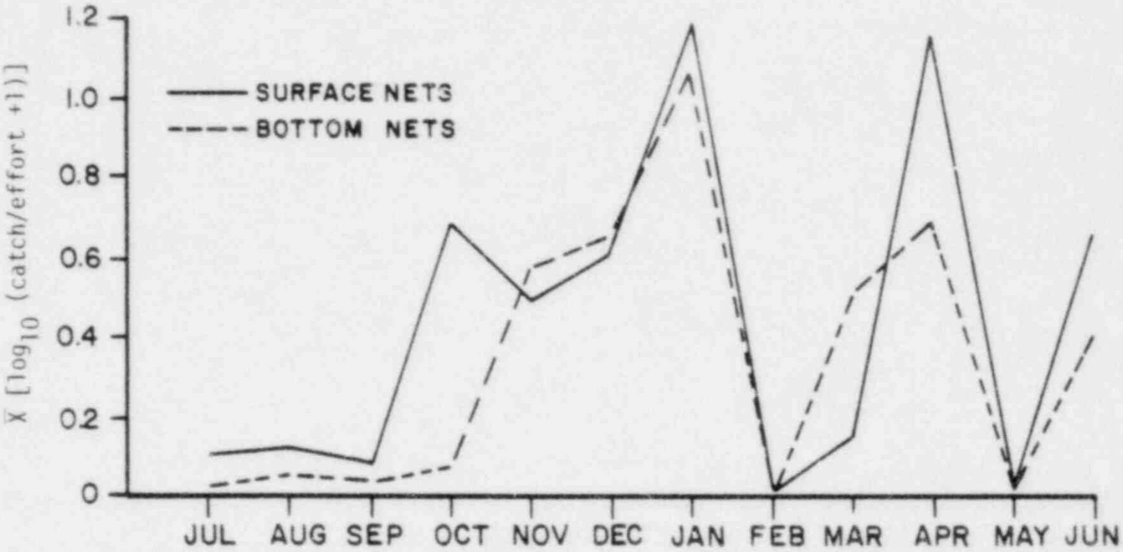


Figure 5.4-2a. Mean [$\log_{10}$(catch/effort +1)] of *Clupea harengus* for surface and bottom gill nets, all stations and years combined. Seabrook Environmental Studies, 1976-1977.

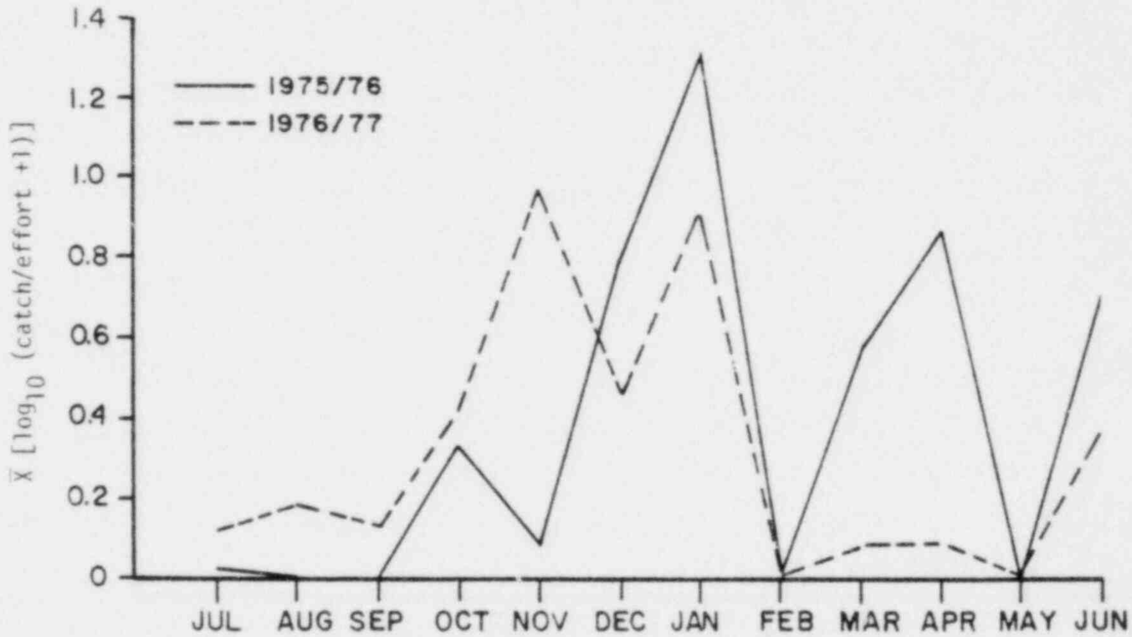


Figure 5.4-2b. Comparison of 1975/76 and 1976/77 mean [$\log_{10}$(catch/effort +1)] of *Clupea harengus* for all gill net stations averaged over depths and days. Seabrook Environmental Studies, 1976-1977.

Clupea harengus were numerically less dominant prior to 1975/76. However, they ranked first in gill nets during both 1975/76 and 1976/77 and comprised over 50% of the total gill net catch. The differences in abundance over the years were probably due to natural population fluctuation.

5.4.2 Length of Specimens

Herring ranging in size from 4 to 30.5 cm SL were collected in gill nets and seines (Figure 5.4-3). Mature fish were captured during most months, except July, August and October. Juveniles were more abundant than adults.

5.4.3 Eggs and Larvae

Clupea harengus eggs are demersal (Leim and Scott, 1966) and were not collected during this investigation. Larvae were present October 1975-March 1976 and October 1976-May 1977, with November (1975) and October (1976) maxima (Table 5.4-1). This seasonal pattern contrasts with Das (1968) who found *C. harengus* larvae as early as July in the Bay of Fundy, but is in general agreement with Sameoto (1971) who found hatching occurring between mid-September and early October. The low numbers collected during March and April may reflect spring spawning, which was quite frequent during the 1930's (Das, 1968), but more recently, has been infrequently observed (Das, 1968; Sameoto, 1971). These larvae could also be slower growing products of late fall spawning contingents; Sameoto (1971) collected fall spawned larvae > 30 mm total length during March-June in St. Margaret's Bay with an Isaacs-Kid mid-water trawl.

Clupea harengus larvae were generally more abundant at Transect 3 and least at Transect 2 in 1975-76, whereas they were generally more abundant at Transect 2 during 1976-1977 (Table 5.4-1). Mean annual abundance in 1975-1976 was 275% of that observed during 1976-1977.

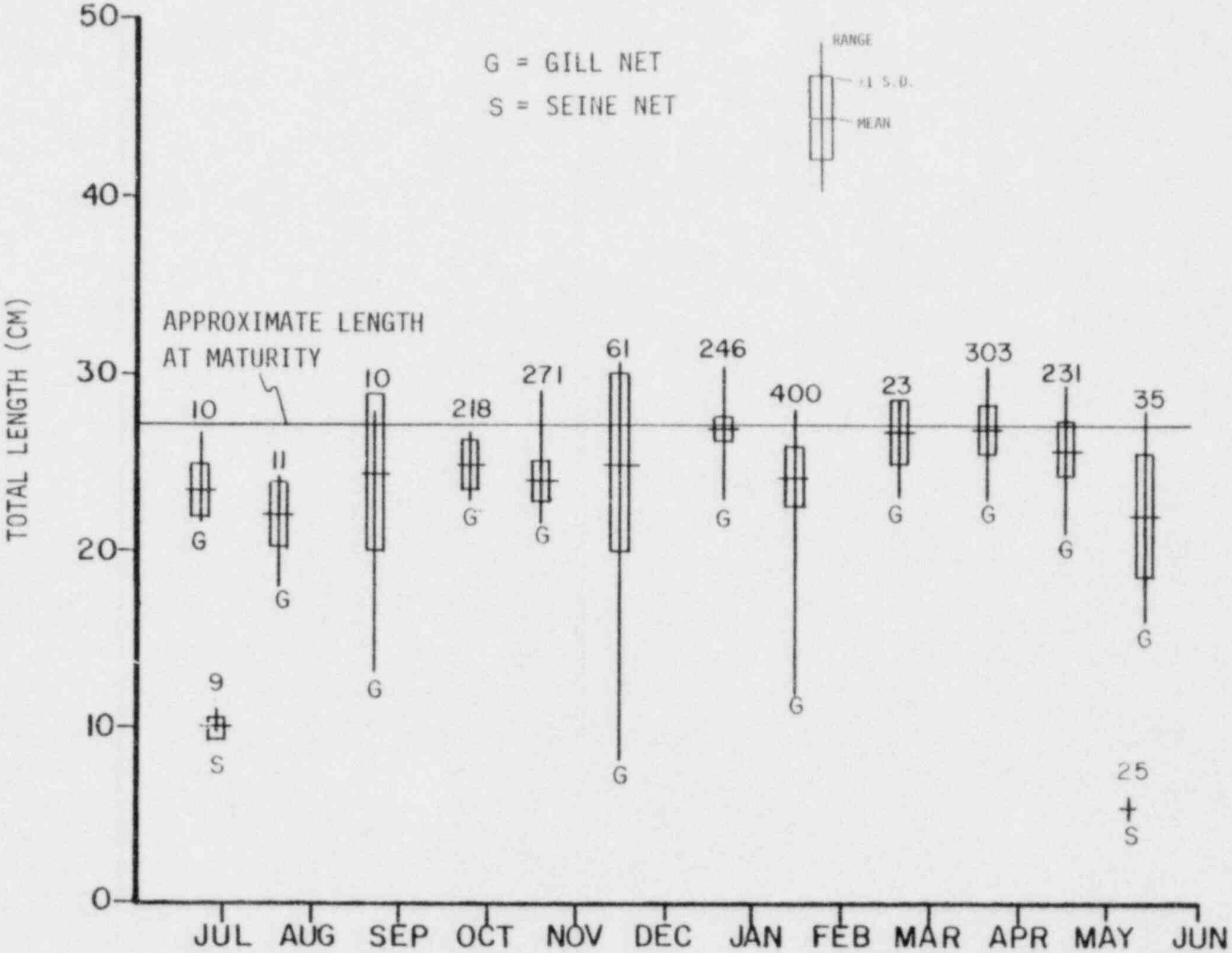


Figure 5.4-3. Standard length, means, ranges and standard deviations of *Clupea harengus* captured near the Hampton-Seabrook estuary. Seabrook Finfish Studies, 1978.

TABLE 5.4-1. ABUNDANCE[a] OF *CLUPEA HARENGUS* LARVAE IN ICHTHYOPLANKTON COLLECTIONS OF HAMPTON-SEABROOK AREA, 1975-1977. SEABROOK FINFISH STUDIES, 1976-1977.

DATE	TRANSECTS 1	TRANSECTS 2	TRANSECTS 3	$\bar{x}^b$	DATE	TRANSECTS 1	TRANSECTS 2	TRANSECTS 3	$\bar{x}$
28 Oct 75	0.005	0.071	0.106	0.061	27 Oct 76	0.250	0.693	0.215	0.386
19 Nov 75	1.153	0.281	1.831	1.088	16 Nov 76	0.077	0.038	0.097	0.071
15 Dec 75	0.118	0.200	0.039	0.119	2 Jan 77	0.000	0.000	0.000	0.000
5 Feb 76	0.000	0.005	0.000	0.002	26 Jan 77	0.000	0.004	0.001	0.002
25 Feb 76	0.007	0.000	0.015	0.007	2 Mar 77	0.000	0.000	0.000	0.000
23 Mar 76	0.003	0.000	0.002	0.002	7 Apr 77	0.004	0.000	0.001	0.002
20 Apr 76	0.000	0.000	0.000	0.000	3 May 77	0.000	0.000	0.000	0.000
18 May 76	0.000	0.000	0.000	0.000	24 May 77	0.000	0.007	0.000	0.002
$\bar{x}^b$	0.161	0.070	0.249	0.460	$\bar{x}$	0.041	0.093	0.039	0.058

[a] no./m^3

[b] $\bar{x}$ = transect means (columns) and date means (rows)

5.4.4 Utilization

The New Hampshire coastal zone appears to be an important wintering area for *C. harengus*. Catches during 1975/76 and 1976/77 show both mature and immature individuals frequently collected in the winter months. Spawning occurs in the area in the fall and spring (Messieh, 1976).

5.5 HAKES, *UROPHYCIS* SPP.

5.5.1 Spatial and Temporal Abundance

Urophycis spp. (primarily *U. chuss*), ranked second in trawl, sixth in gill net and eleventh in beach seine catches. They were present from April through December, which agrees with 1975/76 results. *Urophycis* spp. were most abundant in August and September 1976 (Appendix Tables 8.0-2 through 8.0-10), although during August 1975 they were present in relatively low numbers. Richards (1963) reported that *U. chuss* were migratory, appearing in the spring and fall, but did not correlate this movement with temperature. The reason for the difference between August 1975 and 1976 may be temperature related. Average bottom temperatures during August 1975 were the warmest over the 2-year study period, 15.3°C (59.5°F). Average bottom temperature for August 1976 was 10.8°C (Figure 5.4-1). *Urophycis* spp. may have been more abundant inshore in 1976 because of the cooler bottom temperatures.

Trawl C/E for *Urophycis* spp. was highest at Transects 1 and 3, the offshore stations, and lowest at Transect 2 (Table 4.1-4). The overall C/E for 1976/77 was higher than for 1975/76, but differences between stations over years were very similar.

5.5.2 Length of Specimens

Urophycis spp. ranging from 5 to 53 cm standard length were collected in trawls, gill nets and seines (Figure 5.5-1). Gill nets captured predominantly adults, whereas trawls and seines captured juveniles. Young-of-the-year were common offshore in early winter and early spring which agrees with previous years' results.

5.5.3 Eggs and Larvae

Urophycis spp. data were divided into two comparable time periods (July-October; April-June) to permit direct comparisons of progeny abundance. *Urophycis* spp. eggs were present in the Seabrook area between June and October with greatest abundance during July and August over the two year (1975-1977) period (Table 5.5-1). *Urophycis* spp. eggs were generally more abundant at Transect 3 although mean abundance for the two years was greatest at Transect 1 (1.962/m^3) and reflects a large pulse at this transect on 18 August 1976 (Table 5.5-1). Egg abundances at Transects 1 and 3 were generally similar and greater than Transect 2 during the July-October period of each year. No consistent trend was noted for the April-June dates.

Urophycis spp. larvae were present between July-October; during 1975 an August-September peak was observed, while during 1976 densities were generally low and no peak was observed (Table 5.5-1). There were no apparent differences in mean abundance between transects.

Mean egg abundance increased between July-October 1975 and 1976, while mean larval abundance decreased by an order of magnitude (Table 5.5-1). To further emphasize this shift, egg:larvae ratios for the July-October periods were 30.6:1 in 1975 and 3892:1 in 1976. Three explanations are offered for the wide variation observed in these ratios:

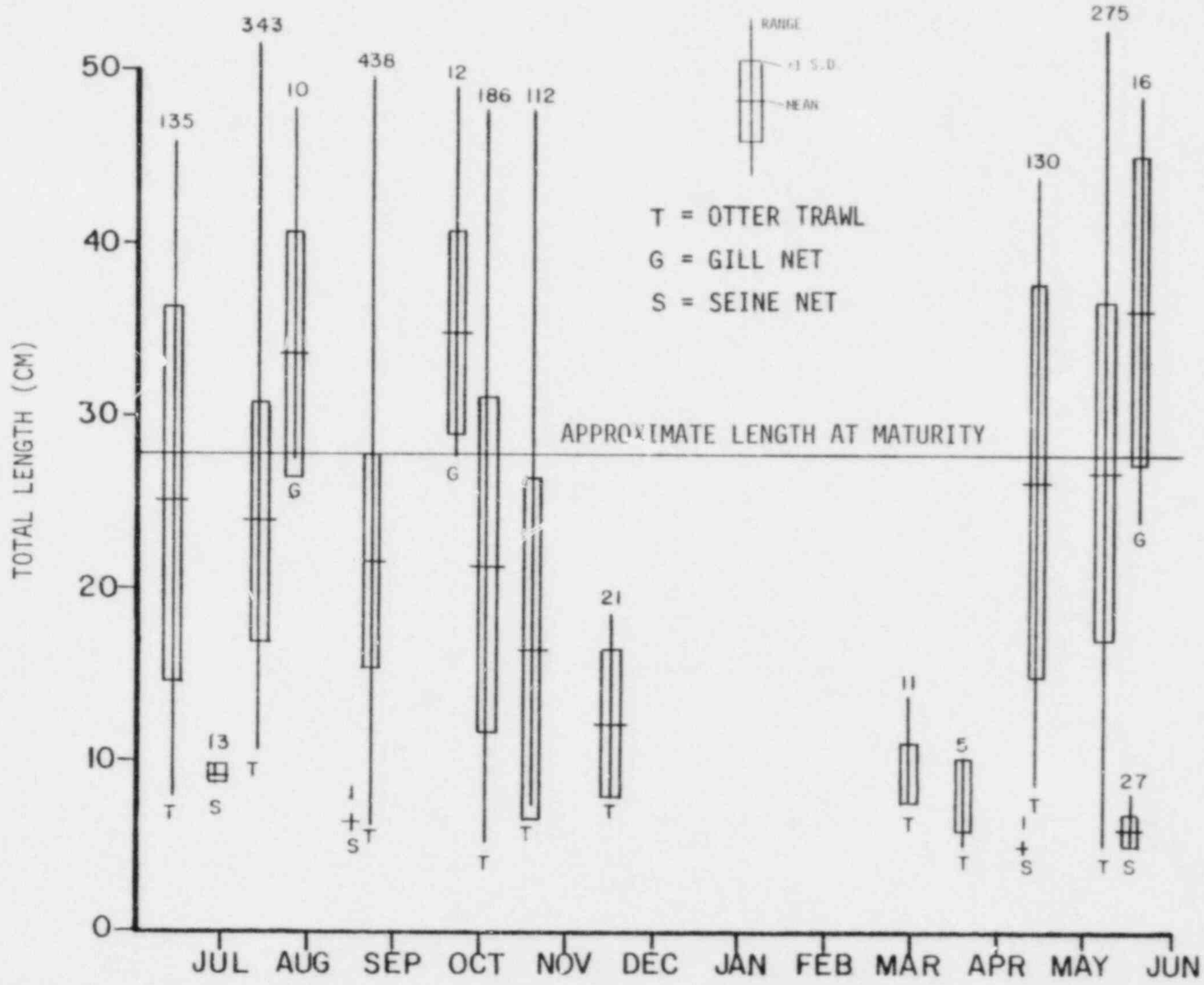


Figure 5.5-1. Standard length, means, ranges and standard deviations of *Urophycis* (hake spp.) captured near the Hampton-Seabrook estuary. Seabrook Finfish Studies, 1978.

TABLE 5.5-1. ABUNDANCE[a] OF *UROPHYCIS* SPP. EGGS AND LARVAE IN ICHTHYOPLANKTON COLLECTIONS, HAMPTON-SEABROOK AREA, 1975-1977. SEABROOK FINFISH STUDIES 1976-1977.

EGGS

DATE	TRANSECTS 1	2	3	$\bar{x}$[b]
24 Jul 75	1.850	0.624	1.680	1.385
27 Aug 75	0.140	0.193	0.316	0.216
29 Aug 75	0.119	0.135	0.087	0.114
28 Oct 75	0.001	0.001	0.000	0.001
$\bar{x}$[b]	0.523	0.238	0.429	0.337

DATE	TRANSECTS 1	2	3	$\bar{x}$
20 Jul 76	1.228	2.301	4.431	2.653
18 Aug 76	22.170	2.386	12.907	12.488
29 Sep 76	0.463	0.233	0.584	0.427
27 Oct 76	0.002	0.000	0.000	<0.001
$\bar{x}$	5.966	1.230	4.481	3.892

DATE	1	2	3	$\bar{x}$
2 Apr 76	0.000	0.000	0.000	0.000
18 May 76	0.000	0.000	0.000	0.000
15 Jun 76	1.057	1.375	0.110	0.847
$\bar{x}$	0.352	0.458	0.307	0.282

DATE	1	2	3	$\bar{x}$
3 May 77	0.008	0.000	0.000	0.003
24 May 77	0.000	0.000	0.000	0.000
15 Jun 77	0.435	1.496	2.482	1.471
$\bar{x}$	0.148	0.499	0.827	0.491

LARVAE

DATE	1	2	3	$\bar{x}$
24 Jul 75	0.000	0.000	0.000	0.000
27 Aug 75	0.007	0.021	0.031	0.020
29 Sep 75	0.027	0.025	0.012	0.021
29 Oct 75	0.000	0.000	0.000	0.000
$\bar{x}$	0.009	0.012	0.011	0.011

DATE	1	2	3	$\bar{x}$
20 Jul 76	0.004	0.002	0.000	0.002
18 Aug 76	0.002	0.000	0.000	<0.001
29 Sep 76	0.002	0.000	0.003	0.002
27 Oct 76	0.000	0.000	0.001	<0.001
$\bar{x}$	0.002	<0.001	0.001	0.001

[a] no./m^3

[b] $\bar{x}$ = transect means (columns) and date means (rows)

1. The results may reflect sampling variability (e.g., patchiness);

2. higher egg or larvae densities may have occurred between sampling dates in 1975;

3. marked changes in egg or larval mortality occurred between 1975 and 1976; whether these would be due to intrinsic (i.e., due to the biology of the species) or extrinsic factors (i.e., in response to physical, hydrologic, chemical factors) is unknown.

5.5.4 Utilization

New Hampshire coastal waters are utilized by *Urophycis* spp. during spring, summer and early winter. The area serves as a feeding ground for adults and juveniles and spawning occurs in the study area during early summer.

5.6 MACKEREL, *SCOMBER SCOMBRUS*

5.6.1 Spatial and Temporal Abundance

Scomber scombrus ranked third in gill net catches, accounting for 10.6% of the total catch (Table 4.2-1). *S. scombrus* were collected from June through December, with August and September the peak months. This does not agree with the previous year (NAI, 1977), when none were collected in August and September. Surface temperatures during both years were similar (Figure 5.4-1), and approximately 90% were captured in surface nets. The presence of *S. scombrus* in August 1976 when temperatures reached 16°C may not be unusual. Bigelow and Schroeder (1953) and Recksiek and McCleave (1973) reported the preferred range for *S. scombrus* is 12-14°C.

Significant ($p \leq .001$) differences in gill net C/E were found for depth, months x years and months x years x depth (Table 4.2-2). Overall, C/E was higher at surface nets in both sample years (Figure 5.6-1a). The significant months x years interaction resulted from different C/E peaks in August and Septembcr 1976, when *S. scombrus* were abundant, as opposed to 1975 when none were captured (Figure 5.6-1b). The year x month x station interaction was also significant ($.05 \geq P >$ $.01$). More individuals were captured at Station C in August and September 1976, while none were caught at Station C during the same months in 1975 (Figure 5.6-1b).

5.6.2 Length of Specimens

Scomber scombrus ranged from 13 to 41 cm ($\bar{x}$ = 30.5 cm). The majority captured were mature fish. One small juvenile was captured in November 1976. No individuals below 22 cm were captured in 1975/76. The results agree with prior years. The low abundance of juvenile *S. scombrus* in the study area during 1976/1977 was consistent with earlier observations.

5.6.3 Eggs and Larvae

Scomber scombrus eggs were present in the Seabrook area between May and July with a major peak during June 1977 (Table 5.6-1). During June-July 1976 and Spring 1977, the mean abundances were similar at all transects. Mean egg abundance increased almost 80 times between April-July 1976 and May-June 1977. *S. scombrus* larvae were collected too infrequently to accurately assess their spatial distribution.

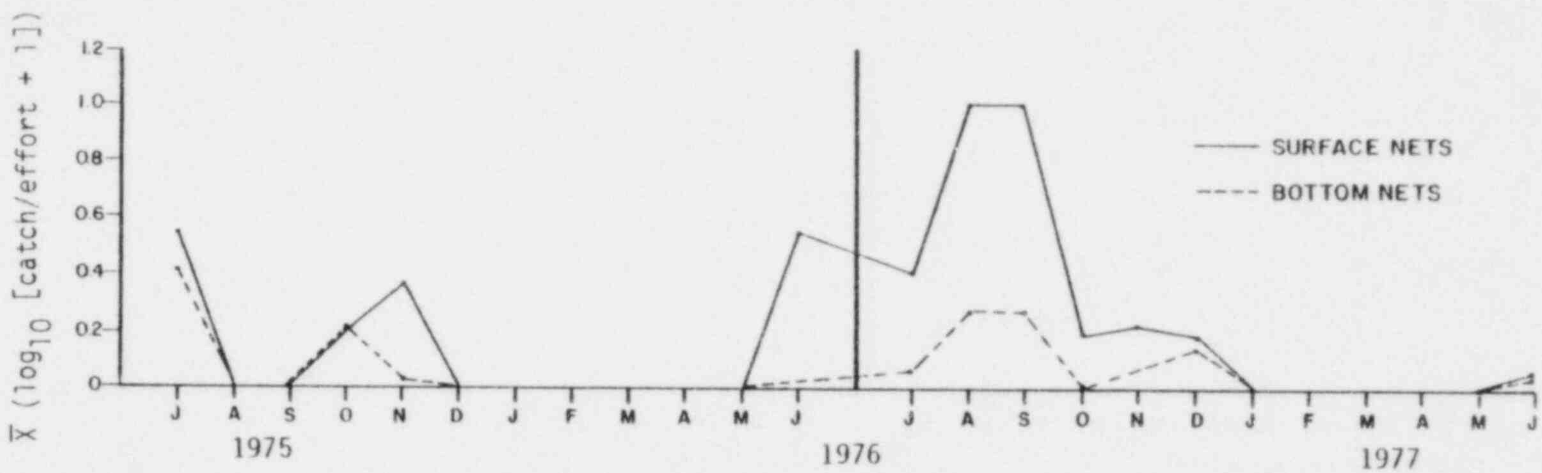


Figure 5.6-1a. Mean [$\log_{10}$(catch/effort +1)] of *Scomber scombrus* for surface and bottom gill nets. Depths averaged over all stations and days. Seabrook Environmental Studies, 1976-1977.

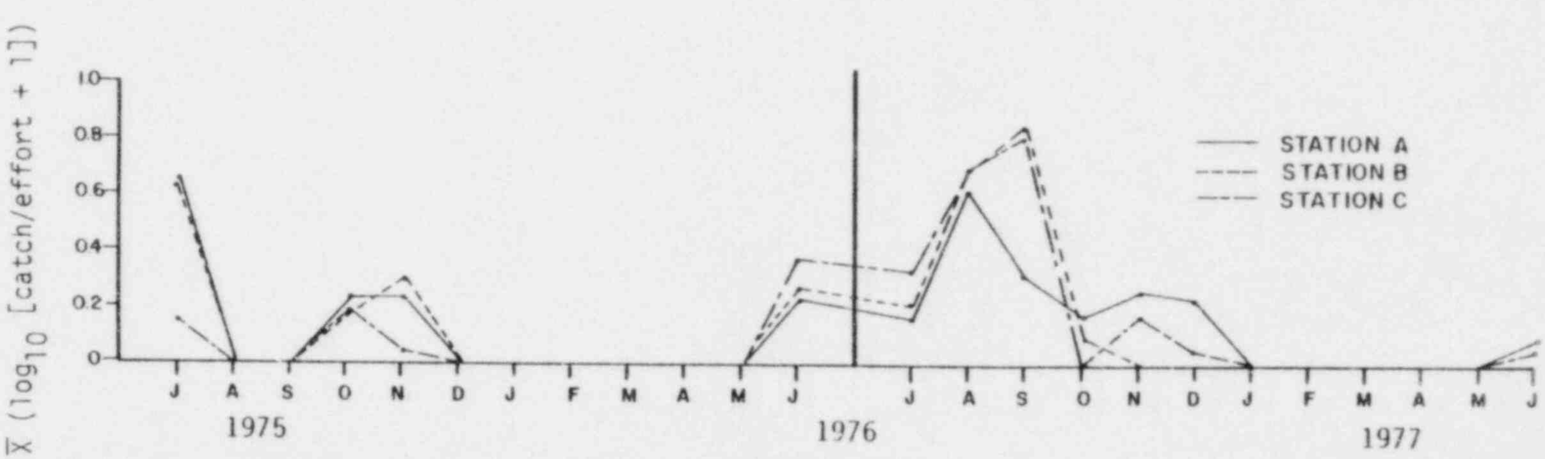


Figure 5.6-1b. Mean [$\log_{10}$(catch/effort +1)] of *Scomber scombrus* for gill net stations A,B and C. Stations averaged over depths and days. Seabrook Environmental Studies, 1976-1977.

TABLE 5.6-1. ABUNDANCE[a] OF *SCOMBER SCOMBRUS* EGGS AND LARVAE IN ICHTHYOPLANKTON COLLECTIONS, HAMPTON-SEABROOK AREA, 1975-1977. SEABROOK FINFISH STUDIES, 1976-1977.

EGGS

	TRANSECTS					TRANSECTS			
DATE	1	2	3	$\bar{x}$ [b]	DATE	1	2	3	$\bar{x}$
24 Jul 75	0.00	0.007	0.000	0.002	20 Jul 76	0.183	0.155	0.133	0.157
20 Apr 76	0.000	0.000	0.000	0.000	3 May 77	0.002	0.000	0.000	<0.001
18 May 76	0.000	0.000	0.016	0.005	24 May 77	0.173	0.036	0.164	0.124
15 Jun 76	0.674	0.784	0.475	0.644	15 Jun 77	25.826	62.004	67.307	51.712
$\bar{x}$ [b]	0.225	0.261	0.164	0.217	$\bar{x}$	8.667	20.680	22.490	17.279

LARVAE

DATE	1	2	3	$\bar{x}$	DATE	1	2	3	$\bar{x}$
24 Jul 75	0.000	0.000	0.000	0.000	20 Jul 76	0.003	0.002	0.032	0.012
15 Jun 76	0.004	0.023	0.004	0.01	15 Jun 77	0.118	0.584	0.276	0.326

[a] no./m^3

[b] $\bar{x}$ = transect means (columns) and date means (rows)

5.6.4 Utilization

Coastal New Hampshire waters were utilized by adult *S. scombrus* during early, mid-summer and fall migration periods. They were not present in mid-summer in some years, possibly due to elevated temperatures. Smaller juveniles do not frequent the nearshore area.

5.7 WINTER FLOUNDER, *PSEUDOPLEURONECTES AMERICANUS*

5.7.1 Spatial and Temporal Abundance

Pseudopleuronectes americanus ranked third in trawls and seventh in beach seine catches. They were collected in trawls every month offshore and juveniles were captured in the estuary during every month sampled (Appendix Tables 8.0-2, 8.0-3, 8.0-4, 8.0-8, 8.0-9, 8.0-10). Maximum abundance occurred in spring and early fall, which agrees with 1975/76 results. Mean C/E was higher at Transect 2 (Table 4.1-4) for both sample years. Overall catch for all transects was higher in 1976/77 than 1975/76. Lower catches at Transects 1 and 3 have occurred since the stations were moved further offshore. Previous studies reported that catches of *P. americanus* were greater when all stations were closer inshore, suggesting that they congregate in the nearshore zone (NAI, 1974, 1975).

5.7.2 Length of Specimens

Pseudopleuronectes americanus ranging from 3.5 to 38 cm were captured by trawls offshore and individuals collected by seine in the estuary ranged from 2.5 to 25.4 cm (Figure 5.7-1). The spring of 1977 was the only year that any potentially mature flounder were captured in the estuary (>21 cm).

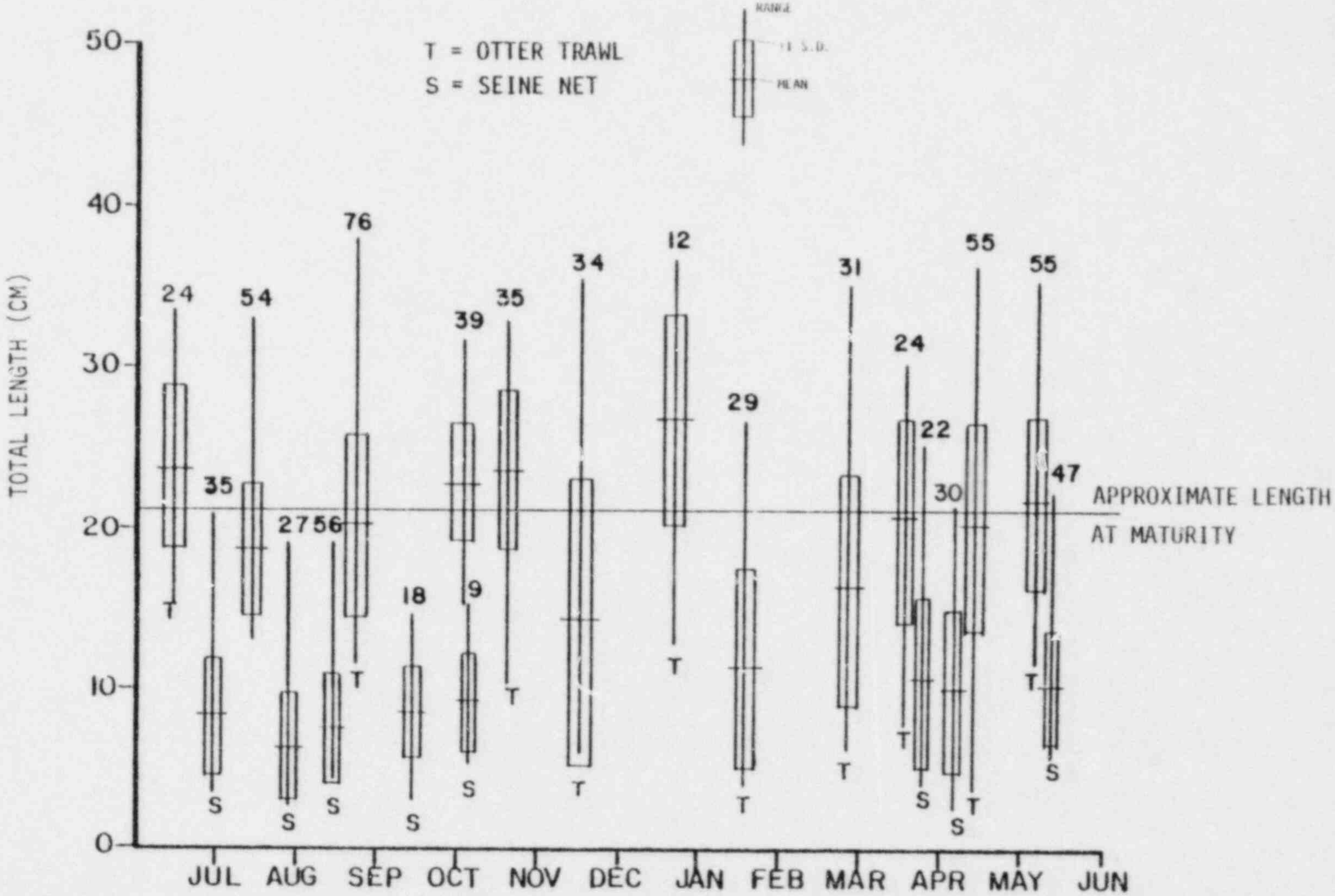


Figure 5.7-1. Standard length, means, ranges and standard deviations of *Pseudopleuronectes americanus* near the Hampton-Seabrook estuary. Seabrook Finfish Studies, 1978.

5.7.3 Eggs and Larvae

Pseudopleuronectes americanus larvae were present April-August 1977 and April-June 1976 with greatest concentrations in May (Table 5.7-1). During both years larvae were generally more abundant at Transects 2 and 3 and least at Transect 1. Mean abundances were similar during both years (Table 5.7-1).

5.7.4 Utilization

Adult and juvenile *Pseudopleuronectes americanus* utilize the nearshore zone as a year-round feeding ground. The Hampton-Seabrook estuary was used as a nursery area for juveniles.

5.8 BLUEBACK HERRING, *ALOSA AESTIVALIS*

5.8.1 Spatial and Temporal Abundance

Alosa aestivalis ranked fourth in gill nets and tenth in seine catches. They were collected from April through December, with maximum abundance in June and August (Appendix Tables 8.0-5 through 8.0-10). No specimens were collected from January through March and only 2 were collected in April. These results agree with 1975/76 data, except that peak abundance during 1975 was in November.

Significant differences in gill net C/E was found for months x years ($p \leq .001$) months x stations ($.05 \geq p > .01$) interactions (Table 4.2-3), which indicated that stations and years were dependent on the month considered. The 1976/77 data show low C/E in October and November, but C/E peaked during these months in 1975/76 explaining the significant months x years interaction (Figure 5.8-1). The months x stations interaction occurred because 53% of the catch occurred at Station A, while catches at Stations B and C were about equal during 1977. The

TABLE 5.7-1. ABUNDANCE[a] OF *PSEUDOPLEURONECTES AMERICANUS* LARVAE IN ICHTHYOPLANKTON COLLECTIONS, HAMPTON-SEABROOK AREA, 1975-1977. SEABROOK FINFISH STUDIES 1976-1977.

DATE	TRANSECTS 1	2	3	$\bar{x}$ [b]
24 Jul 75	0.000	0.002	0.000	<0.001

DATE	TRANSECTS 1	2	3	$\bar{x}$	DATE	TRANSECTS 1	2	3	$\bar{x}$
23 Mar 76	0.000	0.000	0.000	0.000	7 Apr 77	0.013	0.002	0.004	0.006
20 Apr 76	0.032	0.067	0.088	0.062	3 May 77	0.011	0.008	0.017	0.012
18 May 76	0.054	0.130	0.048	0.077	24 May 77	0.083	0.246	0.238	0.189
Jun 76	0.009	0.005	0.007	0.007	15 Jun 77	0.043	0.054	0.009	0.035
$\bar{x}$ [b]	0.024	0.051	0.036	0.037	$\bar{x}$	0.038	0.078	0.067	0.061

[a] no./m^3

[b] $\bar{x}$ = transect means (columns) and date means (rows)

peak for Station A was August, while B and C peaked during June (Figure 5.8-1). Depths were also significant ($.01 \geq P > .001$) with surface nets catching more fish than off-bottom nets in both years; no depth interactions were significant.

The New Hampshire Fish and Game counted large numbers of *A. aestivalis* ascending the Taylor River to spawn during mid-May, 1977 (Ted Spurr, personal communication). In June, adults were captured in gill nets and were probably reproductively spent fish returning to the sea. This period in the spring (mid-May through June) is when spent adults should be returning to the sea (Bigelow and Schroeder, 1953; Loesch and Lund, 1977). During 1973 and 1974 small numbers of adults were collected from May through July, and in 1975 no adults were collected until July.

5.8.2 Length of Specimens

Alosa aestivalis collected in gill nets ranged from 7.5 to 29.2 cm, ($\bar{x}$ = 19.1 cm). Length at maturity is approximately 20 cm SL: thus, most individuals were close to maturity. Lengths of individuals collected in the estuary ranged from 3.8 to 12.7 cm. Those collected in August and September were YOY fish, but 50 individuals caught in May 1977 ranged from 7.6 to 12.7 cm and were probably 1 year old fish.

5.8.3 Eggs and Larvae

Alosa aestivalis are anadromous and spawn in freshwater (Bigelow and Schroeder, 1953); thus, no eggs or larvae were collected.

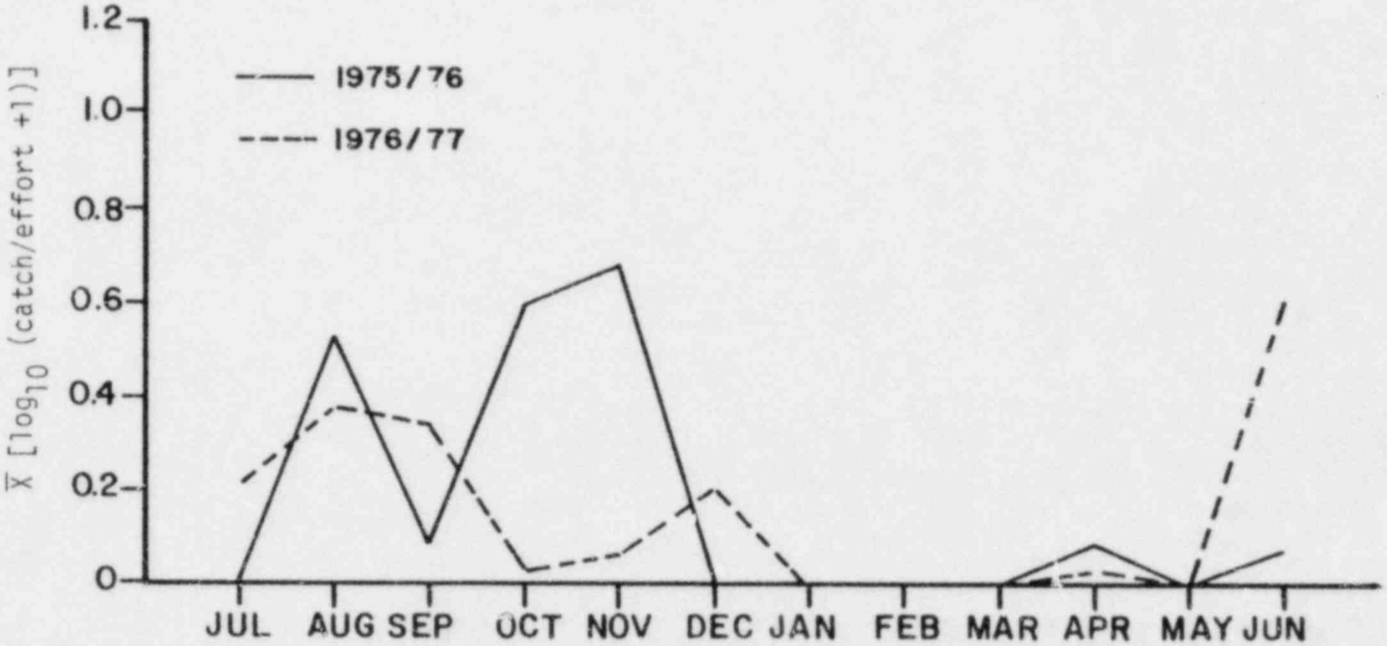


Figure 5.8-1. Comparison of 1975/76 and 1976/77 mean [$\log_{10}$(catch/effort +1)] of *Alosa aestivalis* for all gill net stations averaged over depths and days. Seabrook Environmental Studies, 1976-1977.

5.8.4 Utilization

The large number of juveniles seined in the estuary in 1975/76 and the smaller group captured in 1976/77 suggest spawning does occur in the local tributaries. This is supported by the large numbers of adult *A. aestivalis* reported by New Hampshire Fish and Game ascending the Taylor River, a tributary of Hampton-Seabrook estuary. Juveniles use the estuary as a feeding ground during their development.

5.9 ALEWIFE, *ALOSA PSEUDOHARENGUS*

5.9.1 Spatial and Temporal Abundance

Alosa pseudoharengus ranked seventh in abundance in gill nets and thirteenth in seine catches. The peak catch in 1977 occurred offshore in June, but individuals were present April through June (Appendix Tables 8.0-5, 8.0-6, 8.0-7). Individuals were absent from the study area September through March. The peak abundance in 1975/76 occurred in October but none were captured in June or July. Juveniles were collected in the estuary July through October (Appendix Tables 8.0-8, 8.0-9, 8.0-10).

Significant differences in gill net C/E were found for months x years, months x years x depth interactions ($p < .001$), and months x depths interaction ($.01 \geq p > .001$) (Table 4.2-2). Overall depth differences were not significant. During October 1975 there was a C/E peak for surface and bottom nets but none were collected in October 1976 (Figure 5.9-1). During June 1977 there was peak in C/E but none were collected during June 1976. The differences in abundance between months and years explain the significant interactions.

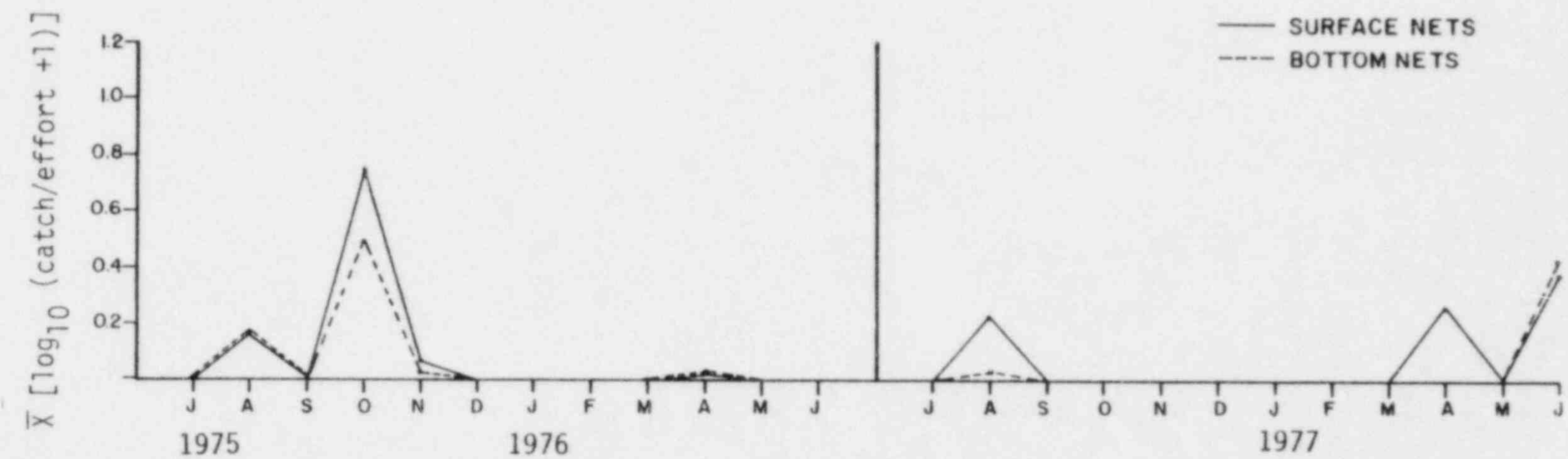


Figure 5.9-1. Mean [$\log_{10}$(catch/effort)] of *Alosa pseudoharengus* for surface and bottom gill nets. Depths averaged over all stations and days. Seabrook Environmental Studies, 1976-1977.

5.9.2 Length of Specimens

Alosa pseudoharengus collected in gill nets ranged from 8.9 to 26 cm ($\bar{x}$ = 18.3 cm). The individuals collected by seine ranged from 6.7 to 12.7 cm. Alewives mature at approximately 25 cm standard length, thus most individuals collected in the study area were immature.

5.9.3 Eggs and Larvae

Alosa pseudoharengus are anadromous and spawn in freshwater tributaries (Bigelow and Schroeder, 1953); thus, no eggs or larvae were collected.

5.9.4 Utilization

Alosa pseudoharengus are similar to *A. aestivalis* because they spawn in freshwater and adults then return to the sea (Bigelow and Schroeder, 1953). Juveniles remain in freshwater all summer and a small number of individuals were collected in the estuary during the summer and fall. Some adults were captured offshore in the spring and late summer, but they do not seem to use the nearshore zone for feeding. The individuals captured in the spring were probably entering Hampton Harbor to spawn.

5.10 COD, *GADUS MORHUA*

5.10.1 Spatial and Temporal Abundance

Gadus morhua ranked ninth in otter trawl and tenth in gill net catches. They are permanent residents in the nearshore zone and were collected every month offshore (Appendix Tables 8.0-2 through 8.0-7). The majority of individuals collected were juveniles. *G. morhua* was

abundant in nearly equal numbers throughout the sampling period (Figure 5.10-1). During 1975/76 *G. morhua* were more abundant in winter and spring and, overall, more were captured during 1975/76 than 1976/77.

During the present study more specimens were captured by trawls at Transects 1 and 3 than Transect 2 (Table 4.1-4). Similar results were obtained during 1975/76, suggesting that cod are more abundant at the offshore stations.

Overall catches in gill nets were low for *G. morhua* during both sample years because nets are fished approximately 3 m off the bottom and cod are demersal fish.

5.10.2 Length of Specimens

Gadus morhua ranged from 5 to 74.3 cm ($\bar{x}$ = 36.5 cm) in trawl catches and ranged 34.2 to 68.6 cm ($\bar{x}$ = 54.5 cm) in gill nets. The average length at maturity is 64 cm; thus, most individuals were immature.

5.10.3 Eggs and Larvae

The ability to describe the distribution of *Gadus morhua* eggs was obfuscated by their inclusion with eggs of *Melanogrammus aeglefinus*. However, larvae of this latter species were generally numerically unimportant, suggesting that *G. morhua* is the predominant contributor to this egg grouping. *Gadus/Melanogrammus* eggs had a bimodal distribution during both years with peaks occurring during November and April-June (Table 5.10-1). The intensity of these peaks varied between years with April-June 1976 and November 1976 maxima. Fewest eggs were collected during August and September. Mean abundance was similar at all transects during both years, with 1976-1977 mean annual abundance reduced from 1975-1976 levels.

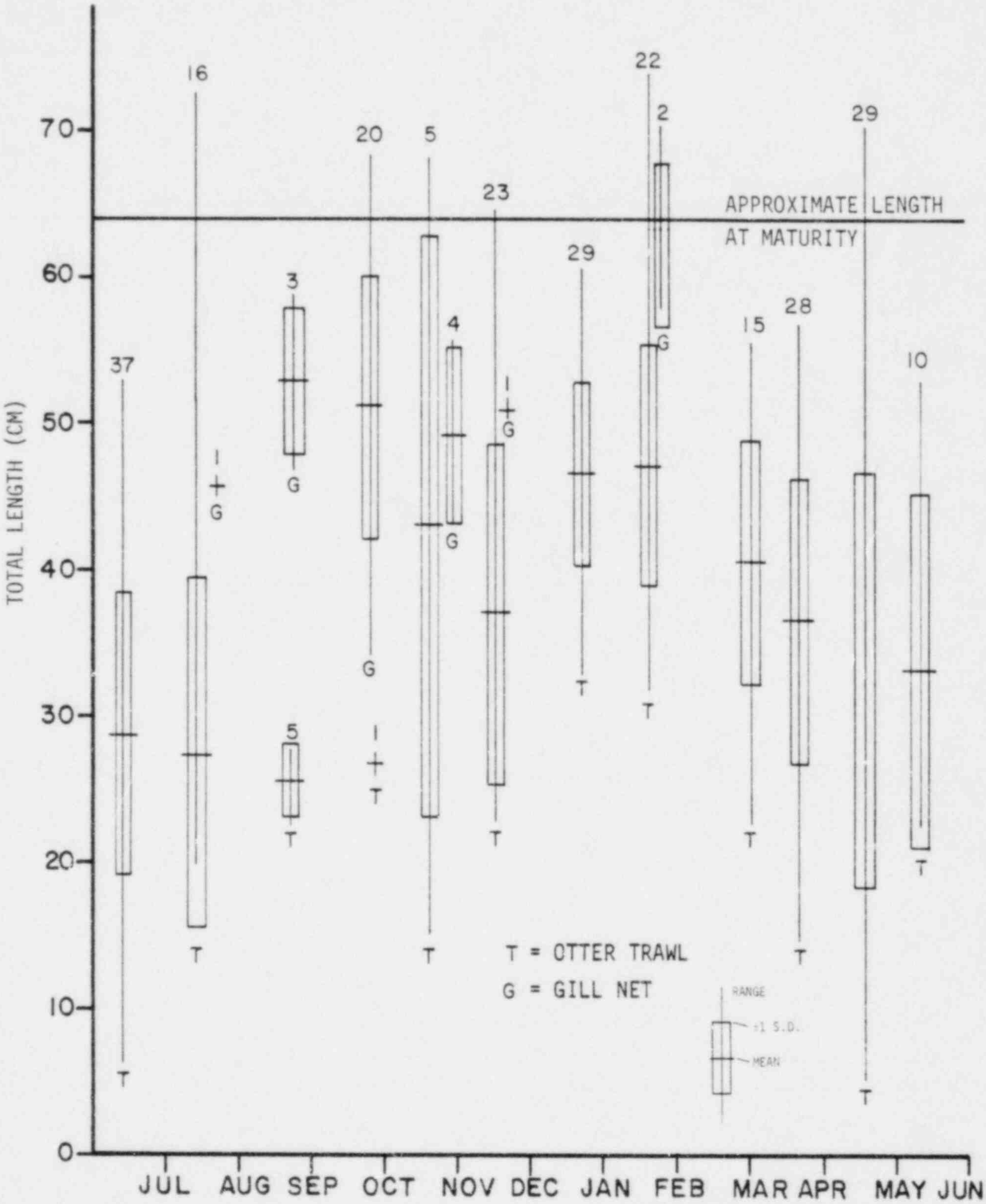


Figure 5.10-1. Standard length, means ranges and standard deviations of *Gadus morhua* captured near the Hampton-Seabrook estuary. Seabrook Finfish Studies, 1976-1977.

TABLE 5.10-1. ABUNDANCE[a] OF *GADUS/MELANOGRAMMUS* EGGS AND *GADUS MORHUA* LARVAE IN ICHTHYOPLANKTON COLLECTIONS, HAMPTON-SEABROOK AREA, 1975-1977. SEABROOK FINFISH STUDIES 1976-1977.

GADUS/MELANOGRAMMUS EGGS

DATE	TRANSECTS 1	2	3	$\bar{x}$[b]	DATE	TRANSECTS 1	2	3	$\bar{x}$
27 Aug 75	0.001	0.009	0.004	0.005	18 Aug 76	0.000	0.004	0.000	0.001
29 Sep 75	0.002	0.000	0.001	0.001	29 Sep 76	0.002	0.000	0.000	<0.001
28 Oct 75	0.047	0.348	0.194	0.196	27 Oct 76	0.047	0.029	0.050	0.042
19 Nov 75	0.051	0.946	1.158	0.718	16 Nov 76	0.996	2.525	0.235	1.252
15 Dec 75	0.026	0.067	0.088	0.060	2 Jan 77	0.132	0.156	0.149	0.146
5 Feb 76	0.179	0.020	0.407	0.202	26 Jan 77	0.010	0.001	0.011	0.007
25 Feb 76	0.016	0.100	0.113	0.076	2 Mar 77	0.000	0.000	0.103	0.034
23 Mar 76	0.216	0.020	0.096	0.111	7 Apr 77	0.062	0.183	0.091	0.112
20 Apr 76	0.891	1.095	0.561	0.849	3 May 77	0.090	0.523	0.804	0.472
18 May 76	2.232	0.843	1.852	1.642	24 May 77	0.713	0.101	0.552	0.482
15 Jun 76	1.110	0.614	0.497	0.740	15 Jun 77	0.084	0.068	0.176	0.109
$\bar{x}$[b]	0.434	0.369	0.452	0.418	$\bar{x}$	0.194	0.334	0.197	0.242

GADUS MORHUA LARVAE

DATE	1	2	3	$\bar{x}$	DATE	1	2	3	$\bar{x}$
24 Jul 75	0.018	0.011	0.029	0.019	20 Jul 76	0.000	0.000	0.000	0.000
19 Nov 75	0.002	0.000	0.000	<0.001	16 Nov 76	0.000	0.004	0.000	0.001
15 Dec 75	0.010	0.008	0.010	0.009	2 Jan 77	0.002	0.000	0.001	0.001
5 Feb 76	0.001	0.000	0.001	<0.001	26 Jan 77	0.003	0.001	0.003	0.002
25 Feb 76	0.001	0.002	0.000	0.001	2 Mar 77	0.000	0.000	0.000	0.000
23 Mar 76	0.000	0.002	0.002	0.001	7 Apr 77	0.000	0.000	0.000	0.000
20 Apr 76	0.004	0.008	0.005	0.006	3 May 77	0.000	0.000	0.000	0.000
18 May 76	0.044	0.029	0.009	0.027	24 May 77	0.098	0.082	0.057	0.082
15 Jun 76	0.029	0.021	0.017	0.022	15 Jun 77	0.032	0.013	0.043	0.029
$\bar{x}$	0.011	0.009	0.006	0.009	$\bar{x}$	0.017	0.014	0.013	0.015

[a] no./m^3 [b] $\bar{x}$ = transect means (columns) and date means (rows)

Gadus morhua larvae were present from November-June, with lowest densities reported November-early May and greatest densities mid-May - mid-June (Table 5.10-1). There was little evidence of spatial heterogeneity, similar to the pattern indicated for the eggs. Mean annual abundance was similar between 1975-1976 and 1976-1977 although there was a general increase during May 1977 relative to May 1976.

5.10.4 Utilization

The coastal waters of New Hampshire were utilized by *G. morhua* as a feeding ground for juveniles. Few mature fish were collected in the area, but one reason for this may be gear selectivity. Larger fish may be able to avoid the trawls and because of their demersal nature, some fish may not be caught by gill nets set 3 m above the bottom. Limited spawning does occur, but the majority probably occurs further offshore, which agrees with the previous years' study (NAI, 1977). Bigelow and Schroeder (1953) report the majority of *G. morhua* spawn offshore in approximately 20 fathoms of water.

5.11 POLLOCK, *POLLACHIUS VIRENS*

5.11.1 Spatial and Temporal Abundance

Pollachius virens ranked fifth in gill nets, twelfth in trawls and eighth in beach seine catches. They were most abundant during spring and summer and were captured every month except November (Appendix Tables 8.0-2 through 8.0-10). A large number of juveniles were captured during July. Seasonality of *P. virens* is similar to previous NAI studies, with the majority appearing in the spring. Steele (1963) reported an inshore migration of juveniles in spring in the Bay of Fundy.

5.11.2 Length of Specimens

Pollachius virens ranging from 15.2 to 41.9 cm were collected by trawls and gill nets. Since they mature at approximately 55 cm, it follows that none collected were mature (Figure 5.11-1). Individuals collected in the estuary were <15 cm.

5.11.3 Eggs and Larvae

Pollachius virens eggs were present between late October 1976 and June 1977 with a January peak; during 1975-1976 eggs were present over the same time period, but greatest abundance was observed in mid-November (Table 5.11-1). Steele (1963) reported that *P. virens* spawns in the Gulf of Maine between November and February, which is consistent with the patterns observed during this study. The presence of eggs into spring months may be biologically real or may reflect misidentification of small *Gadus morhua* eggs. During both years, *P. virens* eggs were more abundant at Transect 3, especially during 1976-1977. Similar mean egg concentrations were observed at Transects 1 and 2 during both years (Table 5.11-1).

Pollachius virens larvae were present October 1976-March 1977 and November 1975-June 1976 with January 1977 and December 1975 maxima (Table 5.11-3). The differences in peak larval abundance are consistent with the maxima noted for eggs. There was no evidence of spatial differences in *P. virens* larval abundance during 1976-1977 whereas larvae were generally more abundant at Transects 1 and 2 during 1975-1976 with few collected at Transect 3 (Table 5.11-1). Mean abundance in 1976-1977 was 39% that of 1975-1976.

Egg:larvae ratios were relatively low (1.70:1 in 1975-1976 and 5.89:1 in 1976 and 1977) suggesting that natural mortality was also relatively low for this species during both years, when compared to other species studied in this investigation.

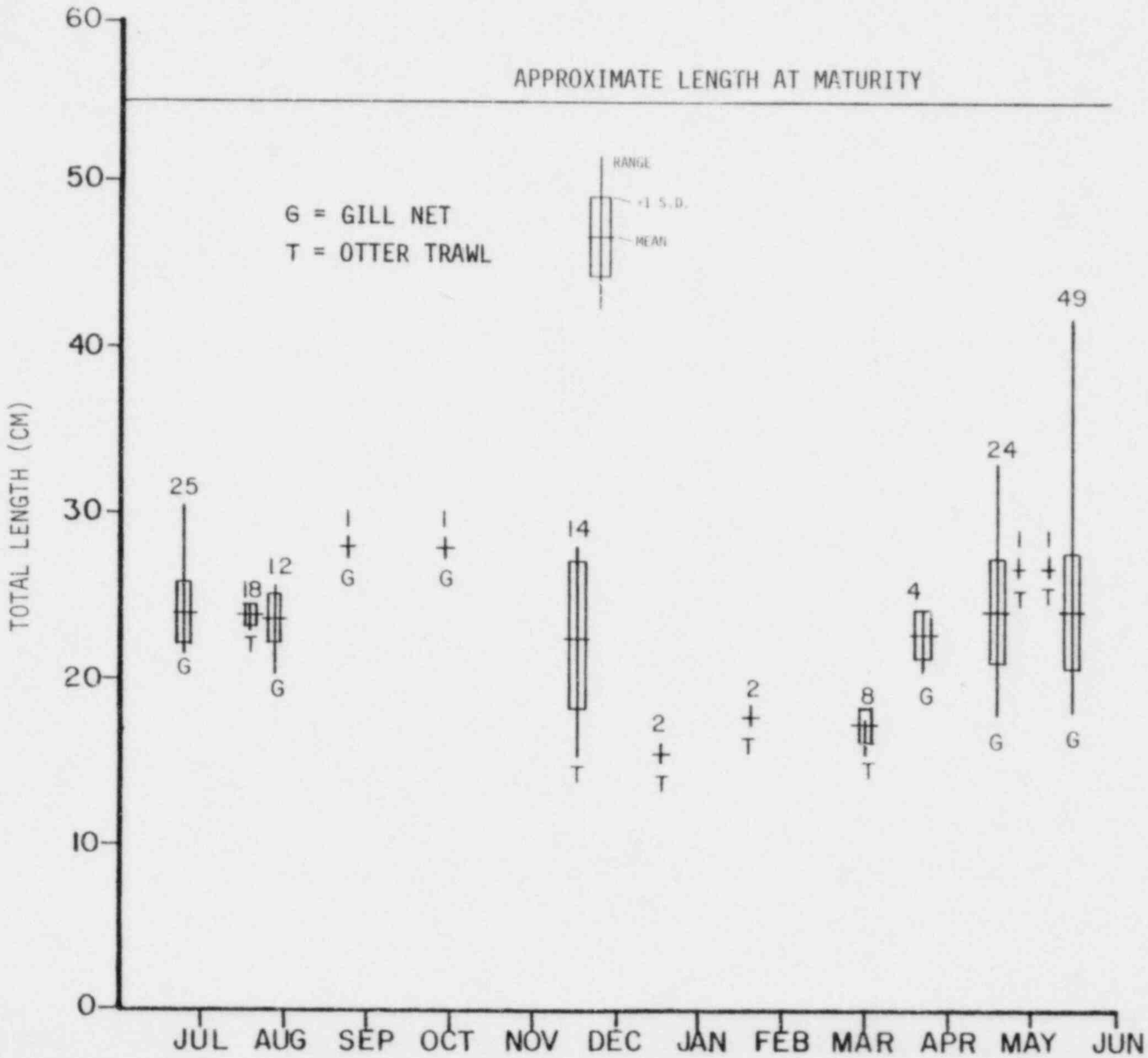


Figure 5.11-1. Standard length, means, ranges and standard deviations of *Pollachius virens* captured near Hampton-Seabrook estuary. Seabrook Finfish Studies, 1976-1977.

TABLE 5.11-1. ABUNDANCE[a] OF *POLLACHIUS VIRENS* EGGS AND LARVAE IN ICHTHYOPLANKTON COLLECTIONS, HAMPTON-SEABROOK AREA, 1975-1977. SEABROOK FINFISH STUDIES, 1976-1977.

EGGS

DATE	TRANSECTS 1	2	3	$\bar{x}$ [b]
28 Oct 75	0.004	0.012	0.001	0.006
19 Nov 75	0.113	0.243	0.384	0.247
15 Dec 75	0.045	0.001	0.000	0.015
5 Feb 76	0.000	0.000	0.002	<0.001
25 Feb 76	0.001	0.003	0.022	0.009
23 Mar 76	0.000	0.000	0.002	<0.001
20 Apr 76	0.018	0.006	0.015	0.013
18 May 76	0.054	0.012	0.030	0.032
15 Jun 76	0.036	0.024	0.018	0.026
$\bar{x}$ [b]	0.030	0.033	0.053	0.039

DATE	TRANSECTS 1	2	3	$\bar{x}$
27 Oct 76	0.005	0.002	0.004	0.004
16 Nov 76	0.002	0.004	0.004	0.003
2 Jan 77	0.270	0.230	0.722	0.407
26 Jan 77	0.000	0.001	0.000	<0.001
2 Mar 77	0.000	0.000	0.000	0.000
7 Apr 77	0.000	0.001	0.002	0.001
3 May 77	0.002	0.009	0.025	0.012
24 May 77	0.074	0.010	0.043	0.042
15 Jun 77	0.008	0.000	0.000	0.003
$\bar{x}$	0.040	0.029	0.089	0.053

LARVAE

DATE	1	2	3	$\bar{x}$
24 Jul 75	0.000	0.002	0.000	<0.001
28 Oct 75	0.000	0.000	0.000	0.000
14 Nov 75	0.021	0.052	0.000	0.024
15 Dec 75	0.237	0.065	0.000	0.101
5 Feb 76	0.081	0.013	0.019	0.038
25 Feb 76	0.011	0.015	0.007	0.011
23 Mar 76	0.000	0.001	0.002	0.001
20 Apr 76	0.000	0.000	0.000	0.000
18 May 76	0.010	0.000	0.000	0.005
15 Jun 76	0.002	0.000	0.000	<0.001
$\bar{x}$	0.040	0.026	0.003	0.023

DATE	1	2	3	$\bar{x}$
20 Jul 76	0.000	0.000	0.000	0.000
27 Oct 76	0.000	0.002	0.000	<0.001
16 Nov 76	0.000	0.011	0.011	0.009
2 Jan 77	0.024	0.028	0.047	0.035
26 Jan 77	0.042	0.024	0.041	0.036
2 Mar 77	0.000	0.000	0.001	<0.001
7 Apr 77	0.000	0.000	0.000	0.000
3 May 77	0.000	0.000	0.000	0.000
24 May 77	0.000	0.000	0.000	0.000
15 Jun 77	0.000	0.000	0.000	0.000
$\bar{x}$	0.008	0.003	0.012	0.009

[a] no./m^3 [b] $\bar{x}$ = transect means (columns) and date means (rows)

5.11.4 Utilization

Pollachius virens utilize the nearshore zone almost exclusively as a juvenile feeding area from April through December.

5.12 RAINBOW SMELT, *OSMERUS MORDAX*

5.12.1 Spatial and Temporal Abundance

Osmerus mordax ranked tenth in trawls, eighth in gill nets and fifth in seine catches. They were collected offshore December through April, with maximum abundance occurring January through March. Juveniles were captured in the estuary July through September. Seasonality in the 1976/77 study compares with 1975/76 results, but mean abundance was lower. *Osmerus mordax* ranked second in trawls in 1975/76 and were even more abundant in previous studies (NAI, 1975, 1976). The C/E in trawls was lower in 1976/77 (Table 4.1-4). Differences in C/E between transects in the present study was insignificant, but in 1975/76 they were more abundant at Transect 2. The total number of individuals collected in gill nets in 1976/77 was low, but vertical distribution between surface and bottom nets was nearly equal. Almost four times as many fish (186) were caught by otter trawls on the bottom as were caught by gill nets (37) in the water column in the 1976-1977 studies; in the 1975-1976 study 19 times more smelt were caught in the trawl than the gill nets. The low numbers collected in 1976/77 and the differences in total abundance between years is probably due to natural population fluctuations.

5.12.2 Length of Specimens

Osmerus mordax ranged from 4.5 to 21.5 cm standard length (Figure 5.12-1). Mature individuals were present in winter and spring though none were captured in the summer, as in the previous year (NAI,

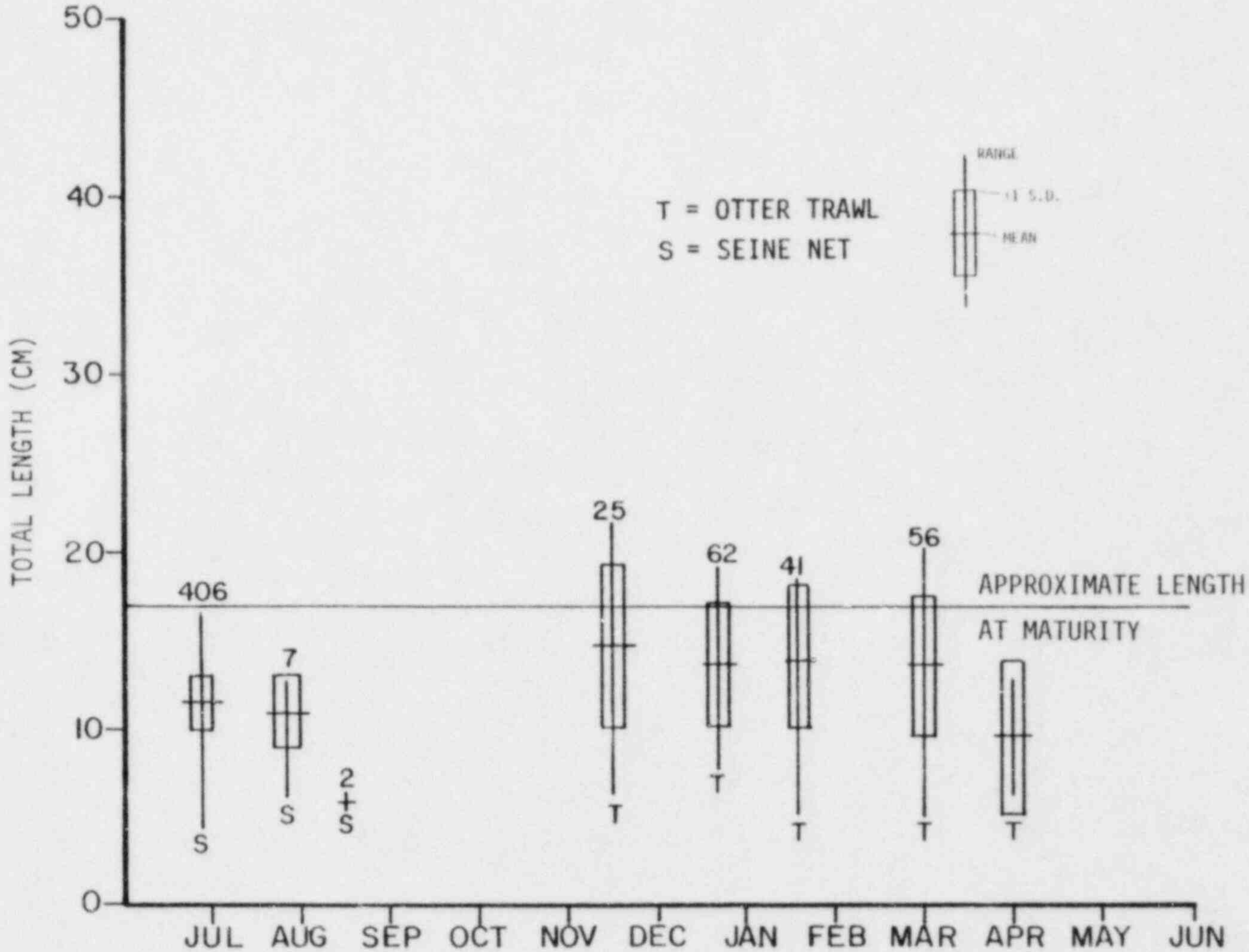


Figure 5.12-1. Standard length, means, ranges and standard deviations of *Osmerus mordax* captured near the Hampton-Seabrook estuary. Seabrook Finfish Studies, 1976-1977.

1977). The majority of fish captured offshore were immature, as were individuals collected in the estuary (<17 cm standard length). Mean length agrees with the results obtained in past years (NAI, 1974; 1976; 1977).

5.12.3 Eggs and Larvae

Osmerus mordax larvae were collected in low numbers and low frequency during both 1975 and 1976 (Table 5.12-1). Since *O. mordax* spawning generally occurs in freshwater streams or above tide waters in estuaries, (Leim and Scott, 1966) those which were present represent individuals flushed from the estuary.

5.12.4 Utilization

Mature *O. mordax* were present in the offshore study area during winter and early spring. No mature adults were collected in the estuary during the spring spawning period, but presence of YOY juveniles in July suggests spawning did take place in the tributaries of the estuaries. *Osmerus mordax* larvae abundance was low at offshore stations. Leim and Scott (1966) reported that larvae remain in brackish water during development. *Osmerus mordax* spend their entire life cycle in the study area.

5.13 SCULPINS, *MYOXOCEPHALUS* SPP.

5.13.1 Spatial and Temporal Abundance

Three species of *Myoxocephalus* were collected in the study area in 1976/77. Two species, *M. octodecemspinosus* and *M. aenaeus*, the longhorn and grubby sculpin, respectively, are common permanent residents in the study area. *M. scorpius*, the shorthorn sculpin, was

TABLE 5.12-1. ABUNDANCE[a] OF *OSMERUS MORDAX* LARVAE IN ICHTHYOPLANKTON COLLECTIONS, HAMPTON-SEABROOK AREA, 1975-1977. SEABROOK FINFISH STUDIES, 1976-1977.

DATE	TRANSECTS 1	2	3	$\bar{x}^b$
19 Nov 75	0.000	0.000	0.010	0.003
15 Dec 75	0.000	0.000	0.017	0.005
$\bar{x}^b$	0.000	0.000	0.014	0.003

DATE	1	2	3	$\bar{x}$
20 Apr 76	0.000	0.000	0.000	0.000
18 May 76	0.010	0.010	0.000	0.007
15 Jun 76	0.000	0.000	0.000	0.000
$\bar{x}$	0.003	0.003	0.000	0.002

DATE	TRANSECTS 1	2	3	$\bar{x}$
3 May 77	0.164	0.016	0.008	0.063
24 May 77	0.015	0.017	0.000	0.011
15 Jun 77	0.000	0.000	0.000	0.000
$\bar{x}$	0.060	0.011	0.003	0.025

[a] no./m^3 [b] $\bar{x}$ = transect means (columns) and date means (rows)

collected infrequently. Longhorn sculpins ranked fourth in trawl abundance and were collected every month (Appendix Tables 8.0-2, 8.0-3, 8.0-4). C/E was higher at Transects 1 and 3 during both study years (Table 4.1-4). Abundance at all three stations was higher in 1976/77.

5.13.2 Length of Specimens

Myoxocephalus octodecemspinosus ranged from 5 to 31.7 cm and *M. aenaeus* ranged from 2.5 to 7.6 cm standard length. The mean length for *M. aenaeus* (5 cm) during 1976/1977 was much lower than the mean of 12 cm in the 1975/76 study period.

5.13.3 Eggs and Larvae

Sculpin eggs are demersal, hence none were collected. Larvae of *M. octodecemspinosus* and *M. aenaeus* were collected in low numbers during March.

5.13.4 Utilization

M. octodecemspinosus and *M. aenaeus* are permanent residents in New Hampshire coastal waters and all lifestages utilize the study area.

5.14 OTHER SPECIES

Raja spp., *Macrozoarces americanus* and *Scophthalmus aquosus* were other species frequently collected offshore, comprising 9% of the trawl catches. Major species collected by beach seine were *Menidia menidia, Fundulus* spp., *Ammodytes americanus* and *Pungitius pungitius*, comprising 95.3% of the catch.

Three species of skates were encountered in the study area, *R. erinacea*, *R. radiata* and *R. binoculata*. Combined, they ranked seventh in trawl abundance. Skates were captured every month and were most abundant at Transect 3 (Appendix Tables 8.0-2, 8.0-3 and 8.0-4). These results agree with the 1975/76 data. Skates are permanent, year-round residents in the study area.

Macrozoarces americanus are permanent residents in New Hampshire coastal waters and were captured by trawls every month (Appendix Tables 8.0-2, 8.0-3, 8.0-4). They ranked eighth in trawl catches with maximum numbers collected in spring and summer. Transect 3 yielded the greatest number (Appendix Table 8.0-4). Abundance was similar during both years, comprising approximately 3% of the trawl catch yearly.

Scophthalmus aquosus ranked eleventh in trawl abundance and were collected every month. These results agree with the 1975/76 data, when they ranked tenth. *S. aquosus* are permanent residents in coastal waters, and eggs and larvae were collected during both years (Table 4.6-1, 2).

Menidia menidia was the most frequently collected species in the study area with 25,056 individuals collected in the estuary. The number of individuals collected in 1976/77 was twice the 1975/76 total. *M. menidia* was most abundant in the estuary from August through October (Appendix Tables 8.0-8, 8.0-9, 8.0-10). A small number of individuals were collected in trawls December through February. Conover (1978) reported that the majority of *M. menidia* returning to spawn are 1 year old fish, while only a very small percentage of 2 year olds survive. *M. menidia* spawn in the estuary during early summer and spend the winter months offshore.

Hippoglossoides platessoides adults and juveniles were captured offshore during 1976/77. This is the first time that any adults or juveniles have been collected by NAI, although eggs and larvae are quite common (Tables 4.6-1, 2). Bigelow and Schroeder (1953) report

that *H. platessoides* are very abundant at depths greater than 30 fathoms which explains the scarcity of adults in previous years when samples were taken at shallower depths. Individuals were collected at Transects 1 and 3 during the spring.

6.0 SUMMARY

6.1 OTTER TRAWLS

Catches in trawls for both sample years (July 1975-76 and 1976-1977) were very similar. *L. ferruginea* continued to be the dominant species with total catches for both sample periods nearly identical. Dominance of certain species did change but within the normal range of variation. *O. mordax* was ranked second in 1975/76 but dropped to tenth in 1976/77. Other major species, *Urophycis* spp., *P. americanus, M. bilinearis, Myoxocephalus* spp. and *Raja* spp. all remained in the top ten ranking and their abundances did not change appreciably over the two year period. The C/E for the major species either remained stable or showed a slight increase for most species in 1976/77, except *O. mordax*.

6.2 GILL NETS

Gill net catches showed some fluctuations in abundances and dominance over the two year period (July 1975-June 1977). *Clupea harengus* ranked first in abundance for both years and total number of individuals collected was similar. *Scomber scombrus* ranked third during 1976/77, doubling its abundance over the 1975/76 catches. *Alosa aestivalis, P. virens* and *O. mordax* abundances remained similar for both years. *Merluccius bilinearis* ranked second both years, but abundance in 1976/77 was nearly double the 1975/76 total.

Statistical tests indicated that years x months was significant ($p \leq .001$) for all species tested. Depth effects were significant for all species except *A. pseudoharengus*. Station effects were significant for *M. bilinearis* only, but three way interactions involving stations with depth, years and months were occasionally significant for other species.

6.3 BEACH SEINE

Beach seine catches increased from 15,837 in 1975/76 to 31,499 in 1976/77. A total of 25,056 individuals in 1976/77 were *M. menidia*, double the 1975/76 *M. menidia* catch. The main reason for the large increase was 10,005 *M. menidia* collected at Station S3 in October. Catches of *A. americanus, Fundulus* spp., *P. pungitius, M. tomcod, P. americanus* and *P. virens* all increased in 1976/77. *O. mordax* and *A. aestivalis* decreased in total numbers collected.

6.4 ICHTHYOPLANKTON

Comparing 1975-76 and 1976-77 ichthyoplankton assemblages in the vicinity of Seabrook, New Hampshire were found to be quantitatively, qualitatively and structurally similar. During 1976-1977, fish egg abundance was greatest during summer and late spring when Labrid/*Limanda* were dominant, a smaller, peak of *Gadids* occurred between November-February. Fish larvae showed March and May abundance maxima due to *A. americanus* (March) and *H. platessoides* and *U. subbifurcata* (May). Both the eggs and larval assemblages were affected by season, however, a seasonal pattern was less apparent for larvae than for eggs. There was little indication of differences by transect or year for either life stage grouping. More species were represented by eggs and larvae in spring, fewer in mid-winter during both years.

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8.0 APPENDICES

APPENDIX TABLE 8.0-1. LIST OF FISH SPECIES ENCOUNTERED IN THE MARINE AND ESTUARINE WATERS IN THE VICINITY OF THE HAMPTON-SEABROOK ESTUARY FROM JULY 1976 THROUGH JUNE 1977. SEABROOK FINFISH STUDIES, 1976-1977.

Scientific name	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 sapidissiana	American shad	x		
Ammodytes americanus	American sand lance	x	x	
Anguilla rostrata	American eel	x		
Apeltes quadracus	Fourspine stickleback	x		
Aspidophoroides moncpterygius	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 heteroclitus	Mummichog	x		
Fundulus majalis	Striped killifish	x		
Gadus/Melanogrammus	Cod and/or Haddock			x
Gadus morhua	Cod	x	x	
Gasterosteus aculeatus	Threespine stickleback	x		
Glyptocephalus cynoglossus	Witch flounder		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		
Lumpenus lumpretaeformis	Snakeblenny		x	
Macrozoarces americanus	Ocean pout	x		
Melanogrammus aeglefinus	Haddock	x	x	
Menidia menidia	Atlantic silversides	x		
Merluccius bilinearis	Silver hake	x	x	x
Microgadus tomcod	Tomcod	x		
Morone saxatilis	Striped bass	x		
Mustelus canis	Smooth dogfish	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		
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 binoculata	Big skate	x		
Raja erinacea	Little skate	x		
Raja radiata	Thorny skate	x		
Salmo gairdneri	Rainbow trout	x		
Salmo trutta	Brown trout	x		
Scomber scombrus	Atlantic mackerel	x	x	x
Scophthalmus aquosus	Windowpane	x	x	x
Squalus acanthias	Spiny dogfish	x		
Stenotomus chrysops	Scup	x		
Syngnathus fuscus	Northern pipefish	x	x	
Tautoga onitis	Tautog		x	
Tautogolabrus adspersus	Cunner	x	x	
Ulvaria subbifurcata	Radiated shanny	x	x	
Urophycis sp.	Hake		x	x
Urophycis chuss	Red hake	x		
Urophycis tenuis	White hake	x		

X = present

APPENDIX TABLE 8.0-2. FISH SPECIES COLLECTED BY OTTER TRAWL AT TRANSECT 1 OFF HAMPTON-SEABROOK, NEW HAMPSHIRE, JULY 1976 TO JUNE 1977. (TOTAL OF FOUR REPLICATES). SEABROOK FINFISH STUDIES, 1976-1977.

SPECIES	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
A. pseudoharengus						1						
Ammodytes americanus										1	2	
Centropristis striata				1								
Gadus morhua		5			3	9	20	15	10	10	10	2
Hemitripterus americanus			1									1
Hippoglossoides platessoides									2		3	
Limanda ferruginea	117	130	135	167	253	172	109	55	133	128	162	151
Lophius americanus		3	2									
Macrozoarces americanus	1	8	2	3	1	4		1	2	3	6	3
Melanogrammus aeglefinus	1	3	6	4	6						1	15
Menidia menidia						4	4					
Merluccius bilinearis	70	33	12	46	60	28					6	5
Myoxocephalus aenaeus						1		1				
M. scorpius						1						
M. octodecemspinosus	12	23	13	18	16	9			2	3	10	50
Osmerus mordax						8	24	18	18	1		
Paralichthys oblongus		1	6	2	1						3	1
Peprilus triacanthus				2								
Pollachius virens						2			1	1		
Prionotus carolinus					2							
Pseudopleuronectes americanus	6	3		13	16	11	8	12	12	5	19	21
Raja spp.			10	6	4	1	3	1	9	1		
Scophthalmus aquosus	1	1	2	2	27	23	4	1	7	10	7	3
Stenotomus chrysops					3							
Syngnathus fuscus			1	2	3							
Ulvaria subbifurcata	3											
Urophycis spp.	76	173	187	172	52	17			2	2	70	138

APPENDIX TABLE 8.0-3. FISH SPECIES COLLECTED BY OTTER TRAWL AT TRANSECT 2 OFF HAMPTON-SEABROOK, NEW HAMPSHIRE, JULY 1976 TO JUNE 1977. (TOTAL OF FOUR REPLICATES). SEABROOK FINFISH STUDIES, 1976-1977.

SPECIES	JUL	AUG[a]	SEP[a]	OCT	NOV	DEC	JAN[b]	FEB	MAR	APR	MAY[a]	JUN[a]
Alosa aestivalis						2						
A. pseudoharengus					3	1						
Clupea harengus										1		
Cyclopterus lumpus			1									
Gadus morhua	1				1	1			1	3	1	
Hemitripterus americanus			2	2					1	1		
Limanda ferruginea	1	10	7	17	35	32	7	11	24	14	12	9
Liparis atlanticus					1		4		1			
L. liparis				1								
Macrozoarces americanus	1							1	9	2	17	10
Melanogrammus aeglefinus	1											
Menidia menidia									1			
Merluccius bilinearis	3	1	9	9	2						4	11
Myoxocephalus aenaeus							5		1	1		
M. scorpius								2				
M. octodecemspinosus	10		1	8	3	1				4	7	
Osmerus mordax						8	9	16	30	1		
Pholis gunnellus				2						1		5
Pollachius virens			18			2		1	1			
Prionotus carolinus						1						
Pseudopleuronectes americanus	14	44	63	11	20	7	1	13	19	10	26	21
Raja spp.	2	2			4	4			5	2	12	10
Scophthalmus aquosus				5	1	6	1	3	10	3		7
Stenotomus chrysops				3								
Syngnathus fuscus			16	1								
Tautogolabrus adspersus				2								
Urophycis spp.	13	40	70	15	1				8		21	36

[a] 3 replicates were 5 min. tows

[b] 2 replicates not taken

APPENDIX TABLE 8.0-4. FISH SPECIES COLLECTED BY OTTER TRAWL AT TRANSECT 3 OFF HAMPTON-SEABROOK, NEW HAMPSHIRE, JULY 1976 TO JUNE 1977 (TOTAL OF FOUR REPLICATES). SEABROOK FINFISH STUDIES, 1976-1977.

SPECIES	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Alosa aestivalis						1						
A. pseudoharengus						4						
Aspidophoroides monopterygius						1		1	1	12		
Enchelyopus cimbrius	2	1	5				1			1		
Gadus morhua	36	11	5	1	1	13	9	7	4	15	18	8
Hemitripterus americanus	1		1			1				1		
Hippoglossoides platessoides												3
Limanda ferruginea	63	139	79	45	96	63	52	44	46	43	61	42
Liparis atlanticus								7	1	4		
Lophius americanus		1	1	1	2							2
Macrozoarces americanus	10	11	14	2	1	1	4	15	10	69	29	6
Melanogrammus aeglefinus	15	84	32	21	31	25					8	14
Menidia menidia						7	2					
Merluccius bilinearis	10	17	31	41	31	10					2	1
Microgadus tomcod									1			
Myoxocephalus aenaeus						4						
M. scorpius								1				
M. octodecemspinosus	19	48	22	30	33	14	3	3	1	25	19	71
Osmerus mordax						9	29	4	11			
Paralichthys oblongus	1											1
Pollachius virens						7	3	3	6			1
Prionotus carolinus				2	2							
Pseudopleuronectes americanus	4	8	13	7	8	16	3	4		8	10	7
Raja spp.	8	7	18	13	24	15	7	3	18	15	18	19
Scophthalmus aquosus	1			7	3	1	4		5	1		
Stenotomus chrysops				1	1							
Tautogolabrus adspersus												1
Ulvaria subbifurcata	1				3		2		1	4		
Urophycis spp.	46	156	181	4[illegible]	59	2			1	3	39	47

APPENDIX TABLE 8.0-5. FISH SPECIES COLLECTED IN GILL NETS AT TRANSECT A OFF HAMPTON-SEABROOK, NEW HAMPSHIRE, JULY 1976 TO JUNE 1977 (TOTAL OF THREE 24 HOUR SETS). SEABROOK FINFISH STUDIES, 1976-1977.

SPECIES		JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR[a]	APR	MAY	JUN
Alosa aestivalis	S	4	43	21	2		2				2	2	21
	B	21	4	2			3						7
A. mediocris	S		1										
	B												
A. pseudoharengus	S		1	1							4	2	5
	B		4										3
A. sapidissima	S												1
	B												1
Ammodytes americanus	S										1		
	B												
Brevoortia tyrannus	S	1		1								7	10
	B												
Clupea harengus	S			4	1	18	16	48	94		131	70	15
	B	1	1		1	33	8	21	87		7	18	
Gadus morhua	S			1									
	B				8	1	1						
Merluccius bilinearis	S	19	12	5	2	1						7	11
	B	24	21	19	12	7						2	21
Osmerus mordax	S							7	2				
	B							5	4				
Peprilus triacanthus	S												
	B	1											
Pollachius virens	S	1											7
	B											2	6
Pseudopleuronectes americanus	S												
	B				1								
Scomber scombrus	S	5	49	11	10	4	4						1
	B		1	1		3	2						1
Urophycis spp.	S												
	B	5	3	6	5								1

a = one 24-hour set

S = surface net

B = bottom net

APPENDIX TABLE 8.0-6. FISH SPECIES COLLECTED IN GILL NETS AT TRANSECT B OFF HAMPTON-SEABROOK, NEW HAMPSHIRE, JULY 1976 TO JUNE 1977 (TOTAL OF THREE 24 HOUR SETS). SEABROOK FINFISH STUDIES, 1976-1977.

SPECIES		JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR[a]	APR	MAY	JUN
Alosa aestivalis	S	1	8	6		1	2					1	16
	B	1		2			9						4
Alosa mediocris	S		4										
	B												
Alosa pseudoharengus	S		4								2	1	10
	B										1		7
Alosa sapidissima	S												4
	B										1		
Brevoortia tyrannus	S		3									5	1
	B					1							1
Centropristis striata	S												
	B												1
Clupea harengus	S	4	8		19	33	2	95	2		73	38	5
	B	1	3	1		28	15	17	57	1	32	11	6
Gadus morhua	S												
	B				11	3					2		
Merluccius bilinearis	S	11	11	25	5							6	6
	B	47	11	16	18	12						3	30
Mustelus canis	S												
	B			1	1								
Myoxocephalus octo-decemspinosus	S												
	B				3								
Osmerus mordax	S									1			
	B							8	1				1
Peprilus triacanthus	S			1									
	B												
Pholis gunnellus	S												
	B											1	
Pollachius virens	S	2											3
	B	19	3		1							9	11
Pseudopleuronectes americanus	S									1			
	B										1		1
Scomber scombrus	S	4	49	62	2		2						
	B	1	4	8			5						
Syngnathus fuscus	S												1
	B												
Tautogolabrus adspersus	S												
	B											1	
Urophycis spp.	S			2									1
	B		2	5	13								10

[a] = one 24 hour set

APPENDIX TABLE 8.0-7. FISH SPECIES COLLECTED IN GILL NETS AT TRANSECT C OFF HAMPTON-SEABROOK, NEW HAMPSHIRE, JULY 1976 TO JUNE 1977 (TOTAL OF THREE 24 HOUR SETS). SEABROOK FINFISH STUDIES, 1976-1977.

SPECIES		JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR[a]	APR	MAY	JUN
Alosa aestivalis	S	5	13	8		3	2					2	15
	B						3						11
Alosa pseudoharengus	S										2	3	4
	B		1									1	8
Brevoortia tyrannus	S											6	6
	B				-								
Clupea harengus	S	4	4	3	167	142	5	68	122		56	76	5
	B			2	2	31	16	26	38	22	7	19	5
Gadus morhua	S								1				
	B		1		3				1				
Merluccius bilinearis	S	29	12	34	1	4						4	10
	B	76	13	29	27	19						2	27
Myoxocephalus octo-decemspinosus	S												
	B				1								2
Osmerus mordax	S							9					
	B						2	9					
Peprilus triacanthus	S	1											2
	B												
Pollachius virens	S			1								1	5
	B	7	7								4	16	18
Pomatomus saltatrix	S												
	B												1
Pseudopleuronectes americanus	S									1			
	B												
Scomber scombrus	S	15	41	75		2	1						1
	B	1	8	3		2							
Scophthalmus aquosus	S												
	B												1
Squalus acanthias	S												
	B	1											
Stenotomus chrysops	S												
	B				1								
Tautogolabrus adspersus	S												
	B		1		9								7
Urophycis spp.	S												
	B	1	6										5

a = One 24 hour set

APPENDIX TABLE 8.0-8. FISH SPECIES COLLECTED BY BEACH SEINING AT STATION 1 IN HAMPTON-SEABROOK ESTUARY JULY 1976 TO JUNE 1977 (TOTAL OF FOUR REPLICATES). SEABROOK FINFISH STUDIES, 1976-1977.

SPECIES	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Alosa aestivalis		8				--	--	--	--			
A. pseudoharengus			1			--	--	--	--			
Ammodytes americanus			1			--	--	--	--			1414
Fundulus spp.	1415	254		4	1	--	--	--	--			
Gasterosteus aculeatus						--	--	--	--	6	3	6
Limanda ferruginea			2			--	--	--	--			
Liopsetta Putnami						--	--	--	--		1	2
Menidia menidia	115	2709	1627	845	5	--	--	--	--	1	1	2
Morone saxatilis	1					--	--	--	--			
Myoxocephalus aenaeus						--	--	--	--			1
Osmerus mordax	6	1				--	--	--	--			1
Pseudopleuronectes americanus		2	4	12	2	--	--	--	--	6	12	16
Pungitius pungitius	8	14	2			--	--	--	--			2
Salmo gairdneri						--	--	--	--			1
Scophthalmus aquosus					1	--	--	--	--			
Urophycis spp.						--	--	--	--			1

-- = no sample taken

APPENDIX TABLE 8.0-9. FISH SPECIES COLLECTED BY BEACH SEINING AT STATION 2 IN HAMPTON-SEABROOK ESTUARY JULY 1976 TO JUNE 1977 (TOTAL OF FOUR REPLICATES). SEABROOK FINFISH STUDIES, 1976-1977.

SPECIES	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Alosa aestivalis		3	1			--	--	--	--		50	
A. pseudoharengus				1		--	--	--	--			
Ammodytes americanus						--	--	--	--	1		1
Apeltes quadracus						--	--	--	--			1
Clupea harengus						--	--	--	--			25
Fundulus spp.	399	937		4		--	--	--	--	1		
Gasterosteus aculeatus						--	--	--	--	16		6
Limanda ferruginea			9			--	--	--	--			
Menidia menidia	43	755	1112	1001	29	--	--	--	--	6		5
Microgadus tomcod						--	--	--	--			1
Osmerus mordax		1				--	--	--	--			
Pollachius virens						--	--	--	--	1		
Pseudopleuronectes americanus	10	21	22		2	--	--	--	--	9	12	5
Pungitius pungitius		5				--	--	--	--			1
Salmo gairdneri						--	--	--	--			2
Syngnathus fuscus						--	--	--	--		1	
Urophycis spp.			2			--	--	--	--			1

-- = no sample taken

APPENDIX TABLE 8.0-10. FISH SPECIES COLLECTED BY BEACH SEINING AT STATION 3 IN HAMPTON-SEABROOK ESTUARY JULY 1976 TO JUNE 1977 (TOTAL OF FOUR REPLICATES). SEABROOK FINFISH STUDIES, 1976-1977.

SPECIES	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
A. pseudoharengus	1	13				--	--	--	--			
Clupea harengus	9					--	--	--	--			
Cyclopterus lumpus						--	--	--	--	1	1	
Gasterosteus aculeatus	7				2	--	--	--	--	3	2	43
Hemitripterus americanus						--	--	--	--		1	
Limanda ferruginea			3		1	--	--	--	--			
Menidia menidia	91	3394	3182	10002	127	--	--	--	--	1		3
Microgadus tomcod	291					--	--	--	--			28
Myoxocephalus aenaeus						--	--	--	--		1	
M. scorpius						--	--	--	--			2
Oncorhynchus kisutch					4	--	--	--	--			
Osmerus mordax	400	5	2			--	--	--	--	3		
Pollachius virens	224					--	--	--	--	1		
Pseudopleuronectes americanus	25	4	39		5	--	--	--	--	7	6	23
Pungitius pungitius	477	1				--	--	--	--			
Salmo gairdneri		1	1			--	--	--	--			
S. trutta					3	--	--	--	--			
Scophthalmus aquosus		1				--	--	--	--			
Tautogolabrus adspersus	1					--	--	--	--			
Urophycis spp.	13					--	--	--	--		1	25

-- = no sample taken

APPENDIX TABLE 8.0-11. RANKED DOMINANCE AND BIOLOGICAL INDEX VALUE OF FISH EGGS BY DATE IN THE HAMPTON-SEABROOK AREA, 1975-1977. SEABROOK FINFISH STUDIES, 1976-1977.

1975-1976	7/24	8/27	9/29	10/28	11/19	12/15	2/5	2/25	3/23	4/20	5/18	6/15	POINTS[a]
Gadus/Melanogrammus		7	7	1	1	1	1	1	2	3	2	4	91
Labrid/Lamanda	1	3	4	5			4		3	2	3	1	73
Enchelyopus cimbrius	3	2	3	2	3					4	4	8	59
Pollachius virens				4	2	2	3	3	4	5	7		58
Hippoglossoides platessoides							2	2	1	1	1	2	57
Scophthalmus aquosus	4	7	6	9						7	5	5	34
Urophycis sp.	2	1	2	7									32
Glyptocephalus cynoglossus	6	5	5								6	7	26
Merluccius bilinearis		6	1	3								9	25
Brosme brosme	8			6						6	8	10	17
Scomber scombrus	5										9	6	13
Peprilus triacanthus	7												4
Brevoortia tyrannus				8									3
Prionotus carolinus		8											3

1976-1977	7/20	8/18	9/29	10/27	11/16	1/2	1/26	3/2	4/7	5/3	5/24	6/15	POINTS[a]
Gadus/Melanogrammus		7	1	1	1	2	1	1	2	2	4	9	90
Labrid/Limanda	1	4	4				2		3	3	1	1	69
Enchelyopus cimbrius	4	3	1	2		3				4	5	3	63
Pollachius virens				3	2	1	2		4	5	8		52
Hippoglossoides platessoides	8				3			2	1	1	2	10	50
Urophycis sp.	3	1	2	4						6		4	46
Merluccius bilinearis	2	2	3	4								7	37
Scophthalmus aquosus	5	5	5							8	3	5	35
Glyptocephalus cynoglossus	7	6	6							4	6	6	28
Scomber scombrus	6									9	7	2	20
Brosme brosme											9	8	5

[a] Biological Index Points

APPENDIX TABLE 8.0-12. RANK BY DATE AND BIOLOGICAL INDEX VALUE OF THE TEN DOMINANT FISH LARVAE SPECIES IN THE HAMPTON-SEABROOK AREA, 1975-1977. SEABROOK FINFISH STUDIES, 1976-1977.

1975-1976	7/24	8/27	9/29	10/28	11/19	12/15	2/5	2/25	3/23	4/20	5/18	6/15	POINTS[a]
Enchelyopus cimbrius	4	2	1	2	3							2	52
Liparis sp.	8						3	2	2	3	1	6	52
Clupea harengus				1	1	1	4	5	7				47
Ammodytes americanus							1	1	1	1	5		46
Hippoglossoides platessoides	6							7	5	2	2	1	43
Gadus morhua	5				4	3	5	6	8	8	6		43
Pollachius virens					2	2	2	4	8				37
Glyptocephalus cynoglossus	1	3	6									3	31
Ulvaria subbifurcata	7	4								7	3	7	27
Tautogolabrus adspersus	2	1	5									10	26

1976-1977	7/20	8/18	9/29	10/27	11/16	1/2	1/26	3/2	4/7	5/3	5/24	6/15	POINTS[a]
Enchelyopus cimbrius	2	5	1	2	3						9	3	52
Ammodytes americanus						2	2	1	1	3	6		51
Gadus morhua					4	3	4				5	7	48
Pollachius virens				4	2	1	1	5					42
Tautogolabrus adspersus	1	1	5									5	32
Merluccius bilinearis	3	4	2	4									31
Clupea harengus				1	1		4		7				31
Scopthalmus aquosus	4	2	3	3									31
Ulvaria subbifurcata	9	3									2	1	29
Hippoglossoides platessoides										1	1	8	23

[a] Biological Index Points

APPENDIX TABLE 8.0-13. MEAN ABUNDANCE[a] OF FISH EGGS BY CLUSTER, HAMPTON-SEABROOK AREA, 1975-1977. SEABROOK FINFISH STUDIES, 1976-1977.

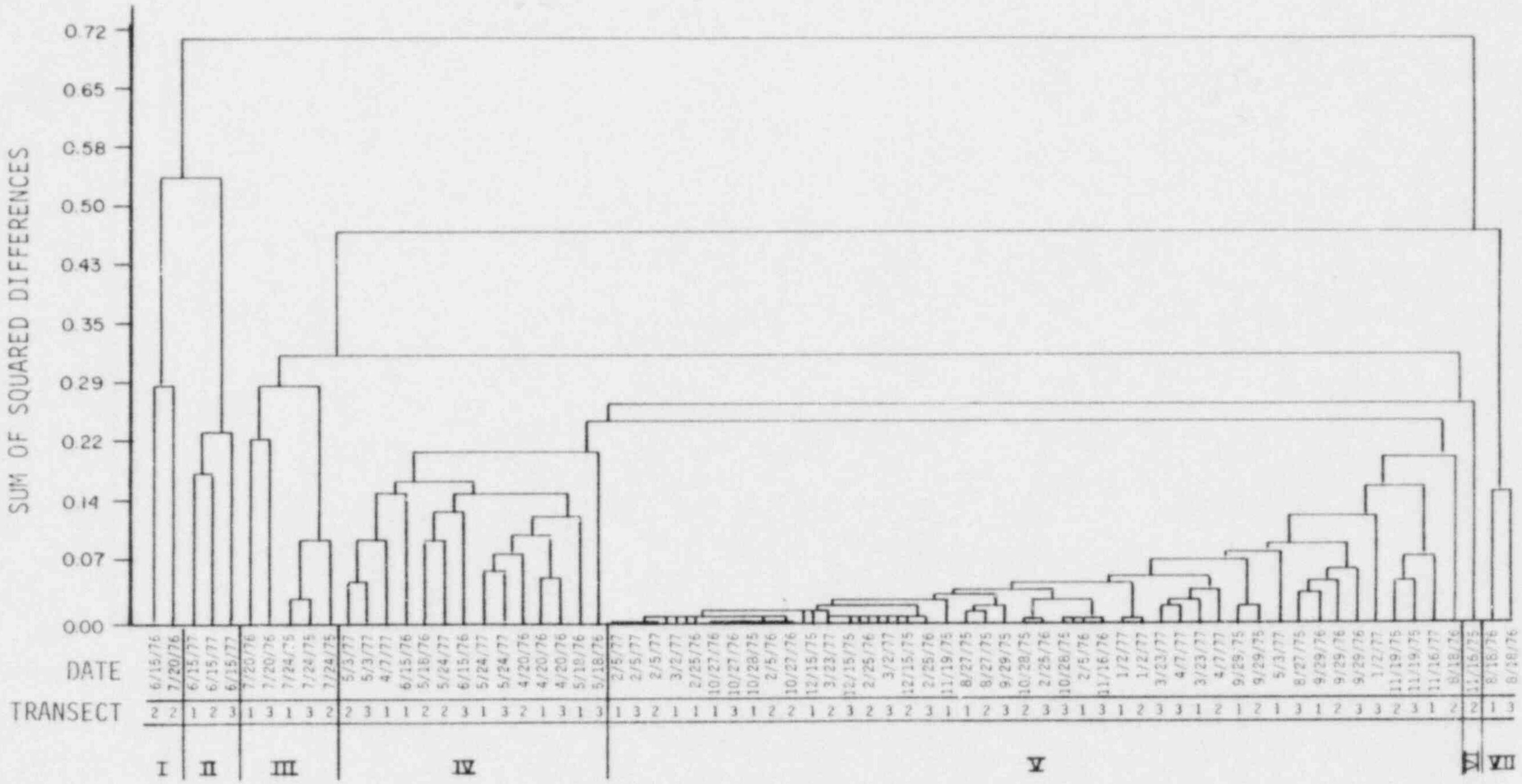
CLUSTER: / TAXON:	I	II	III	IV	V	VI	VII
Gadus/Melanogrammus	0.113	0.044	0	0.314	0.054	0.547	0
Labrid/Limanda	1.801	1.830	0.709	0.342	0.015	0	0.182
Enchelyopus cimbrius	0.118	0.635	0.054	0.159	0.028	0	0.256
Pollachius virens	0.006	0.001	0	0.011	0.035	0.002	0
Hippoglossoides platessoides	0.250	0.029	0.001	0.453	0.015	0	0
Urophycis sp.	0.461	0.365	0.451	0.028	0.032	0	1.254
Scophthalmus aquosus	0.236	0.355	0.022	0.085	0.005	0	0.094
Merluccius bilinearis	0.399	0.105	0.291	0.005	0.020	0	0.344
Glyptocephalus cynoglossus	0.120	0.252	0.014	0.032	0.002	0	0.004
Scomber scombrus	0.168	1.354	0.026	0.089	<0.001	0	0
Brosme brosme	0.010	0.048	<0.001	0.007	<0.001	0	0
Peprilus triacanthus	0	0	<0.001	<0.001	<0.001	0	0
Brevoortia tyrannus	0	0	0	0	<0.001	0	0
Prionotus carolinus	0	0	0	0	<0.001	0	0
Mean Total Abundance	3.682	5.018	1.568	1.525	0.207	0.549	2.134
Total # species	11	11	10	12	14	2	6

[a] log (n+1) transformed: no./m^3.

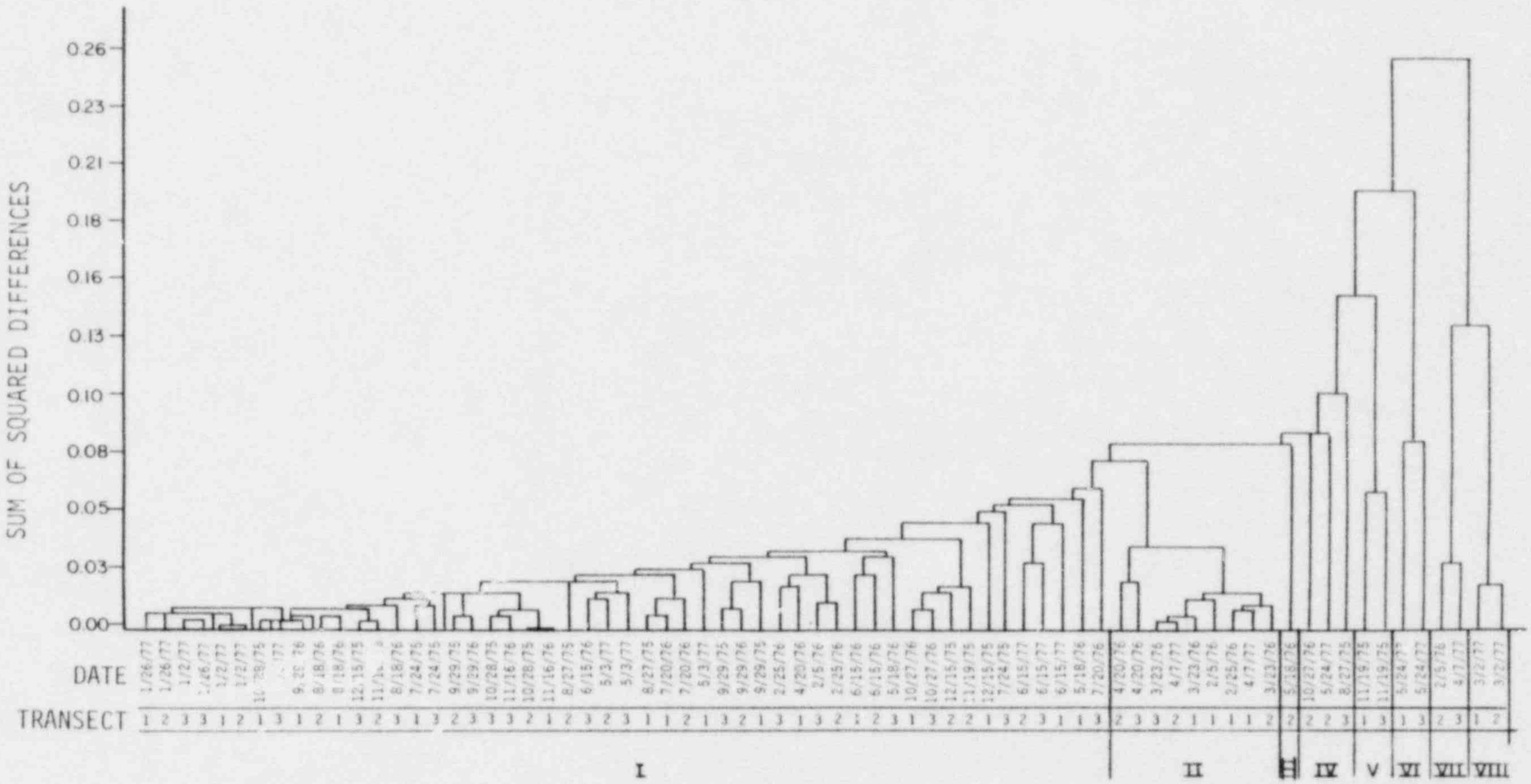
APPENDIX TABLE 8.0-14 MEAN ABUNDANCE[a] OF DOMINANT FISH LARVAE BY CLUSTER, HAMPTON-SEABROOK AREA, 1975-1977. SEABROOK FINFISH STUDIES, 1976-1977.

TAXON: CLUSTER:	I	II	III	IV	V	VI	VII	VIII
Enchelyopus cimbrius	0.019	0	0	0.013	0.004	0.004	0	0
Ammodytes americanus	0.011	0.260	0.026	0.021	0	0.005	0.648	1.011
Gadus morhua	0.003	0.001	0.013	0.013	<0.001	0.032	0	0
Pollachius virens	0.006	0.005	0	<0.001	0.008	0	0.003	0
Clupea harengus	0.012	0.001	0	0.077	0.421	0	0.002	0
Hippoglossoides platessoides	0.015	0.014	0.062	0.027	0	0.656	0	0
Tautogolabrus adspersus	0.012	0	0	0.134	0	0	0	0
Ulvaria subbifurcata	0.012	0.001	0.052	0.089	0	0.064	0	0
Liparis sp.	0.006	0.029	0.288	0.033	0	0.058	0.034	0.024
Glyptocephalus cynoglossus	0.009	0	0	0.001	0	0	0	0
Merluccius bilinearis	0.005	0	0	0.006	0	0	0	0
Scophthalmus aquosus	0.003	<0.001	0	0.004	0	0	0	0
OTHERS	0.026	0.028	0.083	0.044	0	0.076	0.022	0.004
Mean Total Abundance	0.139	0.339	0.524	0.462	0.433	0.895	0.709	1.039
Number of taxa	28	17	11	20	4	11	9	4

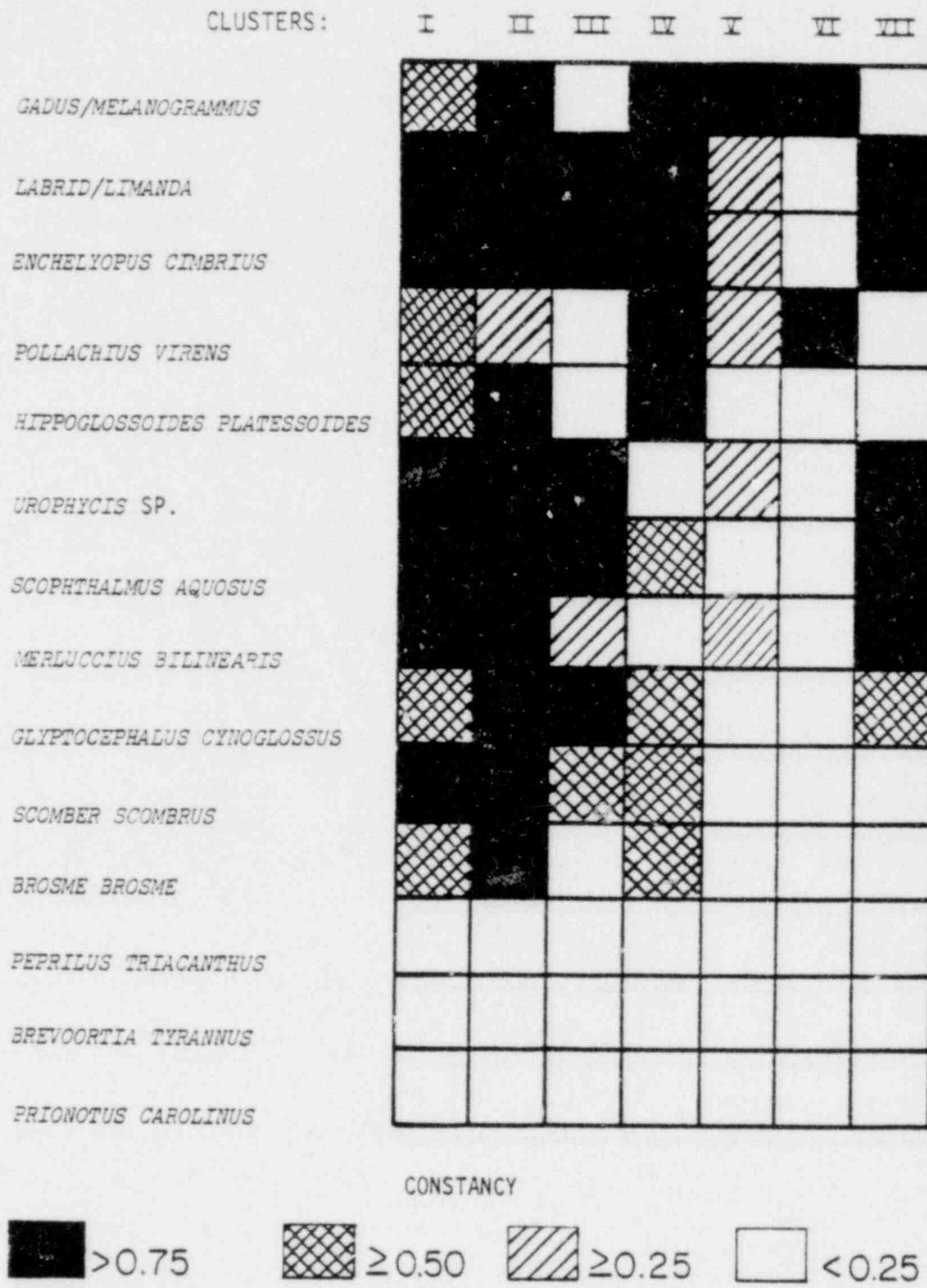
a = log (n+1) transformed; no./m^3.



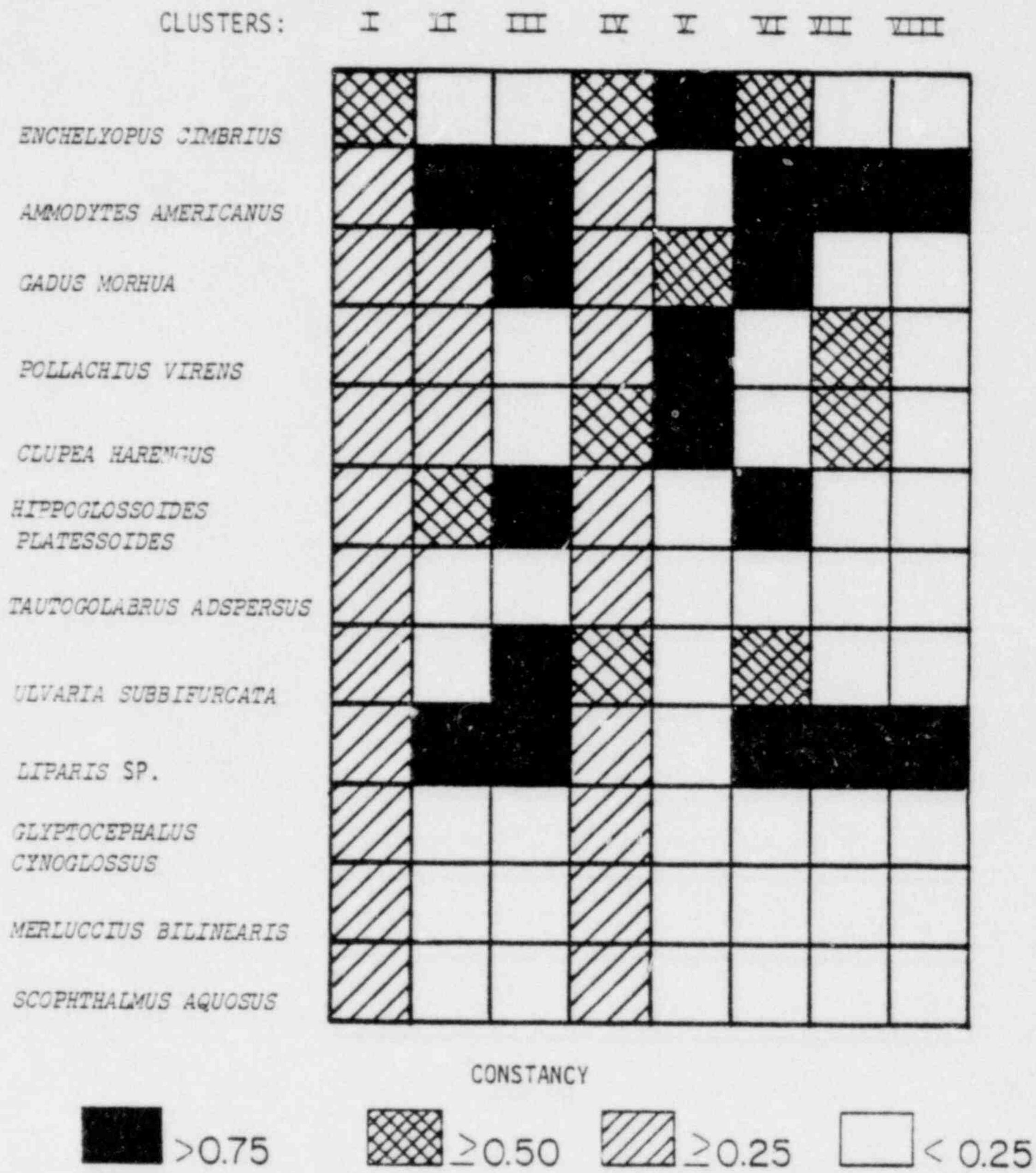
Appendix Figure 8.0-1. Dendrogram of transect associations for fish eggs, Hampton-Seabrook area, July 1975 through June 1977. Seabrook Finfish Studies, 1976-1977.



Appendix Figure 8.0-2. Dendrogram of transect associations for fish larvae, Hampton-Seabrook area, July 1975 through June 1977. Seabrook Finfish Studies, 1976-1977.



Appendix Figure 8.0-3. Nodal constancy in a table of fish egg species and transect-date clusters, Hampton-Seabrook area, 1975-1977. Seabrook Finfish Studies, 1976-1977.



Appendix Figure 8.0-4. Nodal constancy in a table of dominant fish larvae species and transect-date clusters, Hampton-Seabrook area, 1975-1977. Seabrook Finfish Studies, 1976-1977.