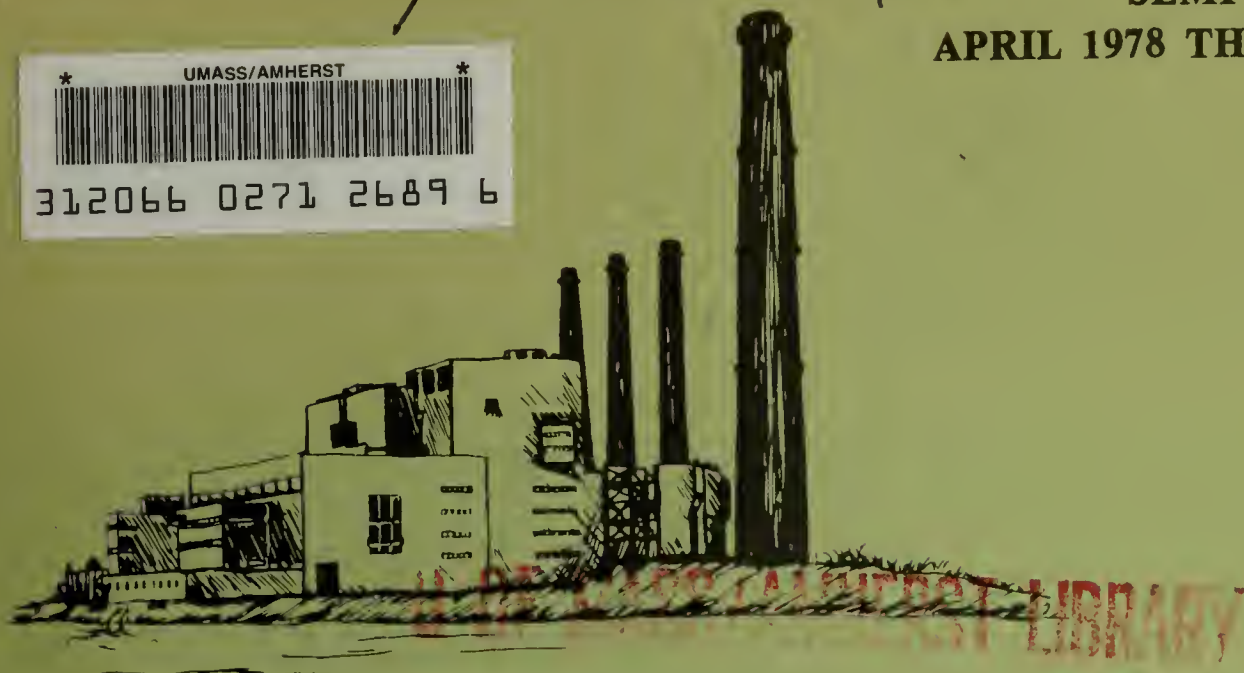
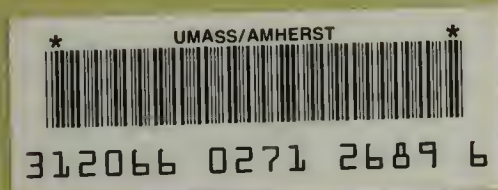


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APRIL 1978 THROUGH SEPTEMBER 1978



*INVESTIGATIONS OF THE EFFECTS OF
ELECTRICAL POWER GENERATION ON
MARINE RESOURCES IN SALEM HARBOR*

**Charles O. Anderson, Jr., David J. Brown, Elaine M. Elliott,
Doris Jimenez and Irene M. Kushlan**

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Approved by Alfred C. Holland
State Purchasing Agent

Division of Marine Fisheries
Department of Fisheries, Wildlife
and Recreational Vehicles
The Commonwealth of Massachusetts



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INTRODUCTION

The following is the third semi-annual report of research performed by the Massachusetts Division of Marine Fisheries under Contract DMF-2-72, Amendment No. 4. The report contains data gathered from April 1, 1978 through September 30, 1978, which are being collected to clarify certain portions of a comprehensive study to assess the effects of the operation of the Salem Harbor Electric Generating Station on the marine ecosystem of Salem Harbor (Anderson, *et al*, 1975). Data from this period have been compared to similar data collected from April 1, 1977 through September 30, 1977 (Anderson, *et al*, 1977) and, where applicable, to data from previous studies.

Laboratory analysis of all ichthyoplankton samples, collected from March 1975 through February 1977, has been completed. The data from these samples have been compiled and analyzed. The first draft of the report on ichthyoplankton studies has been completed and publication of the final results is expected within the next six months.

FINFISH INVESTIGATIONS

Introduction

To determine the effects of the addition of a fourth generating unit on the finfish populations in Salem Harbor, intensive field surveys, using various seines and trawls, were conducted from 1971 to 1974. Although no adverse effects were noted, unexplained fluctuations in the Shannon-Weaver index of diversity ($\bar{H}$) occurred (Anderson, *et al*, 1975). Therefore, it was recommended that the finfish studies be resumed to see if the fluctuations could be attributed to natural cycles or power plant operation.

Methods and Materials

Five stations inside Salem Harbor and one station outside Salem Harbor are sampled every two weeks (Figure 1). Replicate sets are conducted at each station.

Stations 11 and 13 are shore stations and are sampled using a haul seine measuring 120 ft x 8 ft with 1 1/2 in mesh wings and 3/4 in mesh bag. The net is paid off the stern of a twelve ft aluminum boat, and retrieved by haul lines approximately 75 ft in length.

A 30-ft shrimp trawl is used at two offshore stations in Salem Harbor, stations 12 and 14. The trawl measures 30 ft x 25 ft with 1 1/2 in mesh wings and 1 in mesh cod end. The cod end has an inner liner of 1/8 in mesh to retain smaller fish. The net is towed behind a twenty-ft McKee Craft powered by an 85 horsepower outboard motor. The trawl is towed at approximately two knots for five minutes.

A commercial 49 ft x 38 ft otter trawl having 5 in mesh wings and 4 in mesh cod end is towed at about two knots for twenty minutes. Two stations are sampled, Station 5 (a control station outside Salem Harbor) and Station 16 (inside Salem Harbor).

All finfish are sorted by species, measured for total length in millimeters, and enumerated. Any lobsters, incidental to the finfish catch, are sexed and their carapace length recorded in mm.

Since two sets are conducted at each station on any given sampling date, the second set may be biased. Consequently, analyses of catch per unit of effort (CPUE), $\bar{H}$, and number of species are based on the first set taken during each sampling period.

The Shannon-Weaver index of diversity is expressed by:

$$\bar{H} = -\sum \left(\frac{n_i}{N} \right) \log_e \left(\frac{n_i}{N} \right)$$

Where: n_i = total number of individuals of a particular species
N = total number of individuals of all species
 $\log_e$ = Napierian logarithms

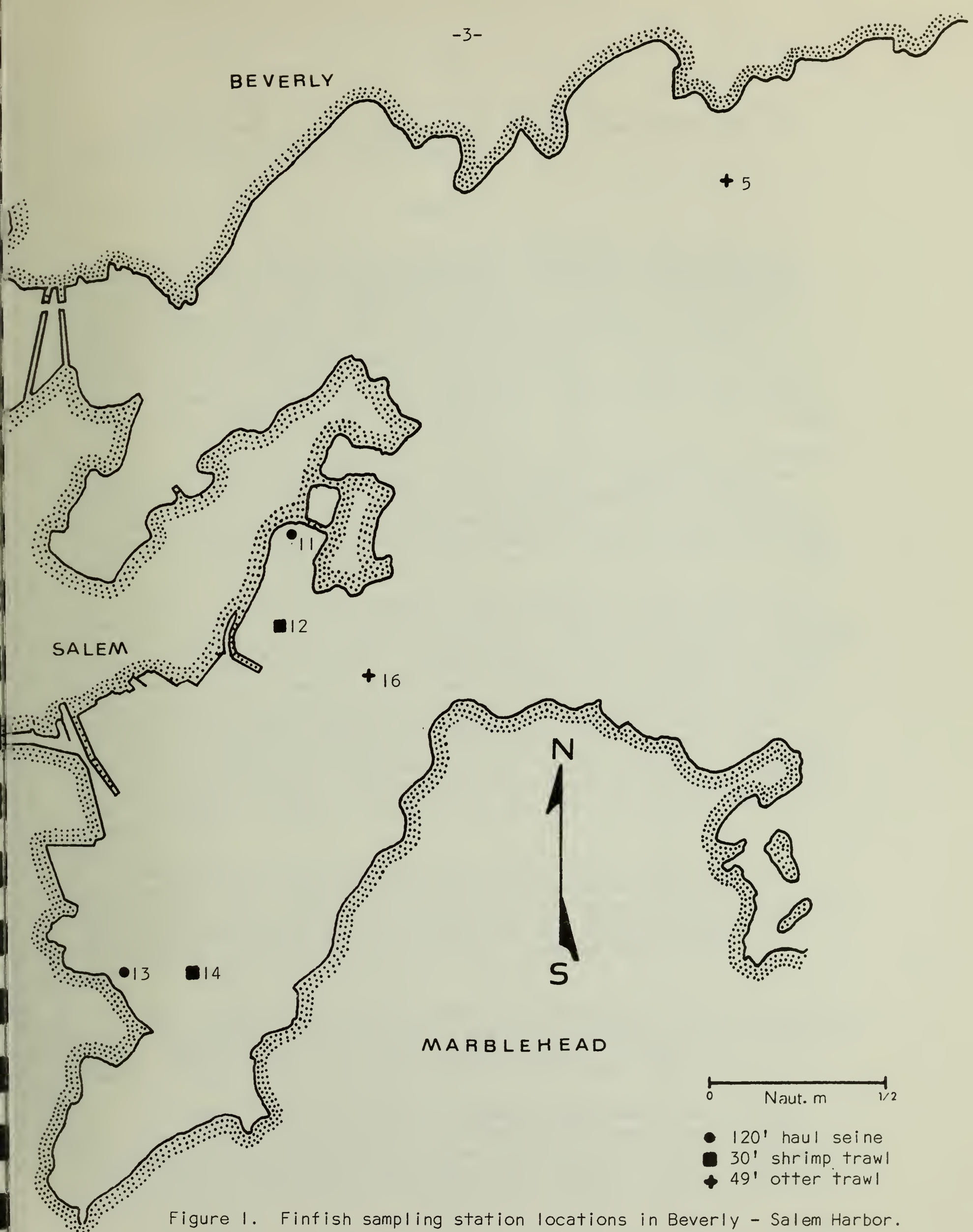
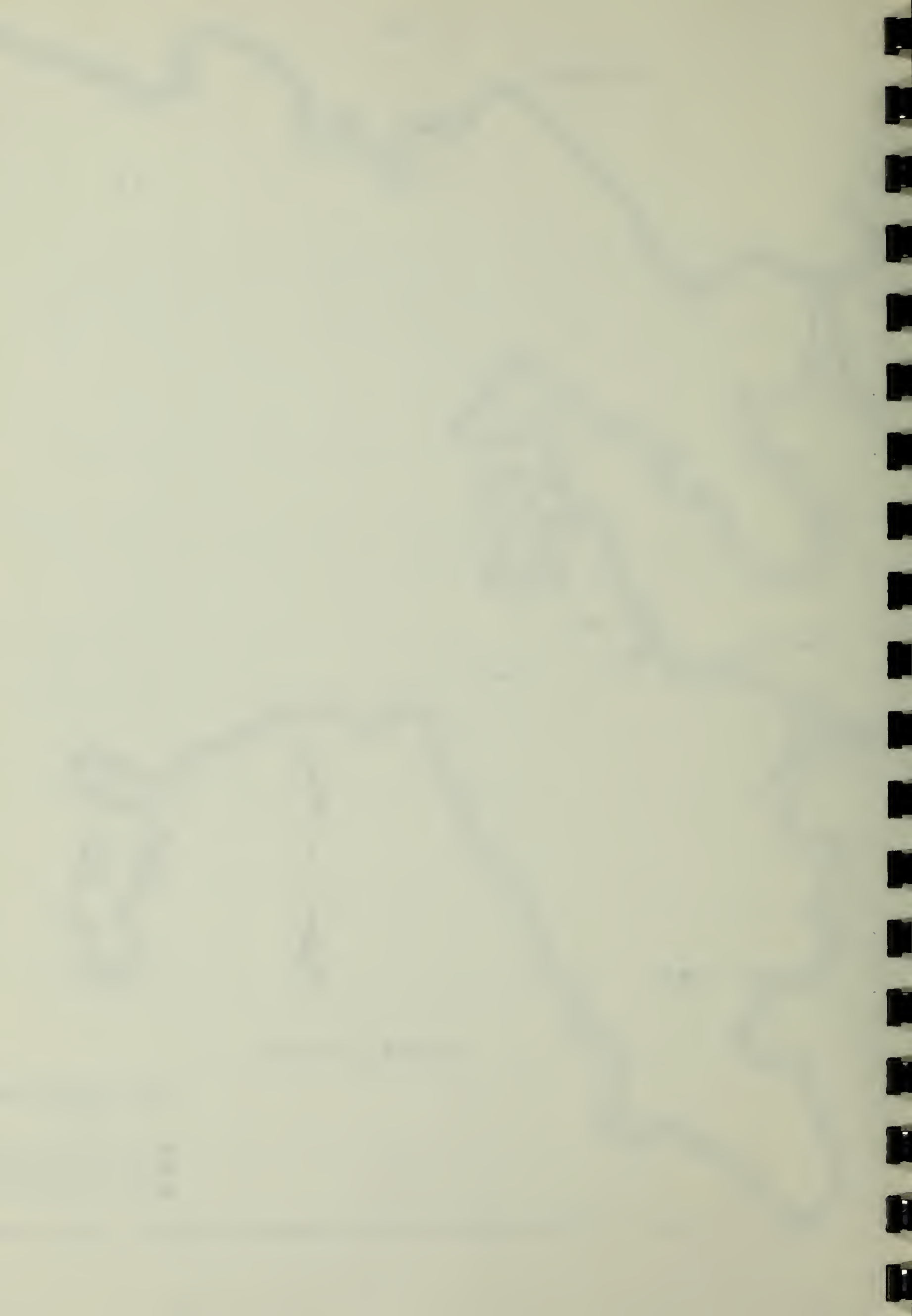


Figure 1. Finfish sampling station locations in Beverly - Salem Harbor.



Comparisons to finfish data reported in Semi-Annual Report No. 1B (Anderson, *et al*, 1977) are presented.

Results

A total of 4,866 finfish, representing twenty-six species and one genus, were taken at the five Salem Harbor stations during the sampling period (Table 1). This represents a decrease of 50% over that reported for the same time span in 1977. The primary cause may be a decrease in CPUE at the 30-ft shrimp trawl station at Pickering Point, Station 14 (Table 2). The 1977 CPUE was 417 but decreased to 145 during this reporting period. Another reason is the fact that in 1978, due to the unusually heavy concentration of lobster gear in Salem Harbor, the 49-ft otter trawl (Station 16) was only sampled once from June through September.

Four species comprised 78% of the total taken and included: Atlantic silverside, *Menidia menidia* (29%); winter flounder, *Pseudopleuronectes americanus* (26%); fourspine stickleback, *Apeltes quadracus* (14%); and threespine stickleback, *Gasterosteus aculeatus* (9%). These same species were also the four most abundant finfish taken in 1977; however, with the exception of the threespine stickleback, their numerical rank was different.

Table 3 presents total numbers, size ranges, and mean lengths for the more abundant finfish species according to method of capture. Stations 12 and 14, sampled with a 30-ft shrimp trawl, exhibited the highest diversity index. This was also true for the same period in 1977. Since the shrimp trawl has an inner liner of 1/8 in mesh, smaller finfish that would pass through the haul seine and otter trawl are captured, resulting in the retention of a greater number of finfish. This makes the trawl less selective in sampling existing finfish populations and renders it the most practical for applying the Shannon-Weaver diversity index (H). Almost 50% of the finfish collected in Salem Harbor were taken with the shrimp trawl, most at Station 14 (Table 4) where extensive beds of eelgrass, *Zostera marina*, exist.

The 120-ft haul seine netted 1,793 individuals or 37% of the total Salem Harbor catch. The Atlantic silverside dominated the catch, as it did in 1977, with 1,056 taken at Station 11 and 334 at Station 13 (Table 5). Other abundant species were: striped killifish, *Fundulus majalis*; blue-back herring, *Alosa aestivalis*; mummichog, *Fundulus heteroclitus*; and winter flounder.

Adult winter flounder were the most abundant species taken with the 49-ft otter trawl. Of 2,413 finfish sampled at Stations 5 and 16, 90% were winter flounder (Table 6). Due to the presence of lobster gear in the tow area, Station 16 was not sampled during the summer months.

The number of American lobster, *Homarus americanus*, taken at the four trawl stations in Beverly - Salem Harbors increased from 393 (April - September 1977) to 498 during this sampling period. As in 1977, approximately 80% were below the minimum legal size limit of 3 3/16 in carapace length.

Table 1. Numerical rank of all finfish collected in Salem Harbor by all gear types, April - September, 1978.

Species	Method of Capture			Totals
	120-ft Seine	30-ft Trawl	49-ft Trawl*	
1. Atlantic silverside	1,390	4		1,394
2. winter flounder	72	435	744	1,251
3. fourspine stickleback	1	669		670
4. threespine stickleback	3	452		455
5. Atlantic tomcod		168		168
ninespine stickleback		168		168
6. striped killifish	158			158
7. mummichog	87			87
8. Atlantic cod		84	2	86
9. <i>Urophycis</i> spp.	6	65		71
10. blueback herring	65			65
11. northern pipefish	2	54		56
12. rainbow smelt		52		52
13. <i>Raja</i> spp.		6	37	43
14. windowpane		7	26	33
15. lumpfish	1	18		19
16. pollock		15	2	17
17. American eel	1	14		15
grubby		15		15
18. white hake		14		14
19. alewife	2	4		6
Atlantic menhaden		6		6
cunner		6		6
20. Atlantic herring	4			4
21. yellowtail flounder			3	3
22. red hake		2		2
23. Atlantic mackerel	1			1
rock gunnel		1		1
Totals	1,793	2,259	814	4,866

*May and June

Table 2. Mean semi-annual values for catch per unit of effort (CPUE), Shannon-Weaver index of diversity ($\bar{H}$), and number of species of finfish at all stations in Salem Harbor, April - September, 1978.*

Date	No. of sets	Catch per unit of effort (CPUE)	$\bar{H}$ index	Number of species
<u>120' Haul Seine</u>				
(Station 11)				
April - June	6	34	0.020	4
July - September	7	50	0.581	9
(Station 13)				
April - June	6	2	0.116	5
July - September	7	62	0.316	5
<u>30' Shrimp Trawl</u>				
(Station 12)				
April - June	6	31	1.016	11
July - September	6	10	0.870	12
(Station 14)				
April - June	6	42	1.401	15
July - September	6	145	1.198	16
<u>49' Otter Trawl</u>				
(Station 16)				
May - June**	3	194	0.351	6

*Set 2 on each sampling data excluded

**Lobster gear prevented sampling July - September

Table 3. Total numbers, size ranges, and mean lengths for the more abundant finfish species collected, by method of capture, in Salem Harbor, April - September, 1978.

Species	Total Collected	Size Range (mm)	Mean Length (mm)
<u>120-FT HAUL SEINE</u>			
Station 11			
Atlantic silverside	1056	15-144	93
blueback herring	65	70- 94	83
Station 13			
Atlantic silverside	334	25-129	52
striped killifish	125	25- 94	65
mummichog	58	25- 94	49
winter flounder	50	30-229	91
<u>30-FT SHRIMP TRAWL</u>			
Station 12			
winter flounder	377	50-424	148
Atlantic cod	64	30- 89	59
rainbow smelt	47	45-149	84
threespine stickleback	45	20- 79	53
<i>Urophycis</i> spp.	44	50-144	75
Station 14			
fourspine stickleback	650	20- 64	46
threespine stickleback	407	20- 79	47
ninespine stickleback	167	25- 74	48
Atlantic tomcod	150	60-244	75
<u>49-FT OTTER TRAWL</u>			
Station 16			
winter flounder	744	75-449	299
<i>Raja</i> spp.	37	105-559	464
windowpane	26	235-339	289

Table 4. Total number of each finfish species collected during sampling at the 30-ft shrimp trawl stations, April - September, 1978.

Species	Station 12						Totals
	Apr (4)*	May (4)	Jun (4)	Jul (3)	Aug (3)	Sept (4)	
alewife				2			2
American eel				1	1		2
Atlantic cod	19	43	2				64
Atlantic silverside						1	1
Atlantic tomcod			15	1	1	1	18
cunner						4	4
fourspine stickleback			4			15	19
grubby			1			5	6
lumpfish			12	1		1	14
ninespine stickleback						1	1
northern pipefish		3				6	9
pollock			14				14
rainbow smelt		36	1	1	2	7	47
<i>Raja</i> spp.				2			2
red hake					2		2
rock gunnel						1	1
threespine stickleback		12	21			12	45
<i>Urophycis</i> spp.		4	40				44
white hake				7			7
windowpane		1			1	3	5
winter flounder	47	78	25	10	60	157	377
							684

Species	Station 14						Totals
	Apr (4)	May (4)	Jun (4)	Jul (4)	Aug (3)	Sept (4)	
alewife				2			2
American eel		2	5	2	3		12
Atlantic cod	8	12					20
Atlantic menhaden				6			6
Atlantic silverside						3	3
Atlantic tomcod		15	48	82	4	1	150
cunner	1					1	2
fourspine stickleback	13	22	78	331	64	142	650
grubby	3	4			1	1	9
lumpfish				1	1	2	4
ninespine stickleback			8	121	11	27	167
northern pipefish		6	2	7	7	23	45
pollock			1				1
rainbow smelt			2			3	5
<i>Raja</i> spp.		2	2				4
threespine stickleback	2	59	50	57	4	235	407
<i>Urophycis</i> spp.		12	6	3			21
white hake				5		2	7
windowpane		1	1				2
winter flounder	8	12	17	13		8	58
							1,575

*Number of sets shown in parenthesis

Table 5. Total number of each finfish species collected during sampling at the 120-ft haul seine stations, Salem Harbor, April - September, 1978.

<u>Station 11</u>							
<u>Species</u>	<u>Apr (4)*</u>	<u>May (4)</u>	<u>Jun (4)</u>	<u>Jul (4)</u>	<u>Aug (6)</u>	<u>Sept (4)</u>	<u>Totals</u>
alewife		2					2
Atlantic herring			2		1		3
Atlantic mackerel					1		1
Atlantic silverside		418	198	397	34	9	1,056
blueback herring					64	1	65
lumpfish						1	1
mummichog			2	12		15	29
northern pipefish			1				1
striped killifish				24		9	33
threespine stickleback					2		2
<i>Urophycis</i> spp.			5	1			6
winter flounder				3	13	6	22
							<u>1,221</u>
<u>Station 13</u>							
<u>Species</u>	<u>Apr (4)</u>	<u>May (4)</u>	<u>Jun (4)</u>	<u>Jul (4)</u>	<u>Aug (6)</u>	<u>Sept (4)</u>	<u>Totals</u>
American eel				1			1
Atlantic herring				1			1
Atlantic silverside	14			2	317	1	334
fourspine stickleback			1				1
mummichog	1				45	12	58
northern pipefish			1				1
striped killifish					35	90	125
threespine stickleback			1				1
winter flounder	3	7		24	13	3	50
							<u>572</u>

*Number of sets shown in parenthesis

Table 6. Total number of each finfish species collected during sampling at the 49-ft otter trawl stations, Beverly - Salem Harbor, May - September, 1978.

<u>Station 5</u>						
<u>Species</u>	<u>May (3)*</u>	<u>Jun (1)</u>	<u>Jul (6)</u>	<u>Aug (4)</u>	<u>Sept (4)</u>	<u>Totals</u>
Atlantic cod	4		3			7
Atlantic mackerel			1		1	2
blueback herring					1	1
ocean pout	2					2
pollock		1	2	2		5
<i>Raja</i> spp.	1		1	2	3	7
red hake					1	1
sea raven		1	1	2	1	5
silver hake		1	2	2		5
windowpane	5	9	32	20	31	97
winter flounder	100	149	460	316	401	1,426
yellowtail flounder	7	2	29	2	1	41
						<u>1,599</u>
<u>Station 16</u>						
<u>Species</u>	<u>May (4)</u>	<u>Jun (1)[†]</u>	<u>Jul</u>	<u>Aug</u>	<u>Sept</u>	<u>Totals</u>
Atlantic cod	2					2
pollock		2		NOT SAMPLED		2
<i>Raja</i> spp.	29	8				37
windowpane	19	7		DUE TO		26
winter flounder	534	210				744
yellowtail flounder	3			LOBSTER GEAR		<u>3</u>
						814

*Number of sets shown in parenthesis

[†]Tow duration was 15 minutes

FINFISH IMPINGEMENT STUDIES

To more accurately predict yearly finfish impingement on the traveling screens at the Salem Harbor Electric Generating Station, weekly 24-hour impingement studies have been conducted since April 1977. Data collected for this semi-annual period (April 1978 - September 1978) are presented and are compared to that collected during the same period in 1977.

Methods and Materials

To collect the fish samples, two traps, constructed of welded steel rods and lined with 1/4-inch mesh galvanized screen, are placed in the screen wash water sluiceway at each unit and are tended while the screens are being rotated. All fish taken are identified, enumerated and measured for total length in mm. Mortality of each is determined by the absence of opercular beats.

The traveling screens at Units 3 and 4 are rotated for approximately 30 minutes at 8:00 A.M., 4:00 P.M. and 12:00 midnight of the first day of a sampling period and at 8:00 A.M. on the second day. Project personnel remain on call at the laboratory for the full 24-hour period in the event that a storm or a buildup of debris on the screens necessitates the operation of the screens at unscheduled times. Data collected from 8:00 A.M. to 8:30 A.M. on the first day are not used, so the sampling period actually runs from 8:30 A.M. on the first sampling day to 8:30 A.M. on the second day.

Results

The Unit 3 traveling screens were monitored for twenty-one 24-hour periods from April through September, 1978. Unit 3 was not operable from April 13 through May 5 due to mechanical problems. Twenty-seven species and two genera were taken. A total of 442 fish, of which 366 were dead, were impinged during the sampling periods. Winter flounder, *Urophycis* spp., Atlantic herring, windowpane and Atlantic menhaden were the most abundant species (Table 7). It is projected that 3,444 fish were impinged during the six-month period (Table 8). Of these, 1,890 would have been dead. For the similar time period in 1977 an estimated 3,423 fish were impinged, of which 2,562 would have been dead (Anderson, *et al*, 1977).

Because Unit 4 was shut down for annual maintenance from the first of April through mid-May, only seventeen 24-hour studies were conducted from April through September 1978. Twenty-three species, three genera, and one family were identified (Table 9). Of the 312 fish impinged during sampling,

Table 7. Numbers of finfish taken during weekly continuous 24-hour sampling at the Unit 3 sluiceway, April 1978 - September 1978.*

Species	4/6-4/7	4/13-4/14	4/20-4/21	4/27-4/28	5/4-5/5	5/11-5/12	5/18-5/19	5/25-5/26	6/1-6/2
winter flounder	6					3	2		1 (1)
<i>Raja</i> spp.	1				1	3 (1)	1		
windowpane	1					1			4 (3)
Atlantic menhaden	1 (1)					7 (6)			2 (2)
fourspine stickleback	1						1		
northern pipefish					3	3			1
red hake					1				
Atlantic cod						5 (4)			
<i>Urophycis</i> spp.						1 (1)			1 (1)
rainbow smelt						1 (1)			
threespine stickleback	1						1 (1)		
Atlantic herring								1 (1)	
silver hake								1 (1)	
mummichog									
Atlantic tomcod									
cunner									
alewife									
butterfish									
striped anchovy									
lumpfish									
spiny dogfish									
white hake									
bluefish									
blueback herring									
ninespine stickleback									
Atlantic mackerel									
lookdown									
grubby									
searobin									

Table 7. Continued

Species	6/8-6/9	6/15-6/16	6/22-6/23	6/29-6/30	7/6-7/7	7/13-7/14	7/20-7/21	7/27-7/28	8/3-8/4
winter flounder		3	3 (1)		2 (1)	10 (4)	14 (4)	16 (5)	
<i>Raja</i> spp.	1	1					1 (1)	3	
windowpane	2		1				2		
Atlantic menhaden		1							
fourspine stickleback		2			2 (1)	1 (1)	1	1 (1)	
northern pipefish									
red hake									
Atlantic cod									
<i>Urophycis</i> spp.		3 (1)	9 (8)		3 (3)	31 (29)	3 (2)	3 (2)	
rainbow smelt	4 (3)		1 (1)						
threespine stickleback	1 (1)	1	1				1 (1)		
Atlantic herring	7 (7)		1				11 (11)		
silver hake		2	1 (1)			1 (1)			
mummichog			2 (2)						
Atlantic tomcod			5 (5)		5 (5)		1 (1)		
cunner			1					1 (1)	
alewife			1 (1)						
butterfish									
striped anchovy					3 (2)	1 (1)	3 (3)		
lumpfish						1			
spiny dogfish									
white hake							1 (1)		
bluefish							2 (2)		
blueback herring							1 (1)		
ninespine stickleback									
Atlantic mackerel									
lookdown									
grubby									
searobin									

No sampling conducted

No sampling conducted

Table 7. Continued

Species	8/10-8/11	8/17-8/18	8/24-8/25	8/31-9/1	9/7-9/8	9/14-9/15	9/21-9/22	9/28-9/29
winter flounder	33 (14)	4 (2)	20 (5)	20 (4)	13 (5)	19 (4)	3 (2)	28 (21)
<i>Raja</i> spp.					2			
windowpane			1 (1)	8 (6)	1	3 (3)		1
Atlantic menhaden								
fourspine stickleback	1 (1)							
northern pipefish						1 (1)		
red hake								
Atlantic cod								
<i>Urophycis</i> spp.	5 (2)	1 (1)						14 (12)
rainbow smelt					1 (1)			1 (1)
threespine stickleback								
Atlantic herring								
silver hake								
mummichog								
Atlantic tomcod								
cunner	1 (1)							5 (1)
alewife			1 (1)		1 (1)			1 (1)
butterfish				1 (1)				
striped anchovy			2 (1)	2 (2)				
lumpfish								
spiny dogfish								
white hake	1 (1)		1 (1)					
bluefish	1							
blueback herring			1 (1)				1 (1)	
ninespine stickleback				1				
Atlantic mackerel				1 (1)			1 (1)	
lookdown					1 (1)			
grubby						1		1 (1)
searobin						1 (1)		

*Number of dead fish shown in parenthesis

280 were dead. Winter flounder, *Urophycis* spp., Atlantic herring, and northern pipefish were the most abundant species taken. Impingement estimation for the entire sampling period was 2,562 fish, of which 2,287 would have been killed (Table 10). Projections for the similar period in 1977 were considerably higher: 4,074 fish impinged and 3,829 killed (Anderson, *et al*, *op. cit.*).

Table 8. Rank of abundance, total number, mortality and projected six-month impingement and mortality for finfish taken during continuous 24-hour monitoring at Unit 3 sluiceway, April - September, 1978.

Rank	Species	Number of fish taken during sampling*		Projected six-month impingement*	
1.	winter flounder	200	(73)	1,533	(553)
2.	<i>Urophycis</i> spp.	78	(66)	630	(532)
3.	Atlantic herring	20	(19)	147	(133)
4.	windowpane	18	(7)	133	(49)
	Atlantic menhaden	18	(15)	126	(105)
5.	<i>Raja</i> spp.	15	(2)	119	(14)
6.	northern pipefish	14	(2)	105	(14)
7.	Atlantic tomcod	11	(11)	112	(112)
8.	cunner	8	(3)	70	(28)
9.	butterfish	7	(6)	49	(42)
10.	silver hake	6	(4)	49	(35)
	red hake	6	(5)	49	(42)
11.	rainbow smelt	5	(5)	42	(42)
	threespine stickleback	5	(2)	42	(14)
12.	alewife	4	(4)	35	(35)
	white hake	4	(4)	28	(28)
13.	striped anchovy	3	(3)	21	(21)
	lumpfish	3	(1)	21	(7)
	fourspine stickleback	3		21	
14.	mummichog	2	(2)	28	(28)
	bluefish	2	(1)	14	(7)
	blueback herring	2	(2)	14	(14)
	Atlantic mackerel	2	(2)	14	(14)
15.	Atlantic cod	1		7	
	spiny dogfish	1	(1)	7	(7)
	ninespine stickleback	1		7	
	lookdown	1	(1)	7	(7)
	searobin	1	(1)	7	(7)
	grubby	1		7	
Totals		442	(242)	3,444	(1,890)

*Number of dead fish shown in parenthesis

Table 9. Numbers of finfish taken during weekly continuous 24-hour sampling at the Unit 4 sluiceway, April 1978 - September 1978.*

Species	4/6-5/12	5/18-5/19	5/25-5/26	6/1-6/2	6/8-6/9	6/15-6/16	6/22-6/23
Atlantic menhaden		6 (6)	4 (4)		1 (1)	1 (1)	19 (19)
<i>Urophycis</i> spp.		1 (1)			1 (1)		1 (1)
northern pipefish		1 (1)	4 (4)		3 (3)		
windowpane			1 (1)		1		2 (2)
Atlantic silverside			1 (1)			10 (10)	10 (9)
Atlantic herring			1 (1)			1 (1)	6 (2)
winter flounder					4 (4)		
threespine stickleback					3 (3)		
unidentifiable					1 (1)		
blueback herring					2 (2)		
<i>Raja</i> spp.							
Atlantic tomcod					1 (1)		3 (3)
pollock					1		1 (1)
silver hake							1
Atlantic cod							
cunner							
butterfish							
lumpfish							
striped anchovy							
rainbow smelt							
Clupeid							
white hake							
grubby							
American eel							
red hake							
alewife							
<i>Cananx</i> spp.							
searobin							

Screens not operating

Unit 4 shut down--annual maintenance

Table 9. Continued

Species	6/29-6/30	7/6-7/7	7/13-7/14	7/20-7/21	7/27-7/28	8/3-8/4	8/10-8/11**
Atlantic menhaden		3 (3)	23 (23)	10 (10)			2 (2)
<i>Urophycis</i> spp.			2	1 (1)	1		1 (1)
northern pipefish			2 (2)	1 (1)			2 (2)
winduppane							
Atlantic silverside		8 (8)		4 (4)			
Atlantic herring			4 (4)	1 (1)	4 (4)		6 (6)
winter flounder			1 (1)	1 (1)	1 (1)		
threespine stickleback							
unidentifiable							
blueback herring							
<i>Raja</i> spp.							
Atlantic tomcod			2 (2)	1 (1)	1 (1)		
pollock							
silver hake		1 (1)	1				
Atlantic cod		1 (1)					
cunner			2 (2)		1 (1)		
butterfish			2 (2)		2 (2)		
lumpfish			1 (1)				
striped anchovy			1 (1)				
rainbow smelt				2 (2)			
Clupeid				1 (1)			
white hake				2 (2)			
grubby				1 (1)			3 (3)
American eel					1 (1)		
red hake							7 (7)
alewife							1 (1)
<i>Cananx</i> spp.							
searobin							

Sampling not conducted

Sampling not conducted

Table 9. Continued

Species	8/17-8/18	8/24-8/25	8/31-9/1	9/7-9/8	9/14-9/15	9/21-9/22	9/28-9/29
Atlantic menhaden			3 (2)			1 (1)	
<i>Urophycis</i> spp.	2 (2)						
northern pipefish	1	1		2 (2)	2 (2)	1	2
windowpane		1 (1)			1 (1)		
Atlantic silverside							
Atlantic herring				2 (2)		4 (4)	
winter flounder	5 (3)			11 (8)	8 (7)	8 (7)	15 (11)
threespine stickleback							
unidentifiable							
blueback herring	2 (2)				2 (2)	2 (2)	
<i>Raja</i> spp.			1				
Atlantic tomcod							1 (1)
pollock							
silver hake							
Atlantic cod	4 (4)						
cunner							
butterfish							
lumpfish							1
striped anchovy				1 (1)		1 (1)	
rainbow smelt						3 (3)	
Clupeid							
white hake	1 (1)						
grubby	2 (2)			1 (1)			3 (3)
American eel	1 (1)				1 (1)		
red hake	2 (2)						
alewife				1 (1)	1 (1)		2 (2)
<i>Cananx</i> spp.				2 (1)			
searobin					1 (1)	1 (1)	

*Number of dead fish shown in parenthesis

**Traps removed by Power Company personnel during sampling period

Table 10. Rank of abundance, total number, mortality and projected six-month impingement and mortality for finfish taken during continuous 24-hour monitoring at Unit 4 sluiceway, April - September, 1978.

Rank	Species	Number of fish taken during sampling*		Projected six-month impingement*	
1.	winter flounder	72	(57)	574	(441)
2.	<i>Urophycis</i> spp.	62	(62)	567	(567)
3.	Atlantic herring	42	(41)	364	(350)
4.	northern pipefish	24	(16)	182	(119)
5.	Atlantic menhaden	14	(13)	98	(91)
6.	grubby	11	(11)	77	(77)
7.	windowpane	9	(8)	63	(54)
	red hake	9	(9)	63	(63)
	Atlantic tomcod	9	(9)	91	(91)
8.	cunner	8	(8)	63	(63)
9.	blueback herring	7	(7)	49	(49)
10.	rainbow smelt	5	(5)	35	(35)
	alewife	5	(5)	35	(35)
11.	threespine stickleback	4	(4)	35	(35)
	butterfish	4	(4)	42	(42)
12.	Atlantic silverside	3	(3)	35	(35)
	striped anchovy	3	(3)	21	(21)
	white hake	3	(3)	21	(21)
	American eel	3	(3)	28	(28)
13.	unidentifiable	2	(2)	14	(14)
	silver hake	2		21	
	lumpfish	2	(1)	14	(7)
	<i>Cananx</i> spp.	2	(1)	14	(7)
	searobin	2	(2)	14	(14)
	<i>Raja</i> spp.	2		14	
14.	pollock	1	(1)	14	(14)
	Atlantic cod	1	(1)	7	(7)
	Clupeid	1	(1)	7	(7)
Totals		312	(280)	2,562	(2,287)

*Number of dead fish shown in parenthesis

EELGRASS BED STUDY

Introduction

An eelgrass monitoring program commenced in September, 1977 at shrimp trawl stations 12 (Cat Cove) and 14 (Pickering Point). This vascular plant is important to harbor ecology and provides a nursery area for many finfish and shellfish. Alterations in these beds may affect the resident populations of aquatic animals. This study will document seasonal variations in the extent and development of the two beds to be used as future baseline information.

Methods and Materials

Qualitative eelgrass samples were obtained on June 21 and September 20, 1978 at Cat Cove and Pickering Point with a quahog bull rake fitted with a 20 ft. telescopic handle. The presence or absence of eelgrass was noted at four different sites along each trawl transect (Figure 2).

Results

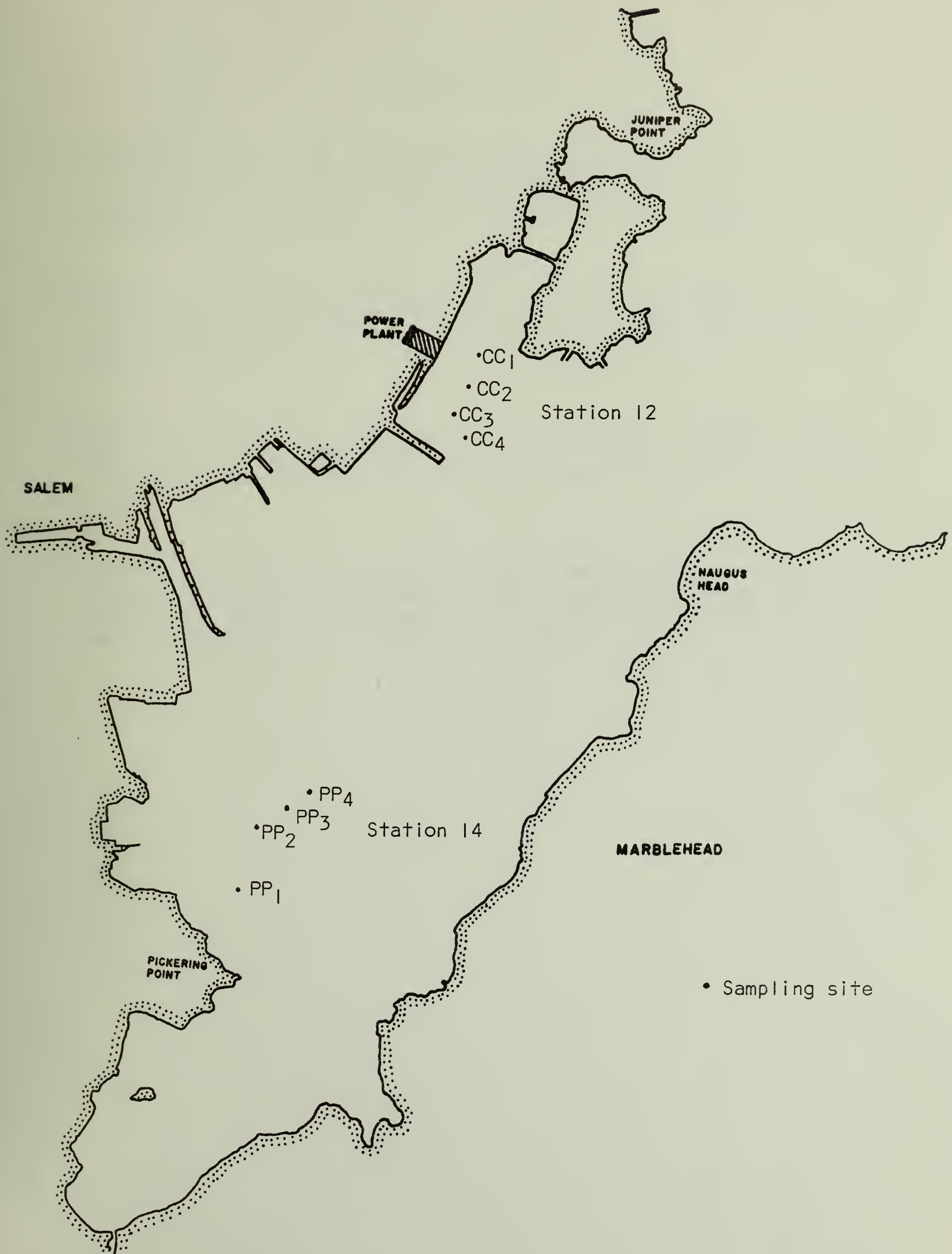
Sampling on a quarterly basis began in September, 1977 (Anderson, *et al*, 1977; Anderson, *et al*, 1978). We observed seasonal variations from autumnal decay through reestablishment of vegetative growth in March, 1978. The continued growth of this plant, as evidenced by the presence of seeds, was apparent in the June samples.

At Pickering Point, overall abundance at each site was reduced from March to June. In June viable eelgrass was found only at PP₄. By September, eelgrass was found at the outer stations (PP₃ and PP₄) and approximately 50% consisted of decaying blades.

Interspersed with the eelgrass were large quantities of *Ulva*. Burkholder and Doheny (1968) state that this alga is often present among clumps of eelgrass.

The bed at Cat Cove continued to be smaller than at Pickering Point. Specimens were found at CC₂ and CC₃ in June and at CC₁, CC₂ and CC₃ in September. The June samples were mature, containing seeds. By September, 50% of the vegetation at CC₁ was dead, while at CC₂ and CC₃ all plants were green.

Figure 2. Station and sampling site locations for eel grass bed surveys in Salem Harbor.



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