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

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INTRODUCTION

This report completes one year of investigation by Division of Marine Fisheries personnel operating under contract Project DMF-2-72 with the New England Power Company. Included are data collected from 1 July through 30 September 1972.

Sampling procedures outlined in Research Proposal Exhibit A, and described in the subsequent Appendix, have opened new frontiers of exploration for project personnel. Difficulties have been encountered. Delivery of continuous recording thermographs were delayed; current meters have not been received; and only limited thermal bioassays on finfish have been conducted due to a series of malfunctions in our laboratory salt water circulating system.

As we enter our second year of investigation, we will broaden our outlook for data in the areas of additional benthic monitoring sites; C₁₄ testing; assessment of sampling gear related mortality; adverse effects of velocity upon certain finfish species; and finfish tagging studies.

ACKNOWLEDGEMENTS

Appreciation is expressed to Mrs. Betsy Brown for preparation of graphics, and to Mrs. Mary Ann Gachignard for typing this report.

PHYSICAL INVESTIGATIONS

Temperature Monitoring

Temperature profiles of the water column were monitored throughout one tidal cycle along parallel transects located 10, 50, 100 and 300 ft east of unit intakes. Average surface water temperatures varied from 0.2 to 1.3 °F depending upon tidal stage; and variations of 0.3 to 0.5 °F were noted between surface and bottom depths along each transect.

Horizontal and vertical temperature and salinity data, collected June 27 in the discharge canal, indicates intrusion of colder harbor water to a point approximately 600 ft from the power plant (Table 1). This cold water wedge along the canal bottom is pronounced from two hours before to two hours after maximum flood. Surface temperatures varied no greater than $\pm \frac{1}{2}$ °C along the length of the canal; and salinity remained relatively constant throughout the water column, 29.3 to 30.2 ‰. Units 1 - 3 maintained an average total output of 282 MW while circulating 183,500 gpm of cooling water during the seven hour sampling period.

Temperature and salinity data was collected for 24 hours from three levels (surface, mid-depth, and bottom) at Stations A through D on July 17 and 18 (Table 2). Units 1 - 3 maintained 288 MW/HR operation during the study period. Ranges and mean surface water temperatures (°C) for the respective stations were: 17.8 (15.9 - 21.6), 19.5 (16.5 - 23.5), 17.5 (16.2 - 18.9), and 17.1 (16.1 - 18.2). Corresponding bottom temperatures were:

Table 1. Temperature and salinity data collected in the power plant discharge canal, Salem Harbor, June 27, 1972.

		Tidal Stage: Low + 2 hrs. Time (EST): 0745					
Temp °C	S		23.8	23.9	23.9	23.9	23.4
	M		23.7	23.8	24.0	23.6	23.4
	B	22.6	23.7	23.8	23.8	23.6	23.4
Salinity 0/00	S		29.4	29.5	29.6	29.3	29.3
	M		29.4	29.4	29.6	29.5	29.4
	B	29.4	29.5	29.5	29.7	29.4	29.5
		Tidal Stage: High Time (EST): 1145					
Temp °C	S	22.1	22.4	22.5	22.4	22.3	22.7
	M	21.3	21.8	21.7	22.2	22.1	22.5
	B	13.6	14.4	13.9	18.8	14.5	22.5
Salinity 0/00	S	29.6	29.5	29.6	29.4	29.5	29.4
	M	29.7	29.8	29.9	29.6	29.8	30.0
	B	29.5	29.6	29.5	29.6	29.3	30.0
		Tidal Stage: High + 2 hrs. Time (EST): 1345					
Temp °C	S	21.5	21.5	21.5	21.5	21.4	21.4
	M	19.7	21.6	21.3	21.5	21.5	21.2
	B	13.9	20.6	13.2	21.5	21.3	21.2
Salinity 0/00	S	29.9	29.9	29.7	29.7	30.0	29.9
	M	30.0	29.8	29.7	29.7	29.6	29.4
	B	29.9	29.9	30.2	29.7	29.6	29.7
		10	9	8	7	6	5
		Distance from Power Plant (hundreds of feet)					

Table 2. Temperature and salinity data collected
in Salem Harbor, July 17 - 18, 1972.

		<u>Station A</u>					
Temp °C	S	19.1	17.9	17.7	17.3	16.9	16.9
	M	11.5	13.0	16.3	16.9	16.2	16.9
	B	9.7	9.9	12.1	16.6	15.2	15.5
Salinity 0/00	S	30.4	30.0	31.4	30.4	30.1	30.4
	M	30.4	30.3	29.9	30.4	30.3	30.6
	B	30.6	30.4	29.9	30.5	30.3	30.2
E.S.T.		1800	1900	2000	2100	2200	2300
		low					
Temp °C	S	17.3	17.1	17.2	16.2	15.9	16.0
	M	17.0	17.1	16.6	15.4	12.6	11.7
	B	14.9	15.5	14.9	13.3	12.1	10.1
Salinity 0/00	S	30.3	30.2	30.1	30.2	30.1	30.1
	M	30.5	30.4	30.4	30.3	30.4	30.5
	B	30.5	30.3	30.2	30.3	30.6	30.5
E.S.T.		2400	0100	0200	0300	0400	0500
		high					
Temp °C	S	*	*	17.8	16.7	18.2	18.0
	M			15.1	16.5	17.7	17.0
	B			10.5	14.0	14.2	16.1
Salinity 0/00	S			30.8	30.2	30.2	30.2
	M			30.4	30.1	30.2	30.2
	B			30.7	30.0	30.2	31.0
E.S.T.		0600	0700	0800	0900	1000	1100
		low					
Temp °C	S	18.3	18.4	18.9	18.9	19.3	21.6
	M	18.2	18.4	18.7	18.2	12.2	16.7
	B	16.1	16.5	17.5	12.9	12.0	10.3
Salinity 0/00	S	30.1	30.1	29.9	30.0	30.0	30.1
	M	30.2	30.2	30.0	30.2	30.3	30.3
	B	30.5	30.3	30.0	30.7	30.0	30.0
E.S.T.		1200	1300	1400	1500	1600	1700
		high					

Table 2. Continued

		Station B					
Temp °C	S	17.1	18.6	19.6	19.8	17.0	16.5
	M	8.8	9.0	9.0	9.2	8.7	8.9
	B	8.6	8.6	8.6	9.5	8.5	9.5
Salinity 0/00	S	30.4	30.4	30.4	30.0	30.1	30.4
	M	30.4	30.8	30.5	30.4	30.3	30.6
	B	30.6	30.0	30.3	30.2	30.6	30.2
E.S.T.		1800	1900	2000	2100	2200	2300
		low					
Temp °C	S	19.7	20.1	20.4	18.9	17.4	16.6
	M	8.7	9.5	10.2	9.4	9.5	9.3
	B	9.0	8.8	8.8	8.6	8.6	8.5
Salinity 0/00	S	30.1	30.3	30.1	30.2	30.3	30.4
	M	30.6	30.5	30.6	30.4	30.3	30.7
	B	30.5	30.6	30.4	30.6	30.5	30.6
E.S.T.		2400	0100	0200	0300	0400	0500
		high					
Temp °C	S	*	*	19.7	18.5	20.0	22.4
	M			8.9	8.6	8.9	8.4
	B			8.4	8.4	8.6	8.4
Salinity 0/00	S			30.3	30.3	30.4	30.5
	M			30.7	30.5	30.6	30.3
	B			30.5	30.3	30.4	30.3
E.S.T.		0600	0700	0800	0900	1000	1100
		low					
Temp °C	S	21.3	23.5	23.4	22.2	20.0	17.0
	M	8.6	8.5	9.2	9.7	10.9	9.4
	B	8.3	8.3	8.2	8.0	8.2	8.1
Salinity 0/00	S	30.2	30.6	30.0	30.3	30.1	30.2
	M	30.3	30.5	30.2	30.1	30.0	30.3
	B	30.3	30.6	30.2	30.5	30.1	30.5
E.S.T.		1200	1300	1400	1500	1600	1700
		high					

Table 2. Continued

		Station C					
Temp °C	S	17.1	17.0	17.2	17.7	17.7	16.8
	M	12.7	13.3	14.4	15.9	14.3	14.1
	B	9.6	10.1	10.2	10.5	10.8	11.3
Salinity 0/00	S	30.1	30.1	30.3	30.4	30.2	30.2
	M	30.5	30.3	30.4	30.5	30.4	30.4
	B	30.6	30.6	30.8	30.5	30.3	30.1
E.S.T.		1800	1900	2000	2100	2200	2300
		low					
Temp °C	S	17.3	17.5	17.0	16.2	16.4	*
	M	11.7	11.4	12.0	11.5	11.6	
	B	9.6	10.3	10.0	9.3	9.3	
Salinity 0/00	S	30.3	30.3	30.4	30.2	30.1	
	M	30.4	30.5	30.6	30.6	30.5	
	B	30.7	30.4	30.4	30.6	30.5	
E.S.T.		2400	0100	0200	0300	0400	0500
		high					
Temp °C	S	16.6	*	17.1	18.7	18.1	18.6
	M	14.2		15.5	15.5	16.7	15.8
	B	9.5		10.8	10.9	13.2	13.0
Salinity 0/00	S	30.2		30.3	29.8	30.4	30.3
	M	30.4		30.3	30.0	30.0	30.5
	B	30.5		30.3	30.1	29.8	30.5
E.S.T.		0600	0700	0800	0900	1000	1100
		low					
Temp °C	S	18.8	18.9	18.0	18.1	17.2	17.5
	M	15.0	13.8	14.4	12.9	12.6	13.1
	B	10.6	9.1	9.6	9.4	9.0	9.6
Salinity 0/00	S	29.9	30.0	30.1	30.3	30.1	30.2
	M	30.0	30.2	28.7	30.4	30.4	30.6
	B	30.0	30.2	30.3	30.6	30.6	30.6
E.S.T.		1200	1300	1400	1500	1600	1700
		high					

Table 2. Continued

		Station D					
Temp °C	S	16.8	16.8	17.0	16.6	16.7	16.4
	M	9.2	9.3	9.0	8.9	12.5	11.6
	B	7.9	8.0	8.0	8.4	8.8	8.6
Salinity 0/00	S	30.1	30.0	30.1	30.1	30.2	30.2
	M	30.7	30.5	30.8	30.5	30.5	30.6
	B	30.6	30.7	30.7	30.5	30.8	30.7
E.S.T.		1800	1900	2000	2100	2200	2300
		low					
Temp °C	S	16.5	16.9	16.5	16.1	*	*
	M	12.1	10.7	9.6	9.0		
	B	9.0	8.4	8.0	7.8		
Salinity 0/00	S	30.1	30.1	30.1	30.1		
	M	30.6	30.6	30.7	30.8		
	B	30.5	30.7	30.6	30.7		
E.S.T.		2400	0100	0200	0300	0400	0500
		high					
Temp °C	S	*	*	17.5	16.4	17.6	18.1
	M			9.9	8.9	8.8	8.9
	B			8.0	7.8	8.8	7.8
Salinity 0/00	S			30.1	30.2	30.2	30.2
	M			30.4	30.8	30.1	30.4
	B			30.5	30.6	30.2	30.4
E.S.T.		0600	0700	0800	0900	1000	1100
		low					
Temp °C	S	17.7	18.2	17.7	18.0	17.7	17.2
	M	11.4	10.5	9.6	18.0	8.5	8.4
	B	8.0	7.9	7.6	7.8	7.6	7.8
Salinity 0/00	S	30.0	30.2	30.0	30.1	30.0	30.0
	M	30.2	30.3	30.5	30.5	30.3	30.5
	B	30.2	30.7	30.4	30.5	30.4	30.5
E.S.T.		1200	1300	1400	1500	1600	1700
		high					

* No data collected

13.6 (9.7 - 17.5), 8.6 (8.0 - 9.5), 10.3 (9.1 - 13.2), and 8.1 (7.6 - 9.0).

Thermoclines were prevalent at the deep water stations (B and D) which exhibited colder and more stable bottom temperatures. Thermal effluent noticeably increased surface temperatures at the discharge, averaging 2.0 °C over the estimated 17.5 °C ambient. Maximum rise (5.1 °C) between surface intake (18.4 °C) and surface discharge (23.5 °C) was noted at 1300 E.S.T. However, actual surface discharge rose 7.0 °C over intake (bottom, 16.5 °C) water (Figures 1 through 4).

Reverse temperature conditions existed at approximately high tide (1800 and 1700 E.S.T.) on July 17 and 18, respectively. Surface water temperatures at Station B were 17.1 and 17.0 °C, 2.0 and 4.6 °C less than surface temperatures at Station A. Thermocline conditions also existed at Station A in conjunction with these contrasting values, which meant that intake cooling water was drafted at temperatures ranging from 9.7 to 16.7 °C.

Discharged thermal effluent appears to dissipate readily in Salem Harbor as evidenced by increased subsurface temperatures at Station C from high to low tide, a condition indicating mixing with surface water.

Salinity did not vary significantly throughout the study.

Bathythermograph (BT) casts were conducted September 6 along 3 transects, concurrently with IRT flights over Salem Harbor (Figure 5). Recorded surface temperatures along the 1,000 ft B transect varied from 19.0 to 17.5 °C (low +4 hrs) to 25.0 to 18.5 °C (high +4 hrs). Thermoclines were found at all tidal stages

Figure 1.

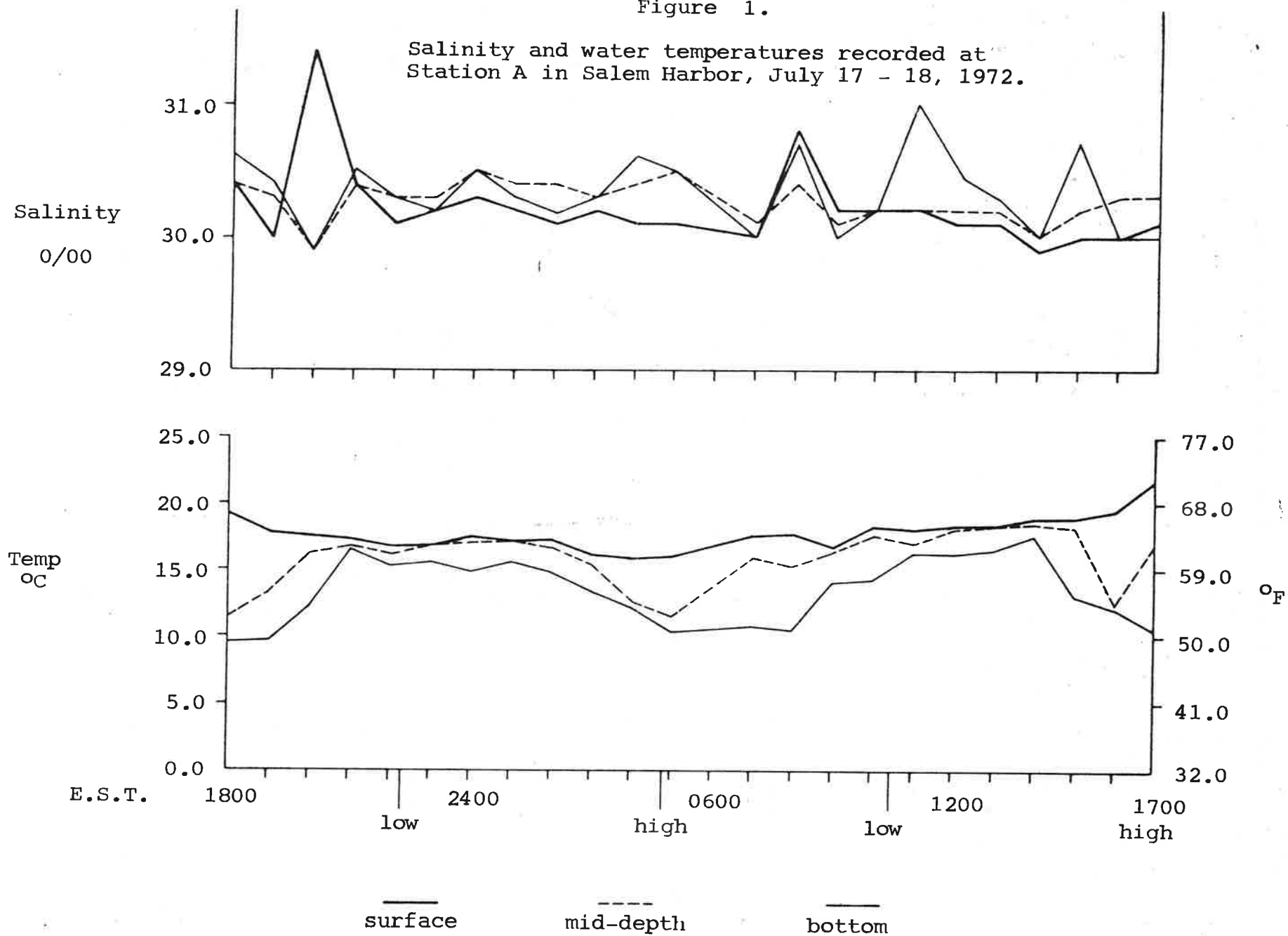


Figure 2.

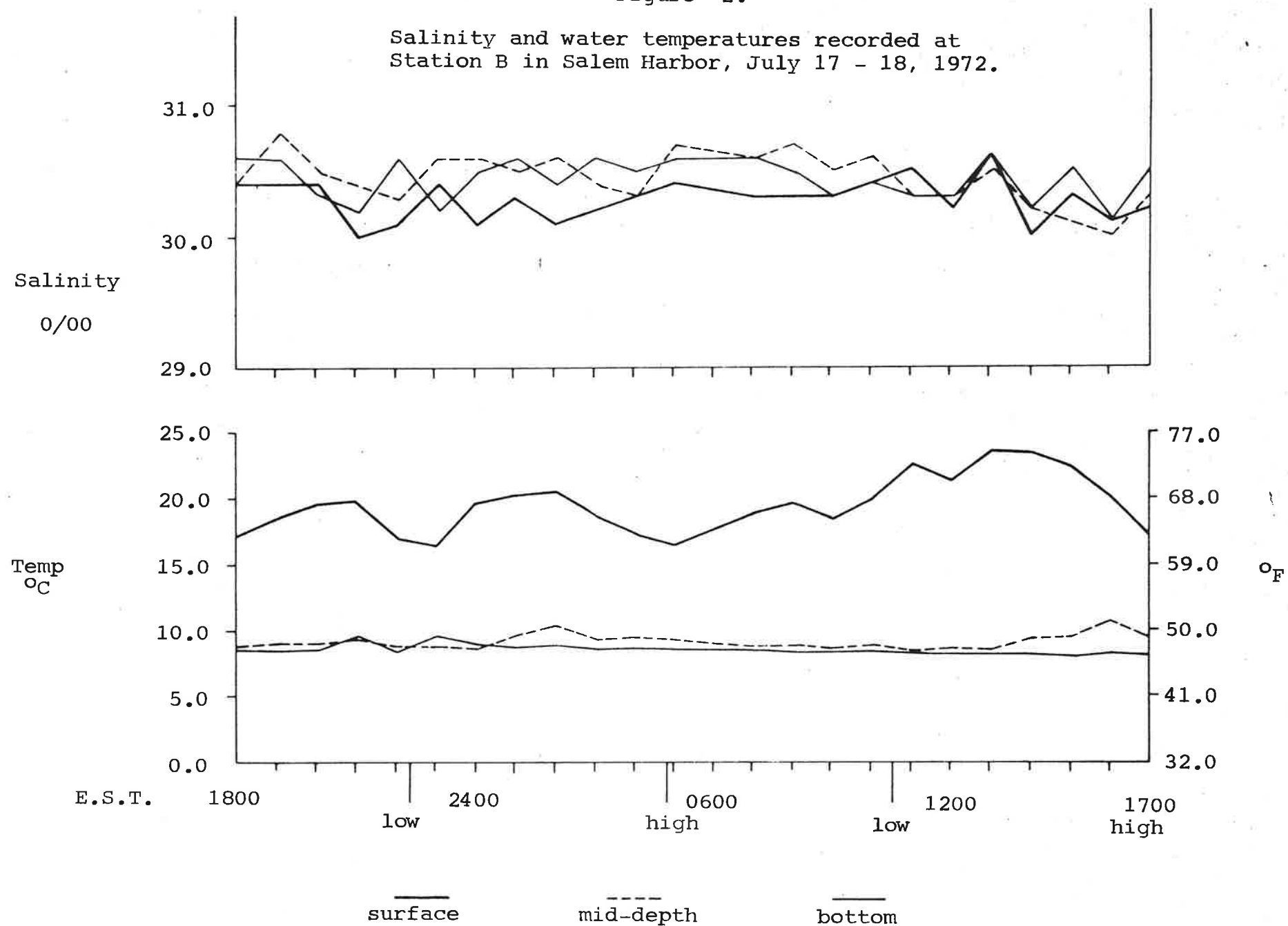


Figure 3.

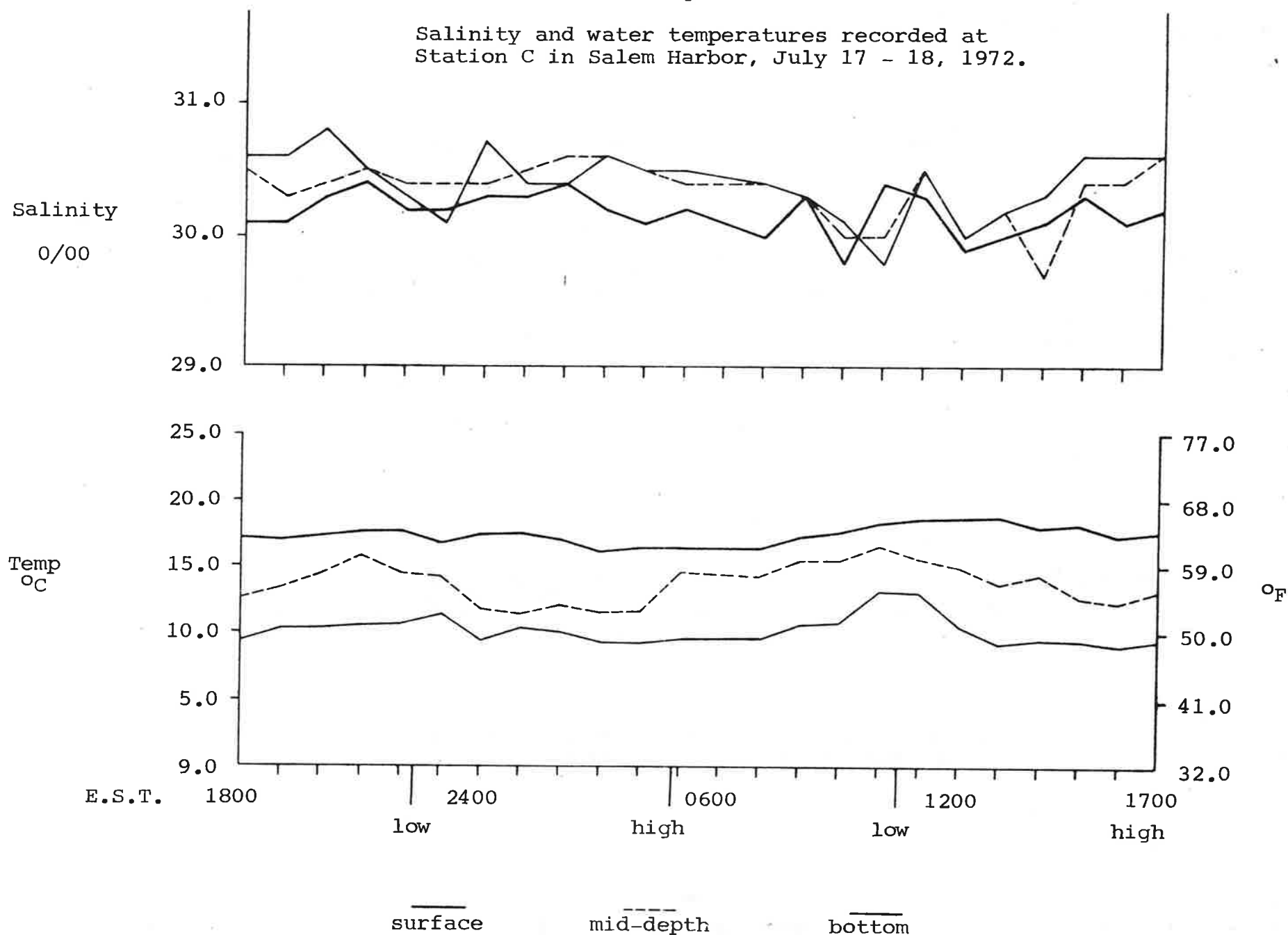


Figure 4.

Salinity and water temperatures recorded at
Station D in Salem Harbor, July 17 - 18, 1972.

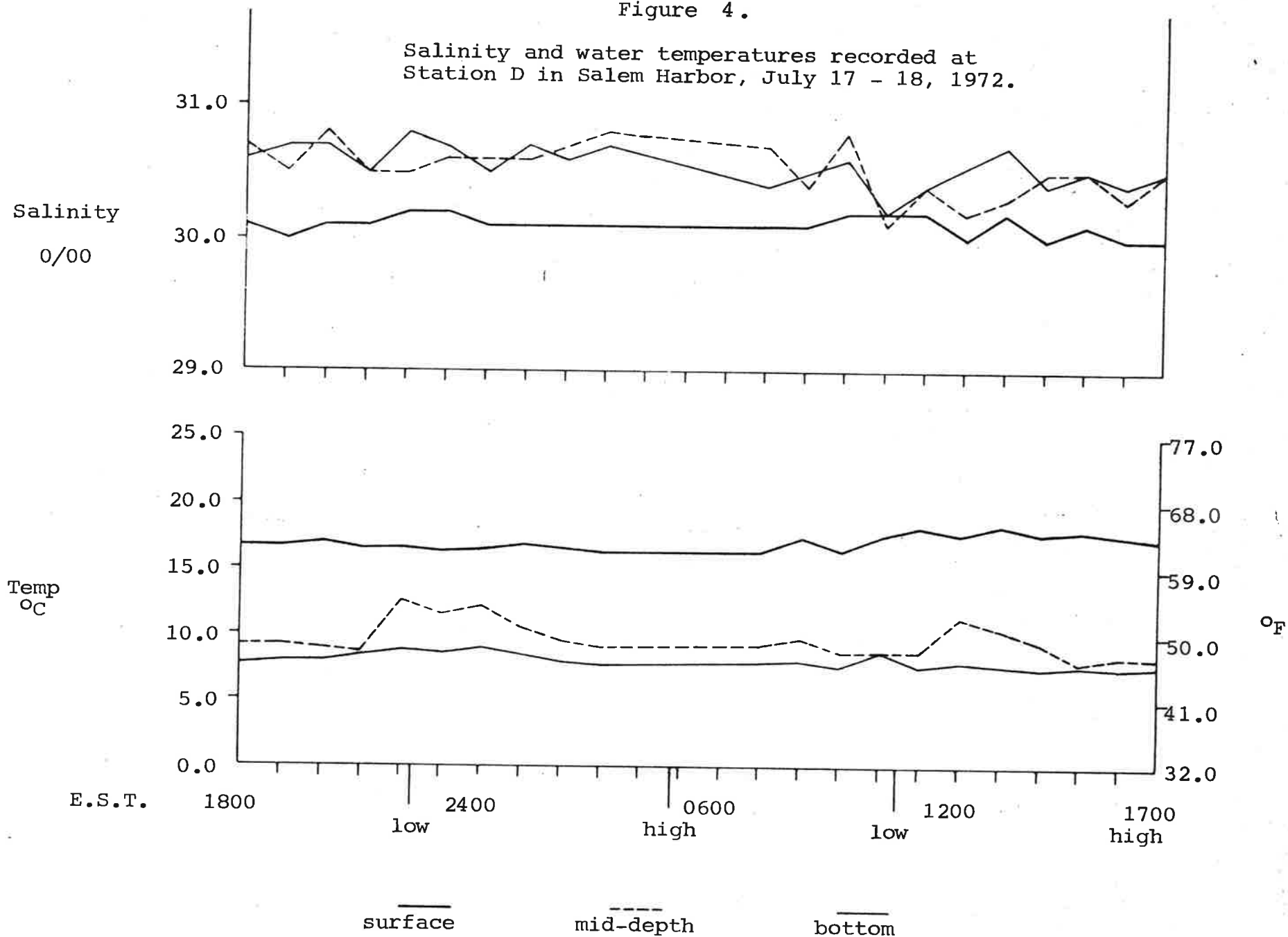
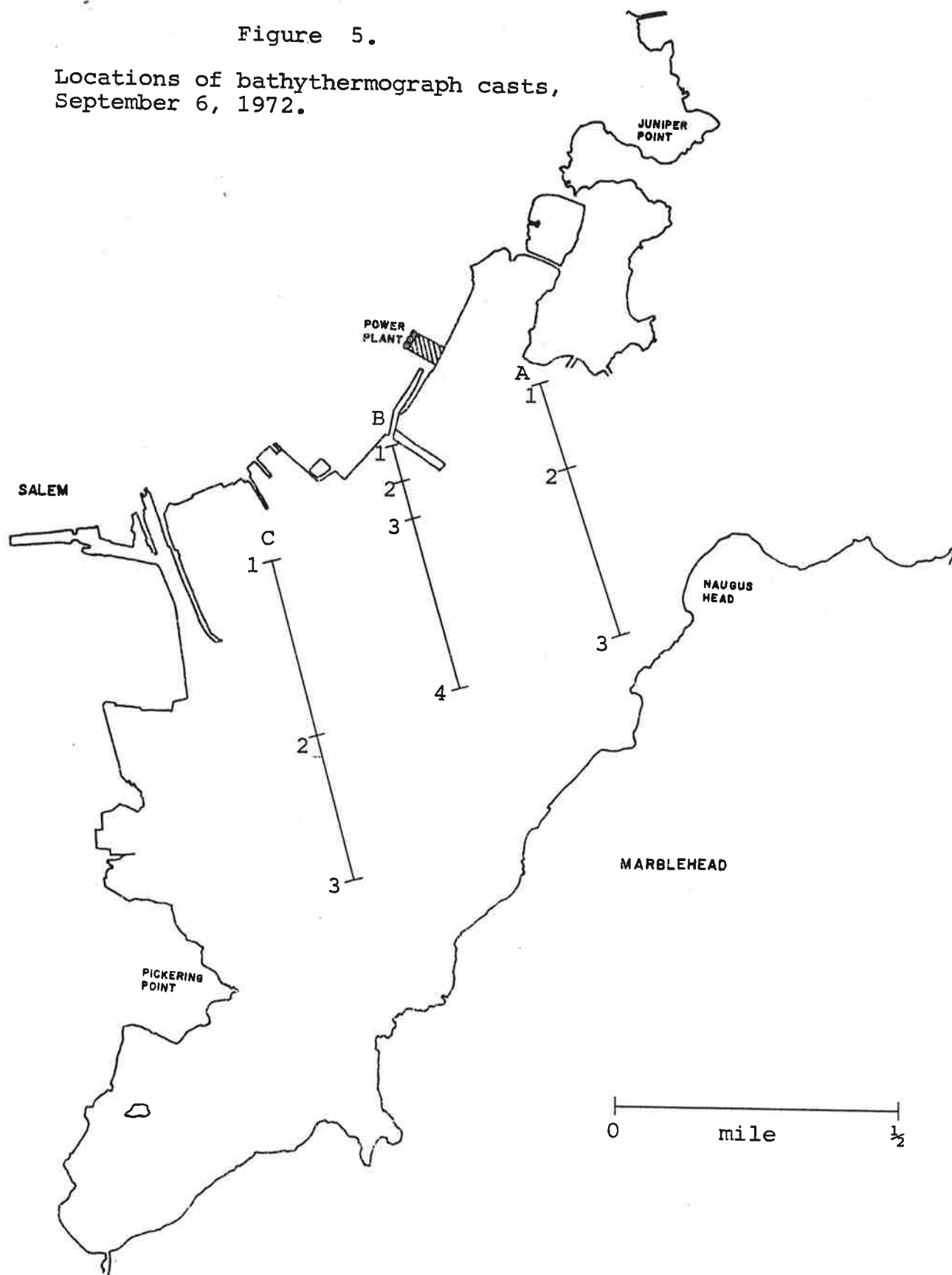


Figure 5.

Locations of bathythermograph casts,
September 6, 1972.



at Stations B-1 and B-2.

BT casts continue monthly at all offshore finfish sampling stations.

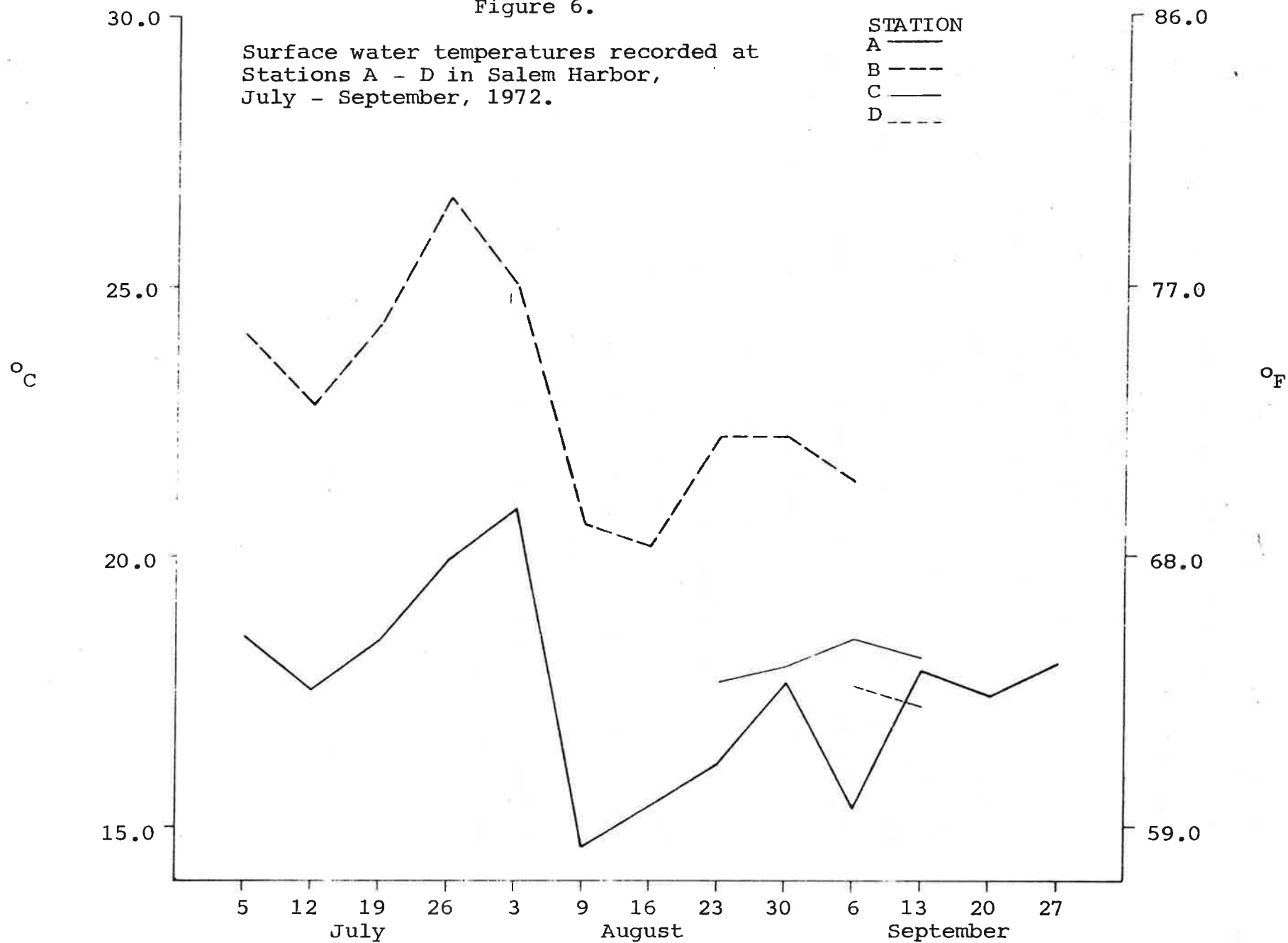
Continuous recording thermographs, installed near Stations C and D on 16 and 29 August respectively, were removed September 28. Malfunctions in both instruments precluded complete data, and required their return to the manufacturer. Average daily readings, approximately 3 ft below the surface, ranged from 15.0 to 21.5 °C at Station C and from 15.5 to 20.0 °C at Station D. Surface water temperatures recorded at Stations A through D are plotted in Figure 6. Average surface water temperatures for the quarter rose 6° to 18 °C. (18-10°C)

Project personnel accompanied survey crews on a one-day cruise aboard the NOAA oceanographic vessel FERREL observing deployment of recording instruments in outer Beverly Harbor. Upon completion of mapping operations along the North Shore, invaluable data will be available on tides, currents and water temperatures for this area.

Figure 6.

Surface water temperatures recorded at
Stations A - D in Salem Harbor,
July - September, 1972.

STATION
A ———
B - - -
C ———
D - - -



CHEMICAL INVESTIGATIONS

Water Quality

Water quality data collected at Stations 1 - 18 (Figures 7 and 8) reflected the following ranges: surface water temperature, 15.0 - 25.0 °C; surface salinity, 20.0 - 30.5 0/00; pH, 8.0; carbon dioxide, 5.0 - 10.0 ppm; and dissolved oxygen, 7.1 - 9.8 ppm (Table 3).

Ranges for parameters sampled at Stations A - D were: surface water temperature, 11.5 - 23.0 °C; surface salinity, 29.6 - 31.4 0/00; pH, 8.0; carbon dioxide, 5.0 - 10.0 ppm; dissolved oxygen, 7.0 - 9.6 ppm; and biological oxygen demand, 1.0 - 3.3 ppm (Table 4).

Except for higher surface water temperatures, and slightly lower dissolved oxygen values, water quality data throughout the study area varied little from last quarter.

The following corrections should be noted for Station D water temperatures recorded from April 5 through June 28 (page 13, Progress Report No. 3): 5.5, 6.5, 7.0, 7.5, 9.5, 8.0, 11.5, 12.0, 11.0, 11.5, 13.5, 14.5 and 18.5.

Heavy Metal Analyses

Monthly analyses for copper in the marine environment continues. Concentrations in soft shell clams, Mya arenaria and American lobsters, Homarus americanus, varied from 3.0 - 12.6 ppm and 14.3 - 52.4 ppm respectively. Detected concentrations in soft shell clams remain below the proposed F.D.A. "alert level" of 25.0 ppm (Table 5).

Figure 7.

Locations of water quality and finfish sampling stations outside Salem Harbor.

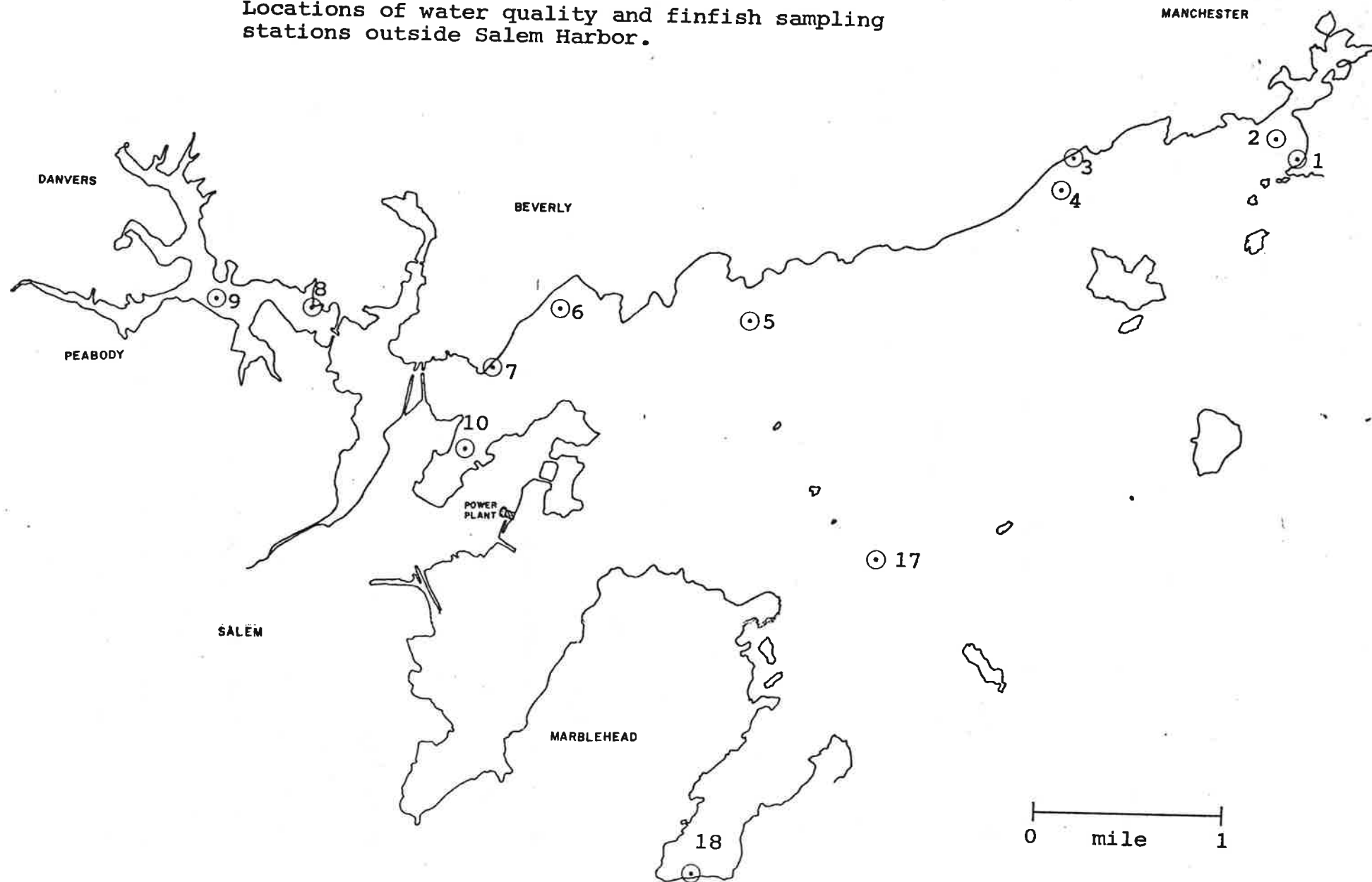


Figure 8.

Locations of water quality and finfish sampling stations in Salem Harbor.

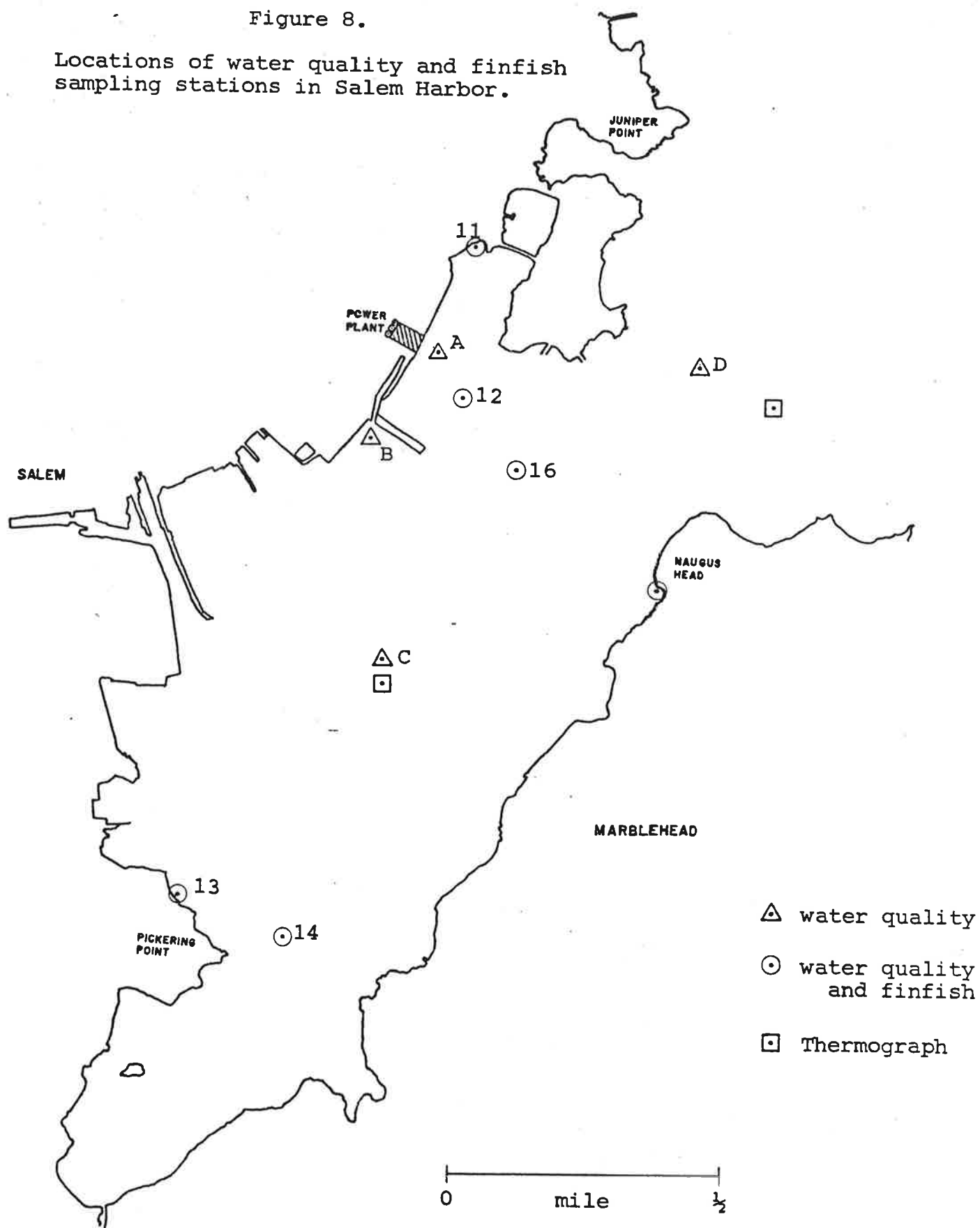


Table 3. Water quality data for Beverly - Salem Harbor, July - September, 1972.

DATE	SAMPLE NUMBER	TIME (EST)	TIDAL STAGE (HOURS)	WIND DIR/VEL (MPH)	CLOUD COVER (%)	DEPTH	TEMP °C		SALINITY (0/00)	pH	CO ₂ (ppm)	O ₂ (ppm)
							AIR	WATER				
<u>Station 1</u>												
7/25	000490	1045	high + ½	0	90	S	28.0	21.0	27.0	8.0	5.0	8.1
8/8	000510	1030	high	S/6	30	S	25.0	22.0	25.0	8.0	5.0	8.4
9/22	000569	0820	high +1½	0	80	S	19.0	15.5	25.5	8.0	5.0	8.0
<u>Station 2</u>												
7/10	000467	1130	high +1	SW/12	90	S	20.5	18.5	28.0	8.0	5.0	9.4
8/9	000519	1235	high +1½		50	S	22.5	15.0	30.0	8.0	5.0	8.8
9/7	000552	1135	high + ½		0	S	17.0	17.0	28.0	8.0	5.0	9.7
<u>Station 3</u>												
7/20	000465	0615	high	0	100	S	20.0	18.0	29.5	8.0	5.0	9.5
7/25	000489	1010	low +5½	0	80	S	29.0	22.0	28.0	8.0	5.0	8.4
8/7	000503	0815	low +5	0	100	S	20.0	18.0	28.5	8.0	5.0	7.9
8/8	000511	0920	low +5½	S/8	10	S	23.5	19.5	28.5	8.0	5.0	8.0
9/20	000561	0855	high + ½	0	100	S	13.0	15.0	30.0	8.0	5.0	8.5
9/22	000568	0800	low +4½	0	80	S	16.5	15.5	28.5	8.0	5.0	8.2
<u>Station 4</u>												
7/10	000466			S/15		S	19.5	18.5				
8/9	000520	1330	high +2½		80	S	20.0	16.5	30.0	8.0	5.0	8.6
9/7	000551	1210	high +1½	0	0	S	20.0	17.5	29.0	8.0	5.0	8.9
<u>Station 5</u>												
7/21	000472	0730	high	S/10	100	S	18.0	17.0	29.5	8.0	5.0	8.8
8/15	000526	0850	low	NE/15	20	S	12.0	15.0	20.0	8.0	10.0	
9/7	000555	0900	low +3½	0	0	S	19.0		29.0	8.0	5.0	7.5

Table 3. Continued

DATE	SAMPLE NUMBER	TIME (EST)	TIDAL STAGE (HOURS)	WIND DIR/VEL (MPH)	CLOUD COVER (%)	DEPTH	TEMP °C		SALINITY (0/00)	pH	CO ₂ (ppm)	O ₂ (ppm)
							AIR	WATER				
Station 6												
7/11	000474	1200	high + ½	SW/6	70	S			28.5	8.0	5.0	8.6
8/9	000521	1410	high +3	S/10	90	S	20.0	16.0		8.0	5.0	8.1
9/7	000550	1250	high +2	0	0	S	19.0	18.0	29.0	8.0	5.0	7.8
Station 7												
7/25	000491	1140	high +1	NE/6	50	S	25.0	25.0	28.0	8.0	5.0	8.2
8/8	000509	1140	high +1½	S/8	40	S	24.0	15.0	30.5	8.0	5.0	8.5
9/22	000570	0915	high +1	0	70	S	20.0	16.0	29.0	8.0	5.0	7.8
Station 8												
7/22	000481	1045	high +4	0	10	S	19.0	18.5	27.0	8.0	5.0	9.8
7/25	000494	1345	high +3½	NE/8	100	S	22.5	21.5	26.5	8.0	5.0	8.3
8/7	000506	0930	high	0	100	S	19.5	19.0	28.0	8.0	5.0	7.6
9/20	000566	0950	high +1	0	100	S	14.0	16.0	28.0	8.0	5.0	7.1
9/22	000571	0935	high + ½		60	S	18.5	16.0	28.0	8.0	5.0	7.5
Station 9												
7/10	000469	0930	low +5	0	80	S	23.0	18.0	28.0	8.0	5.0	7.7
8/9	000517	1500	high +4		100	S	22.0	18.0	27.5	8.0	5.0	7.2
9/7	000549	1320	high +2½	0	10	S	21.0	18.5	26.5	8.0	5.0	7.1
Station 10												
7/10	000468	1030	high	S/15	60	S	23.5	19.0	29.0	8.0	5.0	8.5
8/9	000518	1140	high + ½		90	S	22.0	17.5	29.0	8.0	5.0	7.7
9/7	000553	1040	high	0	0	S	24.0	18.0	29.0	8.0	5.0	7.4

Table 3. Continued

DATE	SAMPLE NUMBER	TIME (EST)	TIDAL STAGE (HOURS)	WIND DIR/VEL (MPH)	CLOUD COVER (%)	DEPTH	TEMP °C AIR WATER	SALINITY (0/00)	pH	CO ₂ (ppm)	O ₂ (ppm)
<u>Station 11</u>											
7/20	000479	0815	high +2	0	100	S	18.5 20.0	28.0	8.0	5.0	7.3 97
7/25	000492	1215	high +2	0	80	S	25.0 22.5	27.5	8.0	5.0	9.1 135
8/7	000505	1120	high +2	SW/6	100	S	21.5 20.5	28.5	8.0	5.0	7.3 99
8/10	000514	1320	high +1½	0	10	S	22.0 15.0	30.0	8.0	10.0	8.6 100
9/20	000567	1120	high +3	0	100	S	14.5 17.0	28.5	8.0	5.0	7.9 100
9/22	000572	1015	high		40	S	26.0 18.0	28.0	8.0	10.0	8.4 108
<u>Station 12</u>											
7/10	000470	0815	low +4	SW/8	100	S	19.0 18.5	28.5	8.0	5.0	8.9 114
8/9	000516	1020	low +5½		10	S	23.0 15.5	30.5	8.0	5.0	8.4 101
9/7	000554	0950	low +4	0	0	S	19.5 20.0	30.0	8.0	5.0	7.8 10
<u>Station 13</u>											
7/20	000480	0915	high +3	NE/6	10	S	18.5 21.0	27.5	8.0	5.0	7.7 103
7/25	000487	0815	low +4	0	100	S	27.0 21.0	28.0	8.0	5.0	8.7 116
8/7	000504	1230	high +3	0	100	S	26.0 17.5	29.0	8.0	5.0	8.1 92
8/10	000513	1520	high +3½		30	S	14.5 19.5	30.5	8.0	5.0	8.6 115
9/22	000575	1200	high +2		90	S	21.0 19.0	28.5	8.0	5.0	8.8 116
<u>Station 14</u>											
7/10	000471	0715	low +3	SW/10	90	S	19.0 18.5	28.0	8.0	5.0	7.6 99
8/9	000515	0930	low +4½	0	100	S	20.5 16.5	30.0	8.0	10.0	8.0 101
9/7	000555	0900	low +3½	0	0	S	19.0 19.0	29.0	8.0	5.0	7.5 99
<u>Station 15</u>											
7/25	000488	0900	low +4½	0	0	S	27.0 22.0	26.5	8.0	5.0	7.9 108
8/8	000508	1315	high +3		60	S	25.0 21.0	27.5	8.0	5.0	8.0 107
9/22	000573	1115	high +1		100	S	21.0 19.0	27.5	8.0	10.0	7.6 99

Table 3. Continued

DATE	SAMPLE NUMBER	TIME (EST)	TIDAL STAGE (HOURS)	WIND DIR/VEL (MPH)	CLOUD COVER (%)	DEPTH	TEMP °C		SALINITY (0/00)	pH	CO ₂ (ppm)	O ₂ (ppm)
							AIR	WATER				
<u>Station 16</u>												
7/21	000593	1030	high +3	S/6	100	S	21.5	22.5	27.5	8.0	5.0	8.3
9/5	000543	1030	high +1		10	S	24.5	20.5	29.0	8.0	5.0	7.4
<u>Station 17</u>												
7/21	000486	1300	high +5	0 NE/17	100	S	20.0	18.5	28.5	8.0	5.0	9.2
8/15	000527	1200	low +3		10	S	12.0	15.0	30.0	8.0	5.0	
9/5	000544	1300	high +4		10	S	18.5	18.0	28.5	8.0	5.0	8.0
<u>Station 18</u>												
7/25	000493	1300	low +2½	0	80	S	22.5	21.5	22.0	8.0	5.0	7.6
8/10	000512	1430	high +2½		20	S	20.5	13.0	28.5	8.0	5.0	8.9
9/22	000574	1140	high +1½		90	S	23.5	17.5	28.0	8.0	5.0	9.1

Table 4. Water quality data for Salem Harbor, July - September, 1972.

DATE	SAMPLE NUMBER	TIME (EST)	TIDAL STAGE (HOURS)	WIND DIR/VEL (MPH)	CLOUD COVER (%)	DEPTH	TEMP °C AIR WATER	SALINITY (0/00)	pH	CO ₂ (ppm)	O ₂ (ppm)	7-DAY BOD (ppm)	
<u>Station A</u>													
7/7	000464	0850	high +2½	0	70	S	23.0 19.0	29.9	8.0	5.0	9.1	2.8	120
7/12	000478	1120	low +5	0	0	S	21.5 18.5	30.7	8.0	5.0	8.7	2.5	114
7/18	000482	1015	low +1	NE/5	0	S	20.0 18.0	29.7	8.0	5.0	8.9	2.2	116
7/26	000498	1230	high +1	0	40	S	23.0 20.5	29.6	8.0	5.0	9.1	2.5	125
8/3	000499	1200	low +1	SW/7	100	S	27.0 23.0	30.2	8.0	5.0	8.4	2.7	118
8/10	000523	1140	high	0	20	S	16.5 11.5	30.7	8.0	5.0	8.4	3.3*	95
8/18	000533	1425	high +3		10	S	21.5 19.0	30.8	8.0	5.0	9.5	2.7*	127
8/23	000537	1215	high +2		50	S	24.0 18.0	30.6	8.0	5.0	9.2	2.4	119
8/30	000538	1230	low +3½	0	70	S	24.5 19.0	31.4	8.0	10.0	8.0	1.4	107
9/6	000548	1135	high +1½	0	0	S	20.0	30.2	8.0	5.0	7.5	1.3	
9/13	000560	1025	low +2	0	100	S	19.0 18.0	30.6	8.0	5.0	7.2	1.0	97
9/20	000565	1110	high +2½		10	S	12.0 16.5	30.7	8.0	10.0	7.7	1.7	97
9/29	000577	1150	low +2	0	10	S	19.0 17.5	31.0	8.0	5.0	8.0	2.4	104
<u>Station B</u>													
7/7	000463	0940	high +3	0	50	S	22.5 21.0	29.2	8.0	5.0	8.6	2.0	113
7/12	000477	1115	low +5	0	0	S	23.5 22.0	30.7	8.0	5.0	7.8	2.4	108
7/18	000485	1039	low +1	NE/5	0	S	23.5 22.0	30.6	8.0	5.0	8.3	1.6	115
7/26	000497	1215	high +1	0	40	S	24.0 26.0	29.6	8.0	5.0	7.8	2.2	116
8/3	000500				100	S	27.0	29.9	8.0	5.0	7.5	2.4	
8/10	000522	1125	high	NW/7	20	S	19.5 16.0	31.1	8.0	5.0	8.1	2.9*	101
8/18	000532	1420	high +3		10	S	23.0 23.0	30.3	8.0	5.0	9.4	2.4*	118
8/23	000534	0950	high		20	S	23.0 21.5	31.0	8.0	5.0	8.6	2.2	118
8/30	000539	1235	low +3½	0	70	S	24.5 22.5	31.3	8.0	10.0	8.6	3.1	121
9/6	000545	1045	high +1	0	0	S	20.0 26.5	30.4	8.0	5.0	8.6	3.2	130
9/13	000577	0950	low +1½	SW/5	90	S	21.5 20.5	30.4	8.0	5.0	7.0	1.2	95
9/20	000562	0900	high +1		10	S	12.0 22.0	30.8	8.0	10.0	7.9	1.6	110
9/29	000580	1220	low +3	0	10	S	16.5 22.0	30.6	8.0	10.0	7.6	1.7	106

Table 4. Continued

DATE	SAMPLE NUMBER	TIME (EST)	TIDAL STAGE (HOURS)	WIND DIR/VEL (MPH)	CLOUD COVER (%)	DEPTH	TEMP °C AIR WATER	SALINITY (0/00)	pH	CO ₂ (ppm)	O ₂ (ppm)	7-DAY BOD (ppm)	
Station C													
7/7	000462	0830	high +2	0	30	S	23.0 19.5	29.2	8.0	5.0	9.0	2.3	120
7/12	000476	1040	low +4½	S/5	0	S	23.5 18.5	30.6	8.0	5.0	8.5	2.8	112
7/18	000484	1030	low +1	E/5	0	S	24.0 19.0	29.3	8.0	5.0	9.6	2.9	125
7/26	000496	1210	high +1	NW/13	50	S	22.5 21.0		8.0	5.0	9.0	2.8	
8/3	000501			SW/5	100	S			8.0	5.0			
8/10	000525	1225	high + ½		30	S	15.5 13.0	30.8	8.0	5.0	8.2	2.3*	96
8/18	000531	1410	high +2½		10	S	20.5 18.0	30.7	8.0	5.0	9.1	2.6*	118
8/23	000535	1040	high +1		40	S	23.5 17.5	30.7	8.0	5.0	8.5	1.9	109
8/30	000540	1245	low +4	0	80	S	24.5 17.5	31.0	8.0	10.0	7.7	2.4	99
9/6	000547	1120	high +1½	0	0	S	20.0	30.3	8.0	5.0	7.7	2.3	
9/13	000558	1005	low +1½	N/5	100	S	20.5 18.0	31.0	8.0	5.0	7.1	1.0	92
9/20	000564	1040	high +2	-	10	S	12.5 17.5	30.6	8.0	5.0	7.2	1.4	92
9/29	000579	1110	low +1½	S/5	10	S	16.5 17.5	31.0	8.0	5.0	7.2	2.1	99
Station D													
7/7	000461	0825	high +2	0	20	S	25.0 17.5	29.8	8.0	5.0	9.0	2.8	115
7/12	000475	1025	low +4½	0	0	S	21.5 18.5	30.6	8.0	5.0	8.8	3.1	114
7/18	000483	1120	low +2	E/5	0	S	20.6 17.5	30.3	8.0	5.0	9.4	2.7	121
7/26	000495	1155	high +1	NW/5	50	S	20.0 21.0	29.9	8.0	5.0	9.1	2.6	125
8/3	000502			SW/5	100	S			8.0	5.0			
8/10	000524	1208	high		30	S	16.5 12.0	30.7	8.0	5.0			
8/18	000530	1400	high +2½		90	S	20.0 18.0	30.4	8.0	5.0	9.1	2.1*	117
8/23	000536	1135	high +1½		50	S	23.0 17.5	30.6	8.0	5.0	9.2	2.0	118
8/30	000541	1255	low +4	0	80	S	24.0 17.0	31.8	8.0	10.0	8.2	2.4	105
9/6	000546	1105	high +1	0	0	S	20.0	30.1	8.0	5.0	7.6	1.6	
9/13	000559	1010	low +1½	SW/5	100	S	19.5 18.0	30.8	8.0	5.0	7.2	0.8	
9/20	000563	0945	high +1		10	S	12.0 16.0	30.6	8.0	5.0	8.0	2.3	
9/29	000578	1200	low +2½		10	S	17.5 17.0	30.8	8.0	10.0	8.0	2.0	

* 8-Day BOD

Table 5. Copper concentrations (ppm) in soft shell clams (Mya arenaria) and lobsters (Homarus americanus) from Salem Harbor, July - September, 1972.

Date	Station	Soft shell clam	Lobster
7/12	A	7.5	14.3
	B	-	-
	C	3.0	32.8
8/10	A	4.0	20.8
	B	6.5	43.9
	C	4.0	42.6
9/8	A	3.7	52.4
	B	3.3	34.6
9/11	Salem Harbor	-	24.1
9/13	11	12.6	
	13	7.6	

BIOLOGICAL INVESTIGATIONS

Benthic Survey

A total of 33 species of benthic invertebrates were identified from March samples, and were reported upon by the William F. Clapp Laboratory. The amphipod, Leptocheirus sp., was most abundant. Greatest diversity existed at Station B-4 (14 species), and the least number were found at Stations B-3 and C-1 (5 species) (Figure 9). Summer sampling was conducted in July.

Plankton and Primary Productivity

Bi-weekly sampling continues for phyto- and zooplankton. Eighteen species of zooplankton, identified at the William F. Clapp Laboratories, were presented in their first report by individual counts/bottle. Standardization was undertaken using total volume of water filtered during field collection, and the data re-presented as zooplankton/m³ (Table 6). Phytoplankton analyses are incomplete.

Surface water samples, collected concurrently with plankton, showed variable levels of chlorophyll (Table 7). Detected ranges were:

Chlorophyll A	2.23 - 13.61 mg/m ³
B	0.27 - 2.28 mg/m ³
C	1.31 - 5.56 mg/m ³
Carotenoids	1.82 - 6.84 mg/m ³

For comparison, Chlorophyll A levels on 13 sampling days are plotted in Figures 10 and 11. Upon completion of phytoplankton analyses, interpretations will be made.

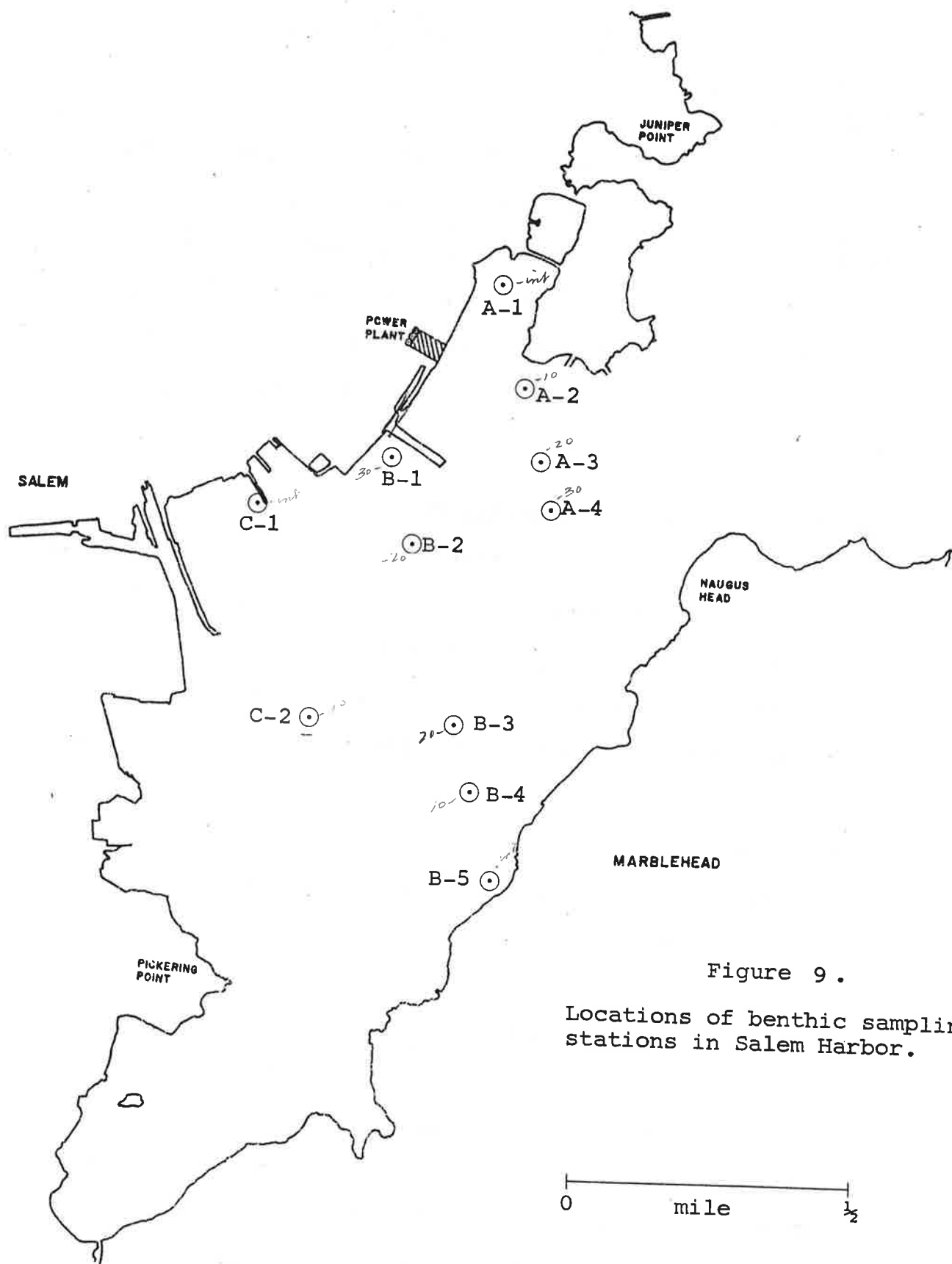


Figure 9.
Locations of benthic sampling
stations in Salem Harbor.

Table 6. Zooplankton collected in Salem Harbor, March, 1972.

ZOOPLANKTON/m³Salem
LocationTideMarch 1972
Date of Sample

ORGANISM	STATIONS							
	A		B		C		D	
	3/8	3/23	3/8	3/23	3/8	3/23	3/8	3/23
<i>Acartia tonsa</i>								
<i>Acartia clausi</i>	5,395	245	267	49	1,418	990	1,005	239
<i>Temora longicornis</i>	101				112		41	
<i>Centropages typicus</i>								
<i>Centropages hamatus</i>								
<i>Paracalanus parvus</i>								
<i>Harpacticus</i> sp.	50	17	196	136	64		8	
<i>Euretemora herdmanni</i>	8,320	490	391	82	2,072	2,287	972	151
<i>Tortanus discaudatus</i>	50				96			
Copepod nauplii	30,607	12,069	622	1,689	5,609	27,361	2,546	4,537
Immature copepoda	2,597	152	36	98	765	528	264	144
<i>Cirripedia</i> nauplii	8,169	76	338	33	2,056	22	1,978	212
<i>Cirripedia</i> cypris								23
Cyclopoida	4,336	177	18	27	271	528	107	163
Unidentified Cop.	1,160	76	36	22	414	990	190	151
Nematoda			18	5				
Polychaeta	101	25			32	22	25	
Gastropod larvae		42			48		25	

This table supersedes Table 4 in Report No. 14340 prepared by the William F. Clapp Laboratory.

Table 7. Chlorophyll counts (mg/m³) in Salem Harbor, July - September, 1972.

Date	Station	Chlorophyll a	Chlorophyll b	Chlorophyll c	Carotenoids
7/12	A	6.16	1.68	5.37	3.77
	B	10.14	2.17	8.13	6.84
	C	7.28	1.61	5.56	3.49
	D	8.40	0.98	5.22	3.86
7/26	A	6.72	2.28	3.83	2.58
	B	6.89	2.11	2.38	2.59
	C	5.72	2.05	2.19	2.72
	D	7.86	2.20	4.35	3.46
8/10	A	3.43	1.19	2.64	4.14
	B	2.23	0.64	1.38	2.21
	C	3.32	0.92	1.97	2.37
	D	3.04	1.49	3.98	2.92
8/23	A	4.50	0.98	1.68	2.25
	B	5.87	1.11	4.75	3.07
	C	5.60	1.03	3.71	2.98
	D	3.88	0.85	3.53	3.40
9/6	A	2.88	2.07	5.50	2.82
	B	2.67	1.56	4.47	1.82
	C	2.34	1.47	4.51	2.12
	D	2.60	1.63	4.19	2.25
9/20	A	10.23	0.28	1.31	4.54
	B	9.69	0.27	1.55	5.13
	C	7.94	0.44	2.40	4.44
	D	13.61	0.54	2.54	5.91

Figure 10.

Chlorophyll a counts in Salem Harbor, April - June, 1972.

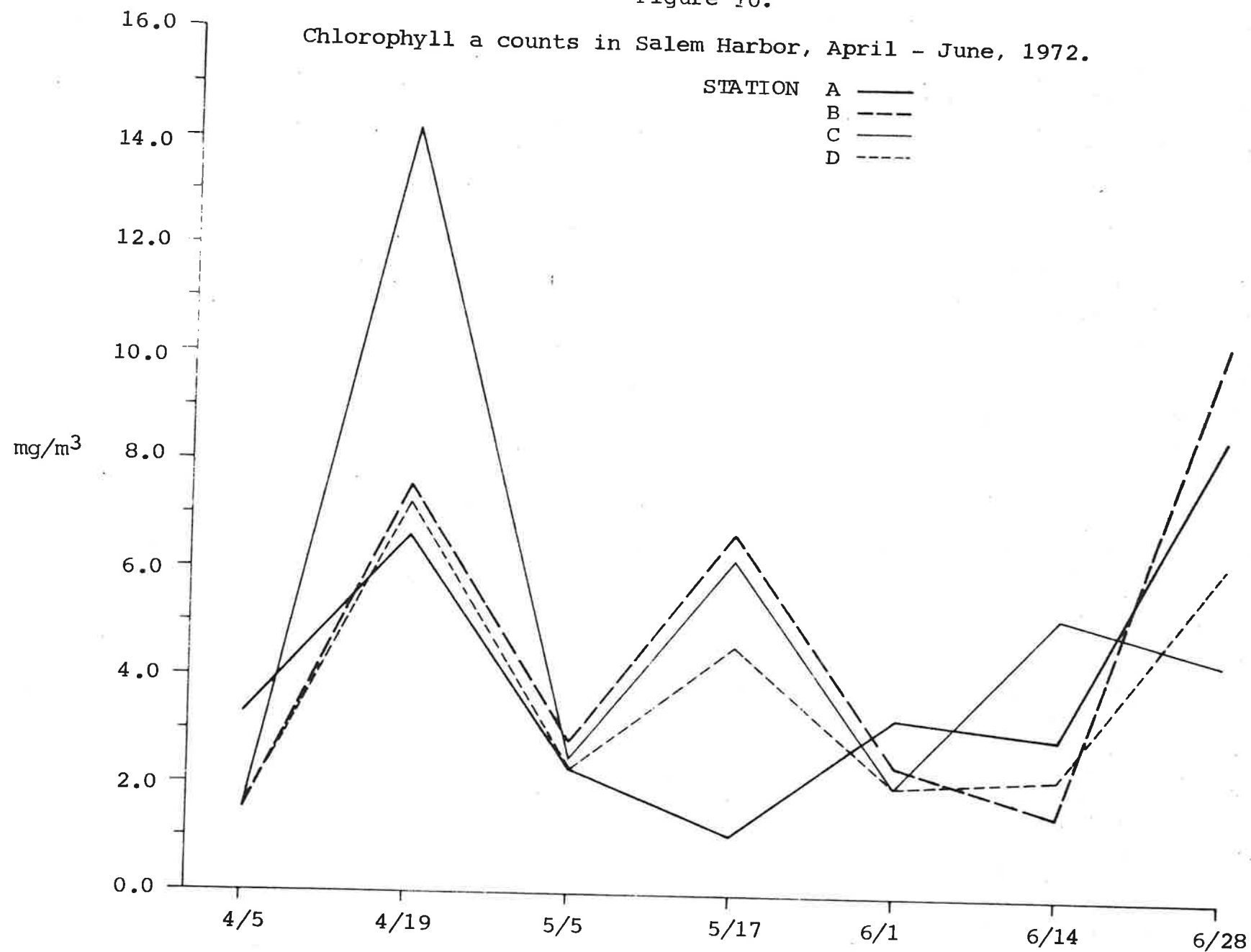
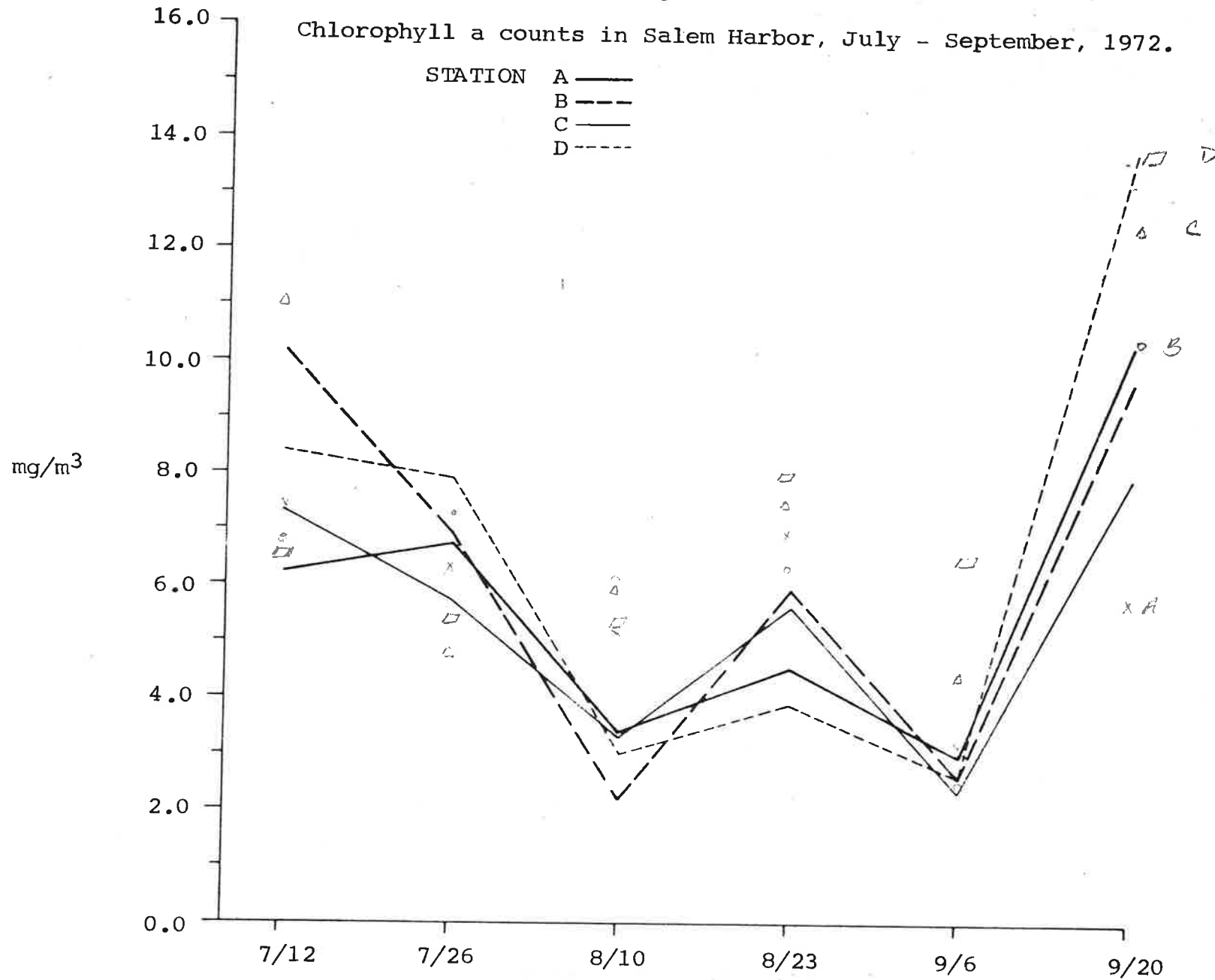


Figure 11.



Bioassays

Temperature effects upon Atlantic silversides and mummichogs are monitored in laboratory bioassays. Procedures employed are outlined in the Appendix. Experiments have been conducted at temperatures ranging from 12 to 20 °C, and findings will be summarized upon completion. Literature is being searched in conjunction with bioassays.

Finfish

Finfish abundance continued to increase during this quarter, with 17,725 individuals collected by all sampling methods (excluding sluiceway traps). Of the finfish sampled, 12,498 (71%) were captured within Salem Harbor and 5,227 (29%) were captured outside Salem Harbor (Tables 8 and 9).

Atlantic silversides remained dominant within Salem Harbor, comprising 63% of the total sampled. Winter flounder predominated outside the harbor, totalling 45% of the catch. Length frequency histograms, prepared for the most abundant finfish species collected in Salem Harbor, exhibit the following ranges: Atlantic silversides (10 - 139 mm); mummichogs (15 - 114 mm); and winter flounder (20 - 484 mm) (Figure 12).

Species diversification was greatest at the 30-ft trawl stations (Table 10). Four silver hake, Merluccius bilinearis, and three saurel, Trachurus trachurus, collected this quarter, brings our total finfish classification listing for the study area to 40 (Table 11).

Table 8. Numerical rank of finfish species collected in Salem Harbor, July - September, 1972.

Species	Method of Capture					Totals
	50-ft Seine	120-ft Seine	30-ft Trawl	49-ft Trawl	Gill Net	
1. Atlantic silverside	7,099	769	18			7,886
2. mummichog	677	995				1,672
3. winter flounder	1	256	102	1,117	15	1,491
4. striped killifish	276	266				542
5. threespine stickleback	1		268			269
6. fourspine stickleback		1	212			213
7. ninespine stickleback			103			103
8. striped bass					66	66
9. windowpane				42		42
10. Atlantic menhaden					41	41
11. white hake			35	1	1	37
12. Atlantic tomcod			32			32
13. northern pipefish		1	29			30
14. pollock					23	23
15. rainbow smelt			13			13
16. alewife		1	7			8
American eel		2	6			8
17. Atlantic mackerel					7	7
18. skate*			2	2	2	6
19. grubby			4			4
20. ocean pout				2		2
silver hake			1	1		2
21. bluefish					1	1
Totals	8,054	2,291	832	1,165	156	12,498

*Not separated by species

Table 9. Numerical rank of finfish species collected outside Salem Harbor, July - September, 1972

Species	Method of Capture				Totals
	50-ft Seine	120-ft Seine	30-ft Trawl	49-ft Trawl	
1. winter flounder		27	246	2,084	2,357
2. Atlantic silverside	1,043	445			1,488
3. Atlantic menhaden	162	115			277
4. mummichog	145	88	5		238
5. northern pipefish	2	2	233		237
6. threespine stickleback		1	132		133
7. Atlantic tomcod			116		116
8. windowpane			12		105
9. yellowtail flounder				93	74
10. Atlantic herring				74	35
11. Atlantic cod		35			29
12. white hake				29	19
13. bluefish		1	13	5	18
14. cunner	3	15			13
grubby			12	1	13
15. American sand lance			13		12
16. blueback herring	12				10
17. longhorn sculpin	9	1			7
18. American eel				7	6
red hake		3	3		6
19. ninespine stickleback			6		5
rainbow smelt		1	4		5
skate*	2	1	1	1	5
20. alewife			5		5
rock gunnel		4			4
silver hake			4		4
21. saurel				4	4
22. sea raven		3			3
23. goosefish				2	2
striped killifish				1	1
Totals	<u>1</u> 1,379	<u> </u> 742	<u> </u> 805	<u> </u> 2,301	<u> </u> 5,227

*Not separated by species

Figure 12.

Length frequency histograms for Atlantic silversides (Menidia menidia), mummichogs (Fundulus heteroclitus), and winter flounder (Pseudopleuronectes americanus) collected in Salem Harbor, July - September, 1972.

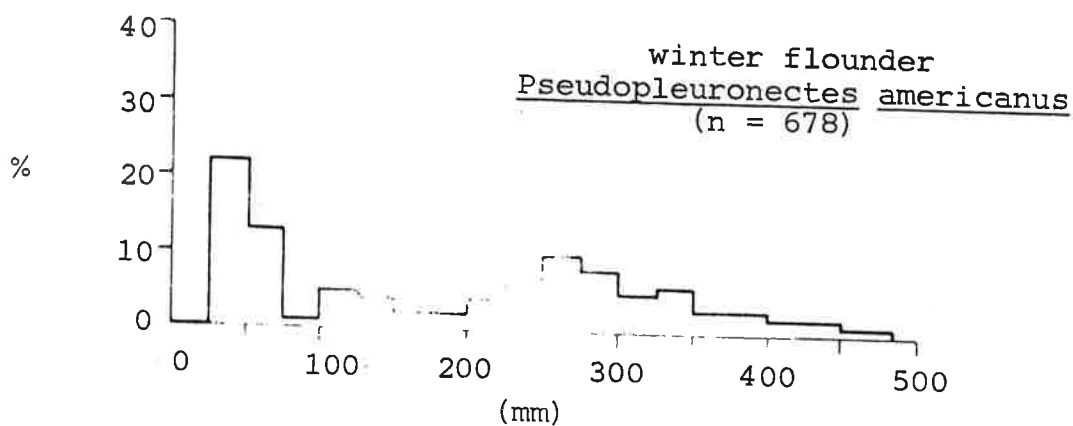
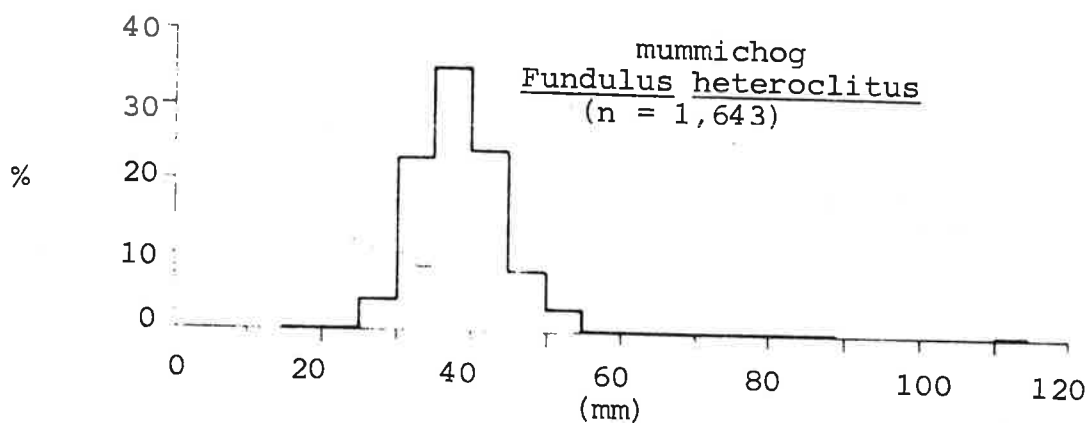
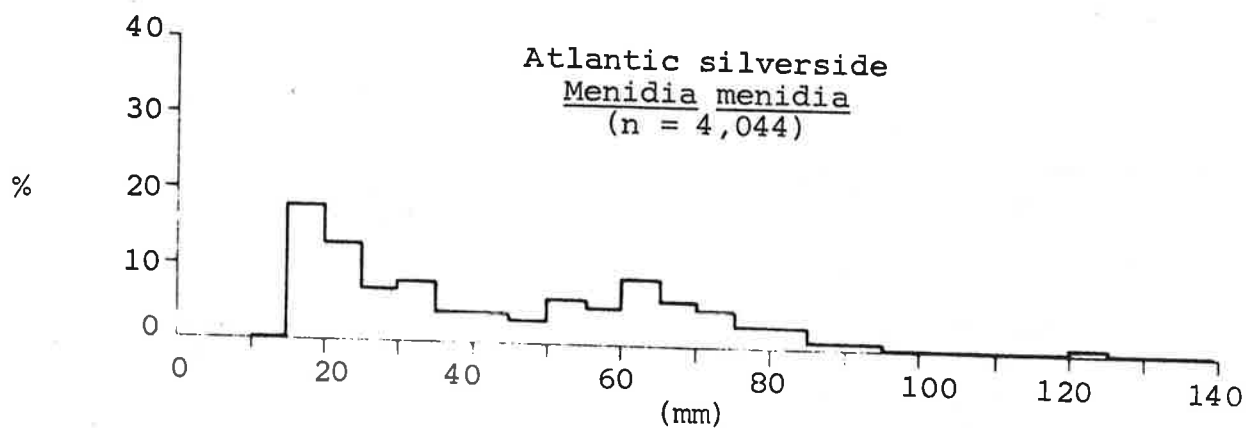


Table 10. Diversification index of finfish species by method of capture, Beverly - Salem Harbor, July - September, 1972.

Date	50-ft Seine	120-ft Seine	30-ft Trawl	49-ft Trawl	Gill Net
7/10			7		
7/11			2		
7/20		10			
7/21				9	
7/25	3				
8/7		11			
8/8	7				
8/9			15		
8/10	3				
8/15				8	
9/5				8	
9/7			12		
9/11 -					
9/12					
9/20		5			8
9/22	6	4			

Table 11. Classification of additional finfish species
collected in Beverly - Salem Harbor.

Class: OSTEICHTHYES

Order: GADIFORMES

Family: Gadidae - codfishes

Merluccius bilinearis - silver hake

Order: PERCIFORMES

Family: Carangidae

Trachurus trachurus - saurel

The selectivity of sampling gear is borne by examination of Tables 12 - 16. Atlantic silversides, Menidia menidia, mummichogs, Fundulus heteroclitus, striped killifish, Fundulus majalis, and juvenile winter flounder, Pseudopleuronectes americanus, are most susceptible to capture by beach seines (50 and 120-ft). Winter flounder, particularly adults, predominate catches by otter trawl (30 and 49-ft). Gill nets are effective in sampling faster pelagic finfish such as, striped bass, Morone saxatilis, Atlantic menhaden, Brevoortia tyrannus, pollock, Pollachius virens, Atlantic mackerel, Scomber scombrus, and bluefish, Pomatomus saltatrix.

Movements of extensive schools of juvenile and adult Atlantic menhaden, and Atlantic herring, Clupea harengus harengus, were noted this summer along the North Shore coastline. On several occasions commercial purse seine operations were observed within Beverly and Salem Harbors, where daily catches approached 250 tons. Incidental species included rainbow smelt, Osmerus mordax, and Atlantic mackerel. Winter flounder stocks were not affected. Juvenile menhaden were frequently observed providing forage for striped bass in the vicinity of the power plant intakes and discharge.

Although not sampled in large numbers, juvenile cunner, Tautogolabrus adspersus, were common throughout the study area and were frequently observed within the discharge canal by biologists using SCUBA.

Table 12. Dominant finfish species collected in Salem Harbor
with the 50-ft seine, July - September, 1972

Atlantic silverside (<u>Menidia menidia</u>)					mummichog (<u>Fundulus heteroclitus</u>)			striped killifish (<u>Fundulus majalis</u>)		
Date	Set No.	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)
Station 11										
7/25	1	36	15-34	25	3	20-64	35			
	2	18	10-34	17						
8/10	1	153	20-69	52	30	20-49	33	2	40-44	42
	2									
9/22	1	83	20-94	58	26	25-59	41			
	2	3	30-64	42	47	20-54	47			
Station 13										
7/25	1				1	-	62			
	2	2	60-64	62	1	-	52			
8/10	1				21	25-49	35			
	2				2	25-34	30			
9/22	1	127	30-104	63	201	30-54	41	175	45-89	60
	2	310	35-104	65	153	30-59	41	77	50-89	61
Station 15										
7/25	1									
	2	75	10-39	18	1	-	37			
8/8	1	1,620	10-134	23	145	25-79	40	28	35-64	49
	2	2,332	10-139	26	18	25-49	34	14	15-59	45

Table 13. Dominant finfish species collected in Salem Harbor with the 120-ft seine, July - September, 1972.

		mummichog (<u>Fundulus heteroclitus</u>)			Atlantic silverside (<u>Menidia menidia</u>)			striped killifish (<u>Fundulus majalis</u>)			winter flounder (<u>Pseudopleuronectes americanus</u>)		
Date	Set No.	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)
Station 11													
7/20	1	5	15-34	24	8	20-39	29						
	2	2	25-29	27	20	20-124	67				5	30-119	81
8/7	1	4	30-64	43	173	20-69	48				2	35-44	39
	2	1	-	82	33	30-134	62	23	40-64	53	14	35-64	47
9/20	1	55	25-74	43	249	25-94	62	14	40-64	53			
	2	19	25-64	44	229	35-99	62	23	35-64	45	2	60-74	67
								7	25-64	43	7	50-164	82
Station 13													
7/20	1	11	50-114	75	6	115-129	122						
	2	5	60-89	69	29	110-134	116				42	30-164	52
8/7	1	577	25-49	36	3	40-59	49				42	30-164	49
	2	205	25-44	34	3	40-54	47	13	40-64	49	31	35-54	45
9/22	1	106	30-54	43	11	45-79	59				43	40-64	48
	2	5	40-79	54	5	60-79	70	151	40-94	61	49	40-129	58
								35	45-84	58	19	40-79	59

Table 14. Dominant finfish species collected in Salem Harbor with the 30-ft trawl, July - September, 1972.

threespine stickleback
(Gasterosteus aculeatus)

fourspine stickleback
(Apeltes quadracus)

ninespine stickleback
(Pungitius pungitius)

winter flounder
(Pseudopleuronectes americanus)

Date	Set No.	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)
Station 12													
7/10	1	4	55-69	67									
	2										10	85-129	105
8/9	1										24	115-407	261
	2										4	120-289	204
9/7	1	1	-	32							2	320-344	335
	2										16	140-430	262
Station 14													
7/10	1	17	25-74	54	7	40-59	51	8	40-69	49	2	120-154	137
	2	12	30-69	58	13	37-54	47	1	-	47	5	110-219	142
8/9	1	23	25-74	55	38	20-59	44	15	45-69	55	38	95-324	141
	2												
9/7	1	96	20-74	35	134	20-59	37	44	50-69	57	1	-	162
	2	115	20-79	37	20	25-59	41	35	45-69	58			

Table 15. Dominant finfish species collected in Salem Harbor with the 49-ft trawl, July - September, 1972.

winter flounder (<u>Pseudopleuronectes americanus</u>)				
Date	Set No.	Total Collected	Size Range (mm)	Mean (mm)
<u>Station 16</u>				
7/21	1	283	185-474	300
	2	105	225-469	310
8/15	No sampling conducted			
9/5	1	375	205-484	319
	2	354	225-454	308

Table 16. Dominant finfish species collected in Salem Harbor with gill nets, September 11 - 12, 1972.

striped bass (<u>Morone saxatilis</u>)			Atlantic menhaden (<u>Brevoortia tyrannus</u>)			pollock (<u>Pollachius virens</u>)		
Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)
66	330-434	345	41	340-404	305	23	250-304	280

Sport Fish Survey

Our six-month sport fish survey within Salem Harbor will terminate October 15. Upon completion, data will be transferred from field sampling records (see Appendix) to data processing cards and a program prepared. A total of 416 hours have been devoted to this survey.

Public access to the waters of Salem Harbor was enhanced by the September 16 opening of a fishing pier on the New England Power Company property. Acceptance of this facility appeared well received by the fishing public. Random checks will be made at this pier to supplement our effort and harvest statistics.

Sluiceway Investigations

Finfish monitoring of Units 3 and 4 intakes continues on a limited scale, with emphasis placed upon determining peak hours of finfish concentration. A twenty-four hour continuous check at Unit 3 was conducted from July 31 to August 1. Unit 4 was monitored concurrently with Unit 3 on September 11 and 12. Additionally, 15 randomly selected hours were checked between August 1 and 17 (Tables 17 and 18).

Observations prior to July indicated minimal numbers of finfish being impinged upon the Unit 3 travel screens, with subsequent discharge into the washwater sluiceways. Even after collection of 684 juvenile menhaden during the September 11 - 12 check, we remain optimistic that the intake design of this North Shore unit has little adverse effect upon the finfish resources of Salem Harbor. In contrast, finfish impingement upon Unit 4

Table 17. Finfish species collected in the Unit 3 sluiceway,
Salem Harbor, July 31 - August 1, 1972.

Species	(EST)	July 31			August 1									TOTALS
		1725- 1925	1925- 2125	2125- 2325	2325- 0125	0125- 0325	0325- 0525	0525- 0725	0725- 0925	0925- 1125	1125- 1325	1325- 1525	1525- 1725	
bluefish									1					1
lumpfish									1					1
northern pipefish			1					1		1				3
threespine stickleback			1		1				2					4
white hake			4	1	1									6
winter flounder							2							2

Table 18. Finfish species collected in the Unit 3 and 4 sluiceways,
Salem Harbor, September 11 - 12, 1972.

Species	(EST)	September 11			September 12								TOTALS	
		1700- 1900	1900- 2100	2100- 2300	2300- 0100	0100- 0300	0300- 0500	0500- 0700	0700- 0900	0900- 1100	1100- 1300	1300- 1500		1500- 1700
Unit 3														
Atlantic menhaden		47	38	155	47	48	182	26	14	21	110	6	684	
Atlantic tomcod								1					1	
cunner														
northern pipefish						2					3		3	
rainbow smelt			1						1				3	
squid							1						1	
winter flounder				1			1	1		1	1	1	6	
Unit 4														
Atlantic menhaden	2			1									19	
cunner	1											16	3	
mummichog		1										2	1	
northern pipefish				1		1	2		1			2	7	
squid							1						1	
winter flounder	6												5	11

travel screens produces nearly 100 percent mortality. To substantiate our belief, random monitoring will continue.

Lobster Tagging

Initiated on 7 July, 446 sub-legal sized lobsters have been tagged and released in Beverly and Salem Harbors (Figures 13 and 14). Through cooperation with local lobstermen and fish dealers, returns reached 117 (26%). Movements up to 6 miles have been recorded; with 89% of the Beverly Harbor releases recaptured within a mile, and 87% of the Salem Harbor releases recaptured within 2 miles from points of release. Tags have been recovered from two lobsters that molted into legal size. A sample poster and lobster tag reporting form are included in the Appendix.

Figure 13.

Recapture locations of tagged lobsters, Homarus americanus, liberated in Beverly Harbor through September, 1972.

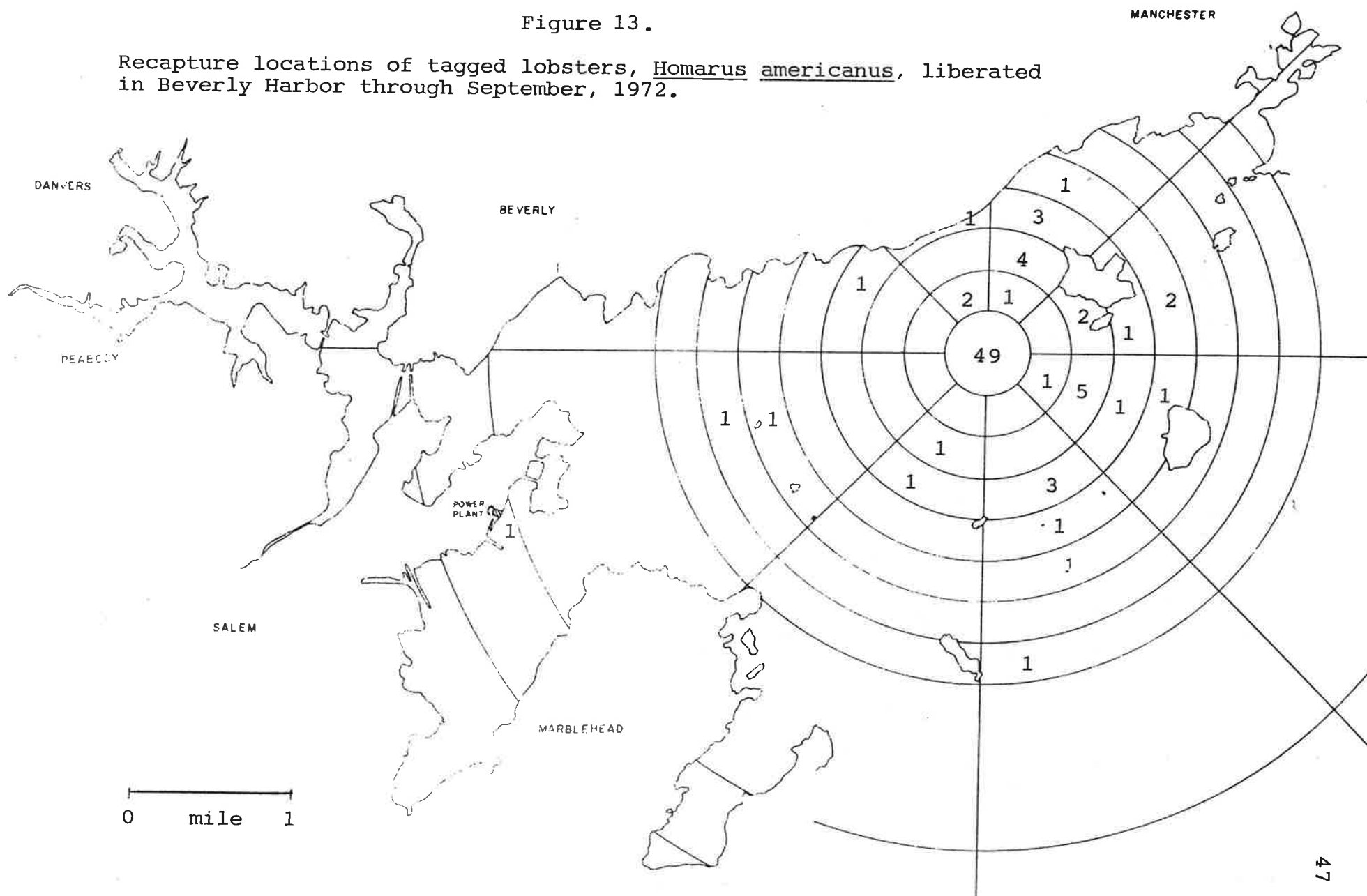
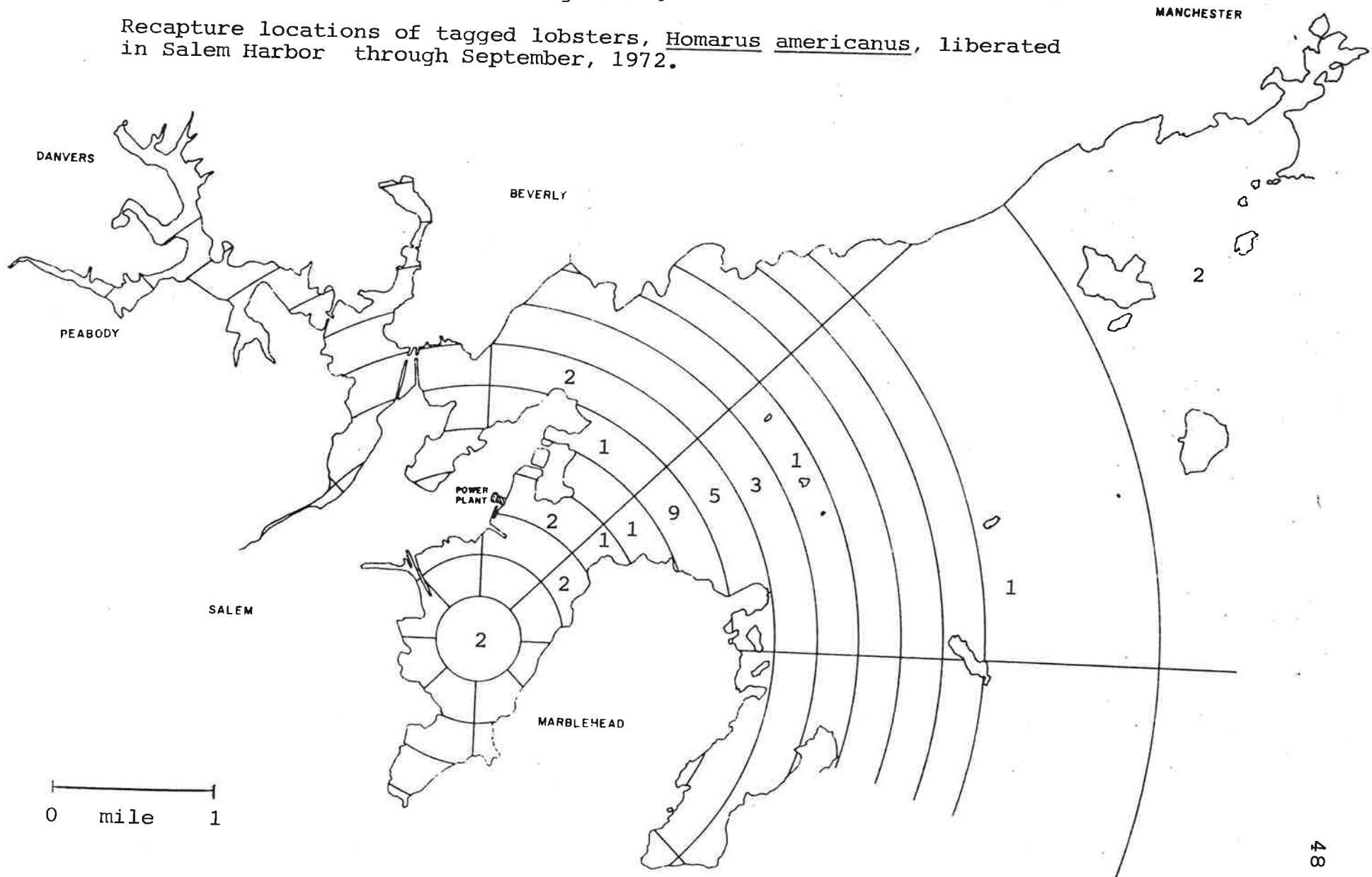


Figure 14.

Recapture locations of tagged lobsters, Homarus americanus, liberated in Salem Harbor through September, 1972.



SUMMARY

A major siltation buildup is occurring at the south end of the power plant discharge canal. We theorize this buildup results from the placement of a rock bulkhead across the canal mouth to prevent shallowing of the harbor basin. At this time the buildup extends approximately 100 yds up the canal, and consists of fine sand and broken shellfish shells.

Apparent increased flows resulting from operational requirements of Unit 4 has forced us to seek alternative means to maintain a live test cage within the discharge canal. On two occasions test cages have been moved considerable distances and subdued by sediment. One cage was recovered.

Unit 4, although yet to be permitted for commercial operation, is generating up to 470 MW of electrical power daily. Periodic shutdowns have been encountered. As of this writing, adverse operational effects are directed toward undue finfish entrapment and impingement upon Unit 4 intake travel screens; and long range effects of additional siltation in the discharge canal.

APPENDIX

SAMPLING PROCEDURES

CHLORINITY

Field Collection: 300 ml/sample of seawater.

Laboratory Analysis: Modified Knudsen method, from Strickland and Parson (1968).

SALINITY

Field Analysis: Direct reading from a G.M. hydrometer, calibrated from 0-45 ‰.

HYDROGEN ION

Field Analysis: Hach Chemical Company test kit, Model CA-10.

Samples collected since May 15, 1972 were analyzed with a Kontes mini-pH meter.

CARBON DIOXIDE

Field Analysis: Hach Chemical Company test kit, Model CA-10.

DISSOLVED OXYGEN

Field Collection: 300 ml/sample of seawater fixed with 1 ml manganous sulfate reagent and 1 ml alkaline iodide reagent.

Laboratory Analysis: Titration by Winkler method.

BIOLOGICAL OXYGEN DEMAND

Field Collection: 300 ml/sample of seawater.

Laboratory Analysis: Titration by Winkler method following 7-day incubation.

COPPER

Field Collection:

Water - 1 liter/sample collected in a nalgene bottle.

Soft shell clam - 6/sample, approximately 2" in length.

Lobster - 1/sample, approximately 3" in carapace length.

Laboratory Analysis: Utilizing a modified Strickland and Parsons (1968) method, the soft portions of clams and 6 grams of lobster gills are digested and analyzed.

BENTHIC

Field Collection: Benthic algae and invertebrates are sampled at sites selected at various depth contours. Quadrats are established by attaching a 12-ft line to the site marker and swinging a circle of 10-ft radius. The first quadrat is located 2 ft from the marker, and subsequent quadrats are located 2 ft and 70° counter-clockwise from the former. This procedure is repeated until 5-1/4m² samples are collected within each circle. Samples are stored and frozen in plastic bags until analyses.

PLANKTON

Field Collection: Phytoplankton and zooplankton are collected in an 80 micron mesh nytex plankton net. Tows are made for 2 minutes at selected sites and strained water volume is recorded on an 8.5 cm T.S. flow meter attached to a one meter ring. Samples are transferred to 250 ml nalgene bottles containing a 5% glutaraldehyde solution, and refrigerated until analyses.

CHLOROPHYLL

Field Collection: Surface seawater is filtered through a 316 micron mesh nytex cloth into a one gallon nalgene bottle and stored in a light-proof box for transport to the laboratory.

Laboratory Analysis: Samples are stored in a cool dark place not exceeding eight hours from collection. Estimation of extracted algae cell pigments is made spectrophotometrically using the SCOR/UNESCO method outlined by Strickland and Parsons (1968).

FINFISH

Field Collection: Duplicate sets are made at selected sites with gear of the following design:

50 x 4 ft seine, with 1/8 in mesh;

120 x 8 ft seine, with 1-1/2 in mesh wings and 3/4 in mesh bag; *1/2 in wings
1/8 in bag*

30 x 25 ft trawl with 1-1/2 in mesh wings and 1 in mesh cod end; *3/8 in cod end*

49 x 38 ft trawl with 5 in mesh wings and 4 in mesh cod end.

Seines are set parallel to shore with the aid of a skiff and drawn to the shore by lines of approximately 75 ft. Trawl cruises are along a fixed course. Where obstructions occur, cruise lines are altered. Fishing time is five minutes with the 30 ft trawl and 20 minutes with the 49 ft trawl.

Gill nets are set at selected sites for 24 hours. All gill nets are constructed of monofilament and measure 100 x 10 ft. Stretched mesh size range from 1-1/2 to 3-1/2 in.

Finfish collected are separated by species, enumerated, and measured for total length in millimeters.

SPORT FISH SURVEY

Starting Date: April 16, 1972

Ending Date: October 14, 1972

Area: Salem Harbor, inside or west of a line drawn between Fort Pickering Light on Winter Island to Naugus Head in Marblehead; and the easterly shorelines of Winter Island and Salem Neck from the Fort Pickering Light to, and including, the public pier at the north end of Salem Neck.

Procedure: Instantaneous fishermen counts are conducted three times during each survey day at randomly selected hours.

Fishermen interviews are conducted throughout the survey day. Survey data is recorded on forms provided for a minimum of 10 percent of all shore and boat fishermen.

Children who are fishing are included in the instantaneous counts, and a separate tally noted. Children are not interviewed when fishing in the accompaniment of an adult.

Schedule: One weekday and one weekend day is surveyed each week. All holidays are surveyed. Selection of day, and 8-hour shift (6 - 2 or 10 - 6), is made at random at 4-week intervals. Changes in routine are made only at time of schedule selections.

FISH EGG AND LARVAE

Field Collection: Procedures employed in collecting and handling fish egg and larvae are identical to plankton, except for use of a 153 micron mesh nytex net.

SLUICeway INVESTIGATIONS

Field Collection: Finfish, invertebrates and marine vegetation are sampled in the intake sluiceways to Units 3 and 4. Traps, constructed of 1/2 in welded steel rod and covered with 3/16 in stretched mesh nylon net, are periodically placed in the respective sluiceways for one hour intervals. All organisms are identified, enumerated and measured. Water temperature and salinity is recorded during each sampling interval.

LOBSTER TAGGING

Field Collection: Division personnel, aboard commercial vessels, collect sub-legal sized lobsters (3 - 3-1/8 in) from Beverly and Salem Harbors. Lobsters are then transferred to a Division boat or returned to our Cat Cove Laboratory for tagging with a fluorescent orange spherion tag.

Tagging Procedure: Tags are attached by securing a stainless steel anchor (.014 dia.) in the body muscle beneath the abdomen with the aid of a #20 hypodermic needle. Each tag is imprinted with a number and the legend "Div. Mar. Fish., Salem, Mass." Tagged lobsters are then released at selected sites in Beverly and Salem Harbors. Sex, carapace length (in millimeters), date, and release point are recorded.

Return Procedure: Through a public awareness program, including personal letters to commercial lobstermen known to fish Beverly - Salem Harbors; distribution of posters and tag reporting forms; and articles in the local news media; individuals are requested to return lobster tags to our laboratory or to a cooperating fish dealer. All returns are acknowledged in writing, and tags are placed on a map designating the point of capture. Records are updated on growth and movements of each recapture.

THERMAL BIOASSAY

Field Collection: Finfish species are collected by seines and trawls and transported to the laboratory in aerated containers of seawater.

Laboratory Experiment: Following acclimation to room temperature (about 18 °C), 96 hour tolerance levels for each species are determined for abrupt and gradual changes in water temperature. Effects are noted for each 5°C gradient over the range -1.0 to 32.0 °C.

WANTED:

LOBSTER



address - Date and location of capture - Tag number.

We will acknowledge promptly receipt of your return with information on the respective lobster.

Mass. Division of Marine Fisheries
Cat Cove Marine Laboratory
92 Fort Avenue
Salem, Massachusetts 01970

Telephone - 745-7667

PROJECT EXPENDITURES

Expenditures as of September 30, 1972 were:

	<u>Total Allotted</u>	<u>Total Expended</u>	<u>Balance</u>
Salaries	\$49,000.00	\$38,142.24	\$10,857.76
Travel	1,500.00	516.74	983.26
Office & Laboratory Supplies	3,500.00	2,516.60	983.40
Equipment	20,500.00	17,041.86	3,458.14
Maintenance	2,000.00	1,165.32	834.68
Overhead	<u>17,000.00</u>	<u>5,965.95</u>	<u>11,034.05</u>
TOTALS	<u>\$93,500.00</u>	<u>\$65,348.71</u>	<u>\$28,151.29</u>
Subcontracts	36,780.00	7,700.00	29,080.00