

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

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January, 1972

Progress Report No. 1
October - December, 1971

Division of Marine Fisheries
Department of Natural Resources
The Commonwealth of Massachusetts

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INTRODUCTION

The following is the first in a series of quarterly reports covering work performed by personnel of the Division of Marine Fisheries operating under contract Project DMF-2-72 with the New England Power Company. Included are data collected prior to contract agreement of 7 October 1971 and data collected through 31 December 1971.

The area of study is bordered on the north by Manchester and Beverly; on the west by Danvers, Peabody, and Salem; and on the south by Marblehead. The eastern or seaward boundary was established as a line passing through a group of outer islands from Marblehead Light, Marblehead, to Gales Point, Manchester (Figure 1).

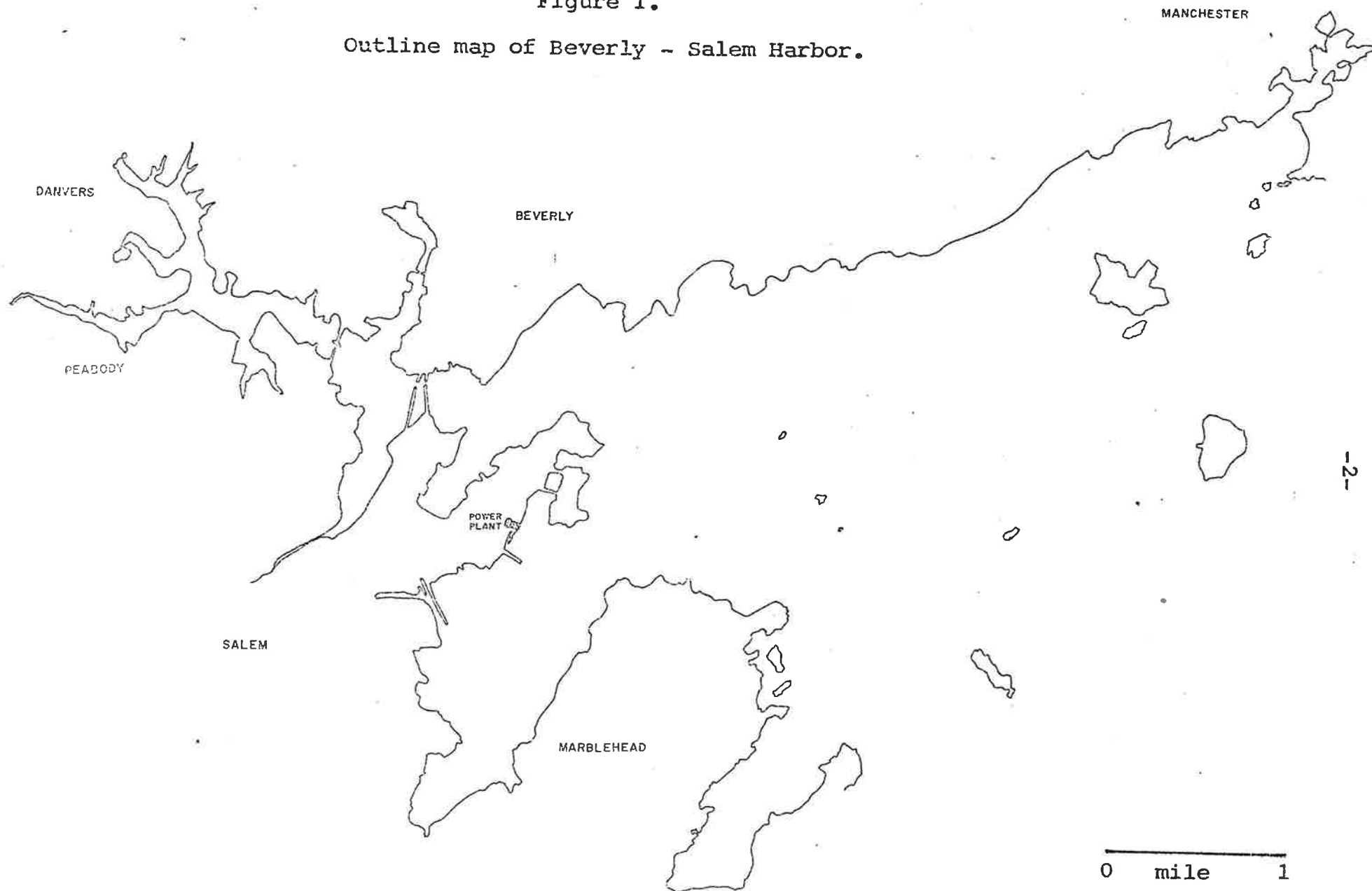
METHODS AND MATERIALS

Objectives and procedures outlined in contract research proposal Exhibit A are employed in data collection.

Air and surface water temperatures are recorded with Taylor pocket thermometers, graduated in 1°C. Salinity is measured with G.M. wide range salinity hydrometers, calibrated from 0-45 ppt. Hach field test kits are used for pH and carbon dioxide determinations. Dissolved oxygen is determined in the laboratory utilizing the standard Winkler method. D.O. samples collected prior to October were analyzed with a Hach field test kit.

Figure 1.

Outline map of Beverly - Salem Harbor.



Finfish are sampled with seines and trawls of the following specifications:

50 ft. seine - 50 X 4 ft. X 1/8 in. mesh

120 ft. seine - 120 X 8 ft. with 1-1/2 in. mesh wings
and 3/4 in. mesh bag

30 ft. trawl - 30 ft. sweep X 25 ft. headrope with
1-1/2 in. mesh wings and 1 in. mesh
cod end

49 ft. trawl - 49 ft. sweep X 38 ft. headrope with
5 in. mesh wings and 4 in. mesh
cod end

Tows are made for five minutes with the 30 ft. trawl,
and twenty minutes with the 49 ft. trawl. Finfish are
measured for total length and recorded in millimeters.

PHYSICAL INVESTIGATIONS

Temperature Monitoring

Four temperature monitoring sites were selected within Salem Harbor and are shown as Stations A, B, C and D on Figure 2. Intake (A) and discharge (B) water are monitored by review of daily operational records at the Salem Harbor power plant. Authorities at the First U.S. Coast Guard District in Boston have granted permission for attaching continuous recording thermographs to navigational aids N "2" (C) and C "21" (D). Purchase requisitions are being prepared and installations at Stations C and D are expected during second quarter operations. Figure 3 shows average daily water temperatures at Stations A and B.

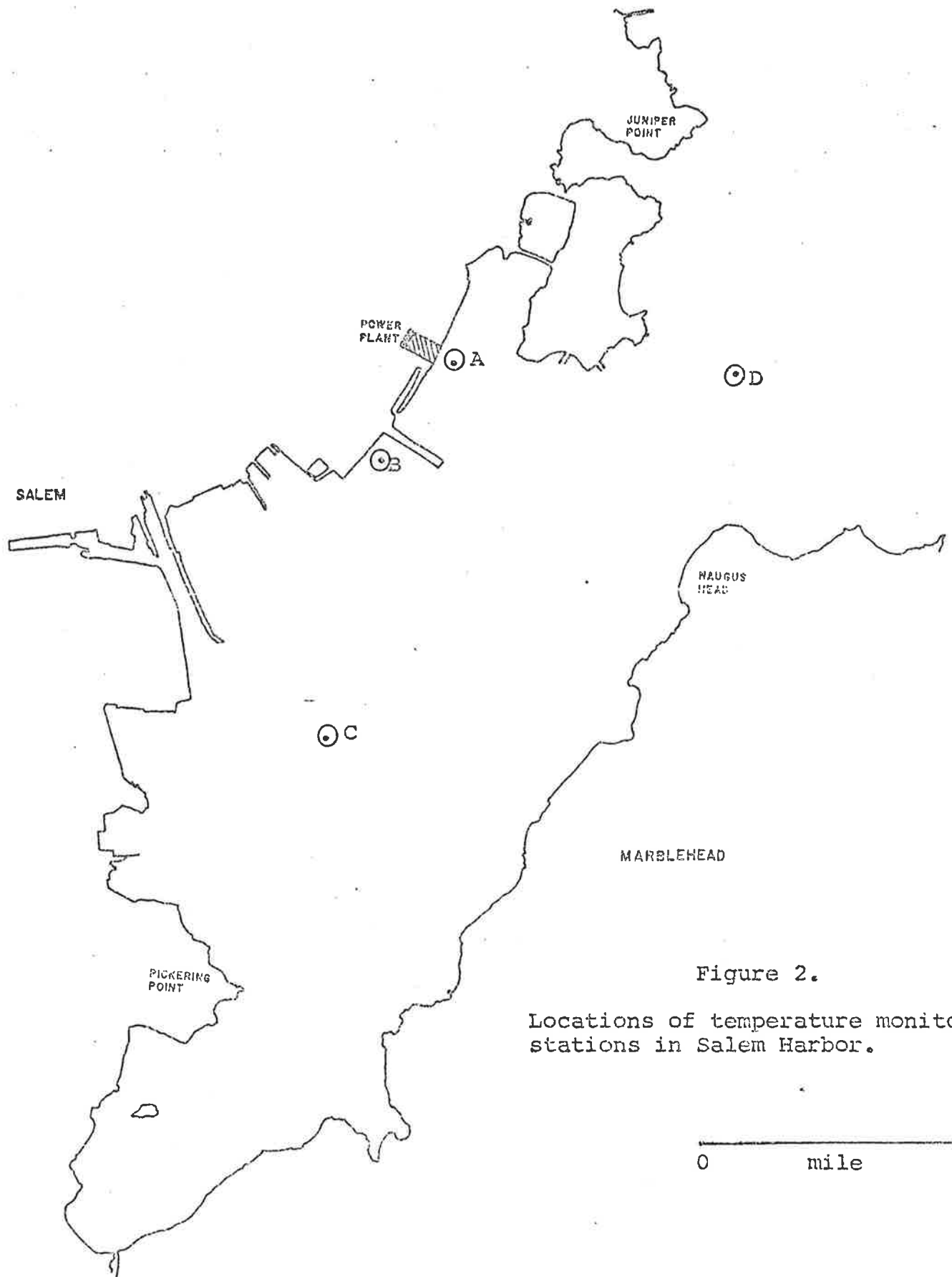
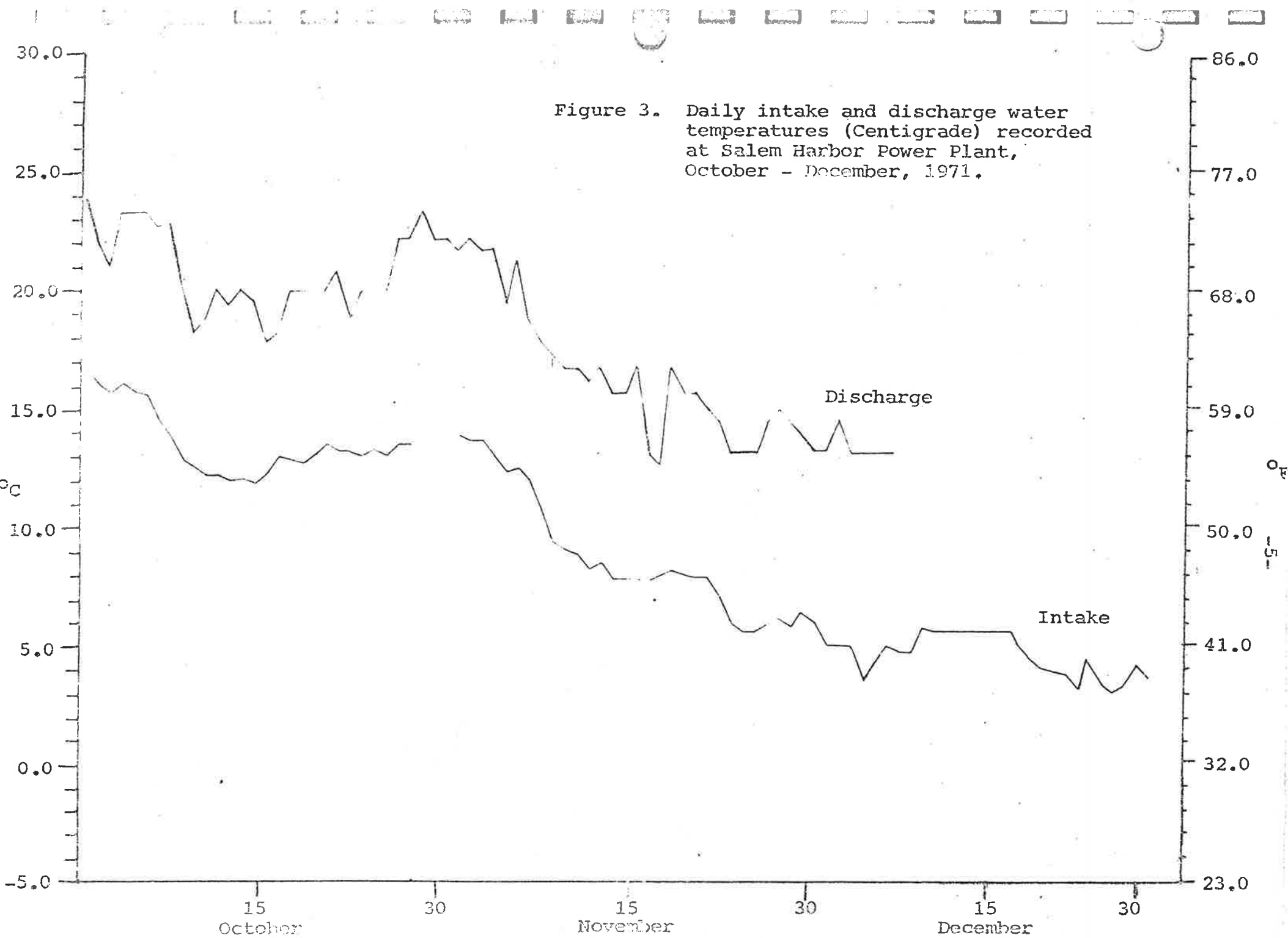


Figure 2.
Locations of temperature monitoring
stations in Salem Harbor.

0 mile 1/2



I.R.T. flights were conducted over Salem Harbor on October 7 and 8, 1971. The results define the warm water discharge plume from the plant under full load operating conditions prior to fourth unit operation. This study was a direct contract between the New England Power Company and Coastal Research Corporation.

CHEMICAL INVESTIGATIONS

Water Quality

Monthly monitoring of surface temperature, salinity, dissolved oxygen, carbon dioxide, and hydrogen ion (pH) is conducted at Stations 1, 3, 7, 8, 11, 13, 15 and 18 (Figure 4). Surface temperature and salinity is also monitored monthly at Stations 2, 4, 5, 6, 9, 10, 12, 14, 16 and 17 (Figure 5).

Ranges for the parameters sampled were: surface water temperature, 0.0 - 22.0°C; surface salinity, 26.0 - 34.0 ‰; dissolved oxygen, 4.0 - 11.2 ppm; carbon dioxide, 5.0 - 20.0 ppm; and pH, 8.0 - 9.0 (Table 1). Carbon dioxide readings of 15.0 ppm at Station 3 in July and 20.0 ppm at Station 1 in August are inconsistent with other water quality measurements and are believed to be sampling errors.

Surface water samples, collected weekly at Stations A, B, C and D (Fig. 2), were analyzed for dissolved oxygen and chlorinity in the laboratory. For comparison, chlorinity

Figure 4.

Locations of water quality and finfish sampling stations in Beverly - Salem Harbors.

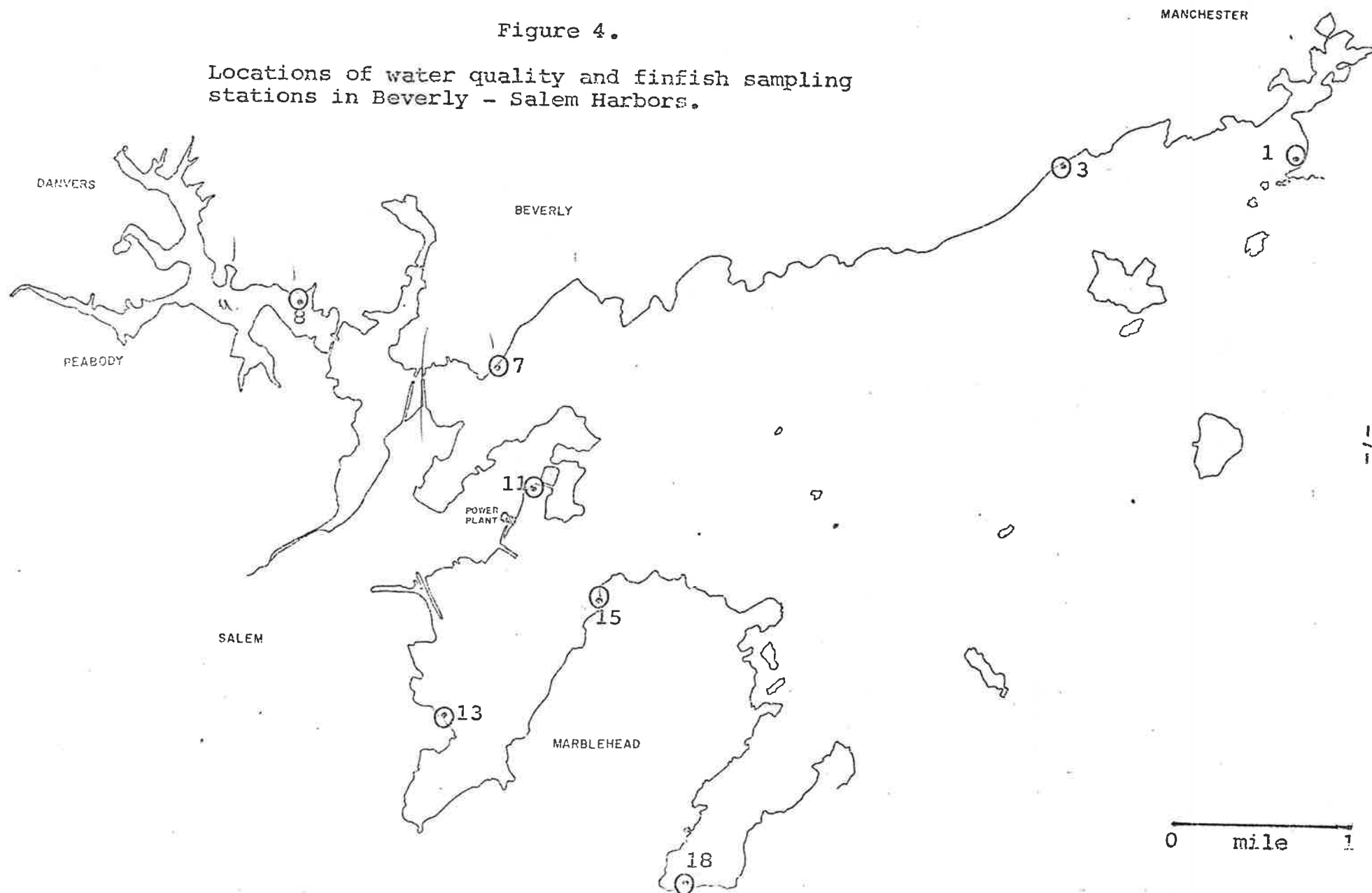


Figure 5.

Locations of water quality and finfish sampling stations in Beverly - Salem Harbors.

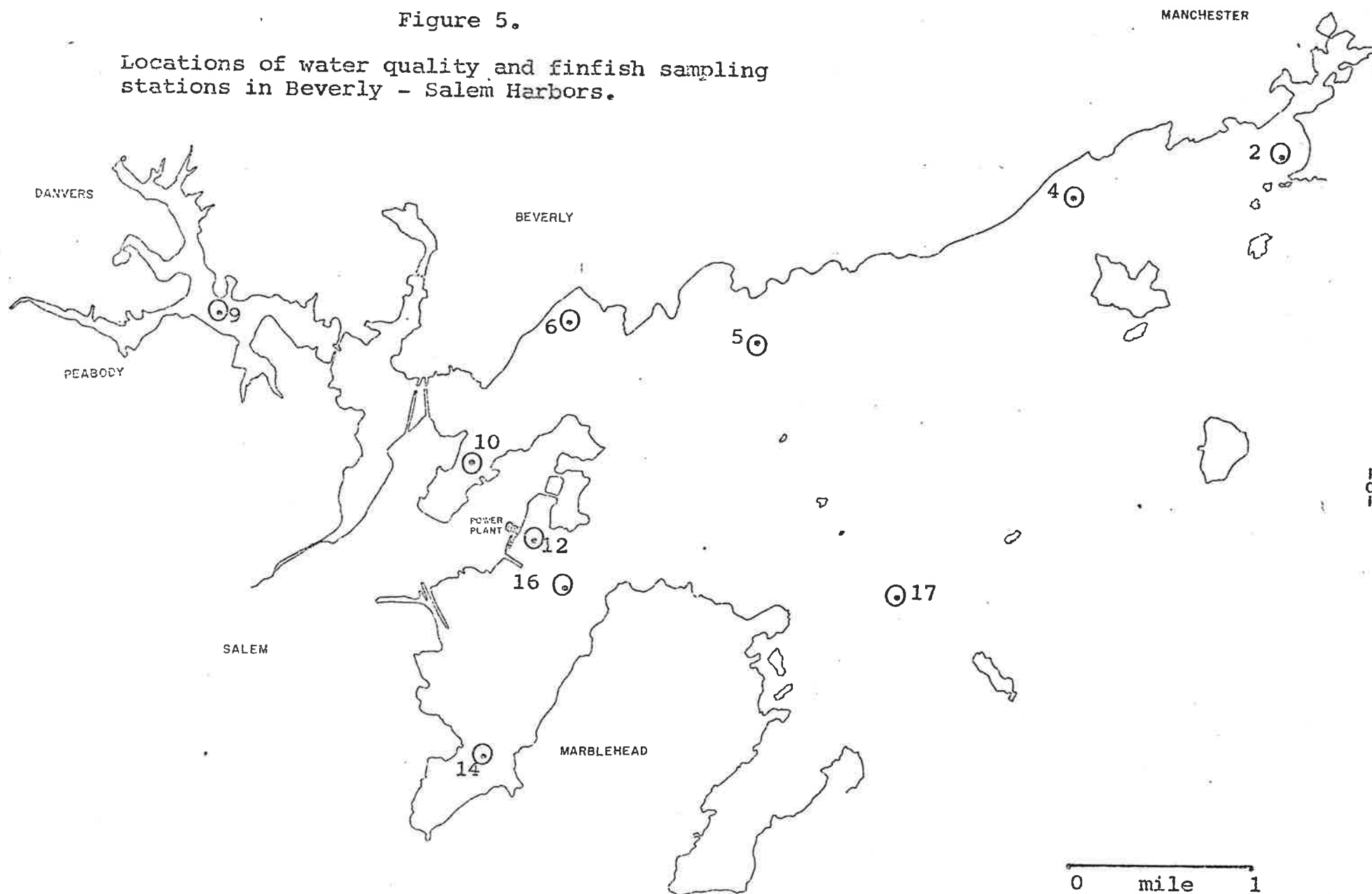


Table 1. Water quality data for Beverly - Salem Harbor,
July - December, 1971.

DATE	TIME (EST)	SAMPLE NUMBER	TIDAL STAGE (HOURS)	DEPTH	TEMP. °C		SALINITY 0/00	O ₂ ppm	CO ₂ ppm	pH
					Air	Water				
<u>Station 1</u>										
7/21	1000	000056	high	S	26.5	16.0	30.0	9.0	5.0	9.0
8/18	0705	000057	low +4	S	28.0	18.5	30.0	7.0	20.0	9.0
9/15	0905	000058	high +1	S	21.0	19.0	29.0	8.0	5.0	8.0
10/19	0930	000230	low +4½	S	15.0	13.5	30.0	8.6	5.0	8.0
11/9	1500	000059	low +5	S	0.5	8.5	30.0	9.9	5.0	9.0
12/6	1210	000060	low +4½	S	4.0	0.0	22.0	11.2	5.0	8.0
12/10	1045	000061	high +5½	S	6.0	6.0	28.0	9.9	5.0	8.0
<u>Station 2</u>										
8/17	1040	000063	high +1	S	18.5	19.0	30.0			
10/20	1245	000064	high +1½	S	13.5	14.5	31.0			
11/5	1035	000065	low +4½	S	6.5	12.0	31.0			
12/29	0900	000066	high +½	S	0.5	5.0	33.0			
<u>Station 3</u>										
7/21	0935	000067	low +5½	S	23.5	14.5	33.0	10.0	5.0	9.0
7/22	0930	000074	low +4½	S	20.5	16.0	30.0			
8/18	0630	000068	low +3½	S	18.0	15.5	29.5	9.0	10.0	9.0
8/19	0800	000075	low +4	S	18.0	18.0	28.5			
9/10	1140	000076	low +3	S	22.0	20.0	27.5			
9/15	0845	000069	high +½	S	20.0	18.5	31.0	9.0	5.0	8.0
10/15	0845	000077	high	S	16.0	14.0	31.0			
10/19	1005	000070	low +5½	S	17.0	14.5	30.0	8.4	10.0	9.0
11/9	1415	000071	low +4	S	4.0	10.0	32.0	9.0	10.0	8.0
12/6	1230	000072	high +5	S	4.5	2.0	34.0	10.6	5.0	9.0
12/8	1520	000079	high	S	3.0	6.0	33.0			
12/10	1125	000078	low	S	9.5	7.0	32.5	9.8	5.0	8.0

Table 1. continued

DATE	TIME (EST)	SAMPLE NUMBER	TIDAL STAGE (HOURS)	DEPTH	TEMP. °C		SALINITY 0/00	O ₂ ppm	CO ₂ ppm	pH
					Air	Water				
<u>Station 4</u>										
9/17	1115	000088	high +1½	S	19.0	18.0	30.0			
10/20	1325	000089	high +2	S	13.0	14.0	32.0			
11/5	1110	000090	low +5	S	8.0	12.0	31.5			
12/29	0920	000091	high +1	S	1.5	5.0	33.5			
<u>Station 5</u>										
9/27	0945	000092	high +5½	S			30.0			
10/18	0900	000093	low +5	S	13.5	13.5	31.5			
11/17	1025	000094	high	S	9.5	8.5	33.0			
12/14	1020	000095	high +2	S	0.0	6.0	32.5			
<u>Station 6</u>										
9/17	1255	000097	high +3	S	18.5	18.0	30.0			
10/20	1348	000098	high +2½	S	13.0	14.0	31.5			
11/5	1130	000099	low +5	S	7.0	13.0	31.0			
12/29	0955	000100	high +1½	S	1.0	5.5	32.5			
<u>Station 7</u>										
7/21	1100	000101	high +½	S	26.5	13.5	32.5	4.0	10.0	9.0
8/18	0600	000102	low +3	S	13.5	16.0	30.0	8.0	10.0	8.0
9/15	0950	000103	high +2	S	23.5	19.5	30.0	9.0	5.0	8.0
10/19	0850	000104	low +4	S	14.5	13.5	29.5	8.1	10.0	8.0
11/9	1350	000105	low +4	S	1.5	10.0	30.0	9.4	10.0	8.0
12/6	1135	000106	low +4	S	1.0	4.0		9.5	10.0	9.0

Table 1. continued

DATE	TIME (EST)	SAMPLE NUMBER	TIDAL STAGE (HOURS)	DEPTH	TEMP. °C		SALINITY 0/00	O ₂ ppm	CO ₂ ppm	pH
					Air	Water				
<u>Station 8</u>										
7/21	1125	000120	high +1	S	33.0	14.5	30.5	6.0	15.0	9.0
7/22	1015	000114	low +5½	S	26.5	15.5	29.5			
8/18	0815	000121	low +5	S	26.0	19.0	29.5	9.0	5.0	9.0
8/19	0850	000115	low +5	S	23.5	20.0	30.0			
9/10		000116		S	22.0	19.0	28.5			
9/15	1010	000122	high +2	S	26.0	20.0	29.0	7.0	10.0	8.0
10/15	0920	000117	high +1	S	18.0	15.0	31.0			
10/19	0815	000123	low +3½	S	15.0	13.5	30.5	8.2	10.0	8.0
11/9	1315	000124	low +3	S	3.0	9.0	32.5	9.1	10.0	8.0
11/15	1000	000118	high +5	S	6.0	7.0	32.0			
12/6	1105	000125	low +3½	S	1.0	3.5	31.5	9.7	10.0	8.0
12/8	1440	000119	high +5	S	3.0	4.5	30.5			
<u>Station 9</u>										
9/17	1355	000133	high +4	S	19.0	20.0	29.5			
10/20	1430	000134	high +3	S	13.0	14.0	30.0			
11/5	1215	000135	high	S	8.0	13.0	30.5			
12/29	1020	000136	high +2	S	1.0	3.5	29.5			
<u>Station 10</u>										
9/17	0905	000137	low +5½	S	19.0	19.5	28.0			
11/5	1155	000138	low +5½	S	8.0	13.0				
12/29	0715	000139	low +5	S	2.0	4.0	31.0			

Table 1. continued

DATE	TIME (EST)	SAMPLE NUMBER	TIDAL STAGE (HOURS)	DEPTH	TEMP. °C		SALINITY 0/00	O ₂ ppm	CO ₂ ppm	pH
					Air	Water				
Station 11										
7/21	1230	000152	high +2	S	18.5	15.5	30.5	10.0	5.0	8.0
7/22	1100	000146	high	S	23.0					
8/18	1045	000153	high +1½	S	26.5	21.0	28.5	8.0	0.0	8.0
8/19	1005	000147	high	S	26.5	22.0	29.0			
9/10	1415	000148	low +5½	S	20.0	21.0	29.0			
9/15	1050	000154	high +3	S	26.5	21.5	29.0	9.0	5.0	8.0
10/15	1045	000149	high +2	S	20.0	18.5	30.5			
10/19	1405	000155	high +3	S	14.0	14.0	30.0	8.8	10.0	9.0
11/8	1530	000156	high +½	S	2.5	11.0	31.0	8.8	10.0	9.0
11/15	1105	000150	high +2	S	9.0	8.5	32.5			
12/5	1430	000157	high +½	S	4.5	2.0	31.5	9.9	5.0	9.0
12/7	1530	000151	high +1	S	5.0	4.0	32.0			
Station 12										
9/17	0955	000160	high	S	18.0	20.0	30.0			
10/20	1105	000161	low +5½	S	14.0	14.0	31.0			
11/5	0915	000162	low +3	S	6.0	13.0	30.5			
12/29	0730	000163	low +5½	S	-0.5	5.0	32.5			
Station 13										
7/21	0730	000169	low +3½	S	20.0	15.0	31.0	8.0	5.0	8.0
7/22	0830	000164	low +3½	S	23.5	16.0	28.5			
8/18	0920	000170	high	S	29.5	21.0	33.5	9.0	10.0	9.0
8/19	0720	000231	low +3½	S	23.5	18.0	29.0			
9/10	1335	000165	low +5	S	21.0	20.5	27.0			
9/15	0715	000171	low +5½	S	19.0	19.0	24.0	9.0	5.0	8.0
10/15	1015	000166	high +1½	S	18.0	15.0	30.5			
10/19	1320	000172	high +2½	S	13.5	14.5	30.0	8.7	10.0	9.0
11/8	1330	000173	low +4½	S	3.5	10.0	31.5	9.9	10.0	9.0
11/15	1045	000167	high +1½	S	6.5	9.0	32.0			
12/3	1500	000174	high +3½	S	4.0	5.5	31.5	10.3	10.0	8.0
12/7	1445	000168	high	S	6.0	7.0	32.0			

Table 1. continued

DATE	TIME (EST)	SAMPLE NUMBER	TIDAL STAGE (HOURS)	DEPTH	TEMP. °C		SALINITY 0/00	O ₂ ppm	CO ₂ ppm	pH
					Air	Water				
<u>Station 14</u>										
9/17	0940	000183	high	S	19.5	20.5	27.0			
10/20	1130	000184	high	S	14.0	15.0	31.0			
11/5	0935	000185	low +3½	S	5.0	13.0	30.5			
12/29	0820	000186	high	S	1.0	3.5	30.0			
<u>Station 15</u>										
9/22	1000	000187	low +3½	S	21.0	20.0	29.5	8.0	10.0	8.0
10/19	1235	000188	high +1½	S	15.0	14.0	30.0	8.7	10.0	9.0
11/8	1445	000189	low +5½	S	2.0	10.5	31.0	8.9	5.0	8.0
12/3	1420	000190	high +3	S	4.0	3.0	27.0	10.6	10.0	8.0
<u>Station 16</u>										
9/27	1130	000196	low +1½	S			30.5			
10/18	1020	000197	high	S	13.0	14.0	31.0			
11/17	1145	000198	high +1½	S	7.0	10.0	32.5			
12/14	1210	000199	high +3½	S	3.0	7.5	32.0			
<u>Station 17</u>										
9/27	1250	000201	low +3	S			29.5			
11/17	1305	000203	high +3½	S	7.0	9.0	32.0			
12/14	1350	000204	high 5½	S	4.0	6.0	32.0			
<u>Station 18</u>										
7/21	0800	000206	low +4	S	22.0	14.5	27.0	8.0	5.0	8.0
8/18	0940	000207	high +½	S	25.5	21.0	26.0	7.0	10.0	9.0
9/15	0750	000208	low +6	S	19.0	19.0	27.5	8.0	10.0	8.0
10/19	1145	000209	high +1	S	13.5	13.5	29.0	7.9	10.0	9.0
11/8	1400	000210	low +5	S	3.0	11.0	31.5	8.3	10.0	8.0
12/3	1345	000211	high +2½	S	3.0	5.0	30.0	9.7	10.0	8.0

NOTE: Dissolved oxygen samples collected prior to October were analyzed with a Hach field test kit.

was converted to salinity. Air and surface water temperatures were recorded on all sampling dates. Water temperatures ranged from 4.5 to 24.0°C; salinity varied from 29.27 to 32.92 ‰; and D.O. fluctuated from 6.35 to 9.70 ppm (Table 2).

HEAVY METAL ANALYSES

Preliminary studies by Ceurvels and DerHovanesian (unpublished) found copper concentrations in water of 0.8 ppm and greater to be lethal to lobsters, Homarus americanus. The authors concluded that the following parameters in lobsters may be used as indicators of environmental copper pollution.

1. Levels of 0.8 ppm copper is lethal.
2. Blood-copper levels increased with concentrations that produced death.
3. Lobster gills appear to represent the most sensitive indicator of increased environmental copper pollution.

Lethal limits of copper uptake in soft shell clams, Mya arenaria and blue mussels, Mytilus edulis will be assessed.

BIOLOGICAL INVESTIGATIONS

Benthic Survey

Three parallel transects were established within Salem Harbor to monitor benthos organisms (Fig. 6). Seasonal sampling will commence next quarter, following

Table 2. Water quality data for Salem Harbor,
September - December, 1971.

DATE	TIME (EST)	SAMPLE NUMBER	TIDAL STAGE (HOURS)	DEPTH	TEMP. °C		SALINITY 0/00	O ₂ ppm
					Air	Water		
Station A								
9/29	1050	000001	high +5	S	20.0	18.0	32.43	8.2
10/8	1450	000002	high + $\frac{1}{2}$	S	13.5	15.0	32.23	6.4
10/13	1235	000003	low	S	14.0	14.0	32.14	7.3
10/20	1215	000004	high + $\frac{1}{2}$	S	14.0	14.5	32.52	8.4
10/28	0938	000005	high +4	S	18.5	17.0	32.07	7.0
11/5	1009	000006	low +4	S	8.5	13.0	32.26	6.8
11/18	1020	000007	low +5 $\frac{1}{2}$	S	7.5	8.0	32.65	7.9
12/2	1000	000008	low +5 $\frac{1}{2}$	S	-0.5	6.0	31.94	8.8
12/9	1117	000009	high +1	S	6.0	6.0	32.27	9.1
12/14	1130	000010	high +1	S	4.0	6.5	32.56	8.9
12/29	0750	000011	low +5 $\frac{1}{2}$	S	-0.5	5.5	32.00	9.4
Station B								
9/29	1200	000013	low	S	21.5	24.0	31.89	7.5
10/8	1425	000014	high + $\frac{1}{2}$	S	14.0	21.0	32.23	6.4
10/13	1210	000015	high +5 $\frac{1}{2}$	S	17.0	21.0	31.31	6.6
10/20	1210	000016	high + $\frac{1}{2}$	S	15.0	21.0	32.25	8.2
10/28	0858	000017	high +3 $\frac{1}{2}$	S	19.0	22.5	31.92	6.7
11/5	1005	000025	low +4	S	7.0	20.0	32.34	7.0
11/18	1039	000018	low +5 $\frac{1}{2}$	S	8.0	15.0	32.73	8.0
12/2	1020	000019	high	S	-1.5	12.5	31.92	8.7
12/9	1133	000020	high	S	5.0	13.0	32.21	9.0
12/14	1140	000021	high +3	S	4.0	12.5	32.36	9.0
12/29	0805	000022	low ~~+6 High~~	S	3.0	12.0	31.00	9.1
Station C								
9/29	1215	000026	low	S	19.5	17.0	32.16	6.9
10/8	1445	000027	high +1	S	14.0	16.0	32.09	6.9
10/13	1220	000028	low	S	13.5	14.0	31.87	7.5
10/20	1200	000029	high + $\frac{1}{2}$	S	14.5	15.0	32.25	8.5
10/28	0915	000030	high +4	S	18.5	15.0	31.92	5.8
11/5	1000	000031	low +4	S	6.5	13.5	32.34	6.9
11/18	1030	000032	low +5 $\frac{1}{2}$	S	6.0	8.5	32.65	8.5
12/2	1010	000033	high	S	-3.0	6.0	31.92	9.0
12/9	1123	000034	high +1	S	5.0	4.5	29.27	9.5
12/14	1150	000035	high +3 $\frac{1}{2}$	S	4.0	6.0	32.45	8.9
12/29	0808	000036	low ~~+6 High~~	S	1.0	5.0	32.50	9.7
Station D								
9/29	1230	000024	low + $\frac{1}{2}$	S	19.0	18.0	31.92	7.5
10/8	1340	000038	high	S	14.0	15.0	32.09	7.0
10/13	1225	000039	low	S	13.0	14.0	32.14	7.1
10/20	1230	000040	high +1	S	13.5	13.5	32.38	8.8
10/28	0955	000041	high +4 $\frac{1}{2}$	S	18.0	17.0	31.92	6.9
11/5	1017	000042	low +4	S	7.0	13.0	32.34	7.0
11/18	1010	000043	low +5	S	7.5	8.0	32.92	8.1
12/2	0950	000044	low +5 $\frac{1}{2}$	S	-1.0	6.0	32.05	8.9
12/9	1108	000045	high +1	S	6.0	6.0	32.27	9.3
12/14	1320	000046	high +5	S	4.0	6.5	32.11	9.3
12/29	0835	000047	high	S	0.0	4.5	32.50	9.5

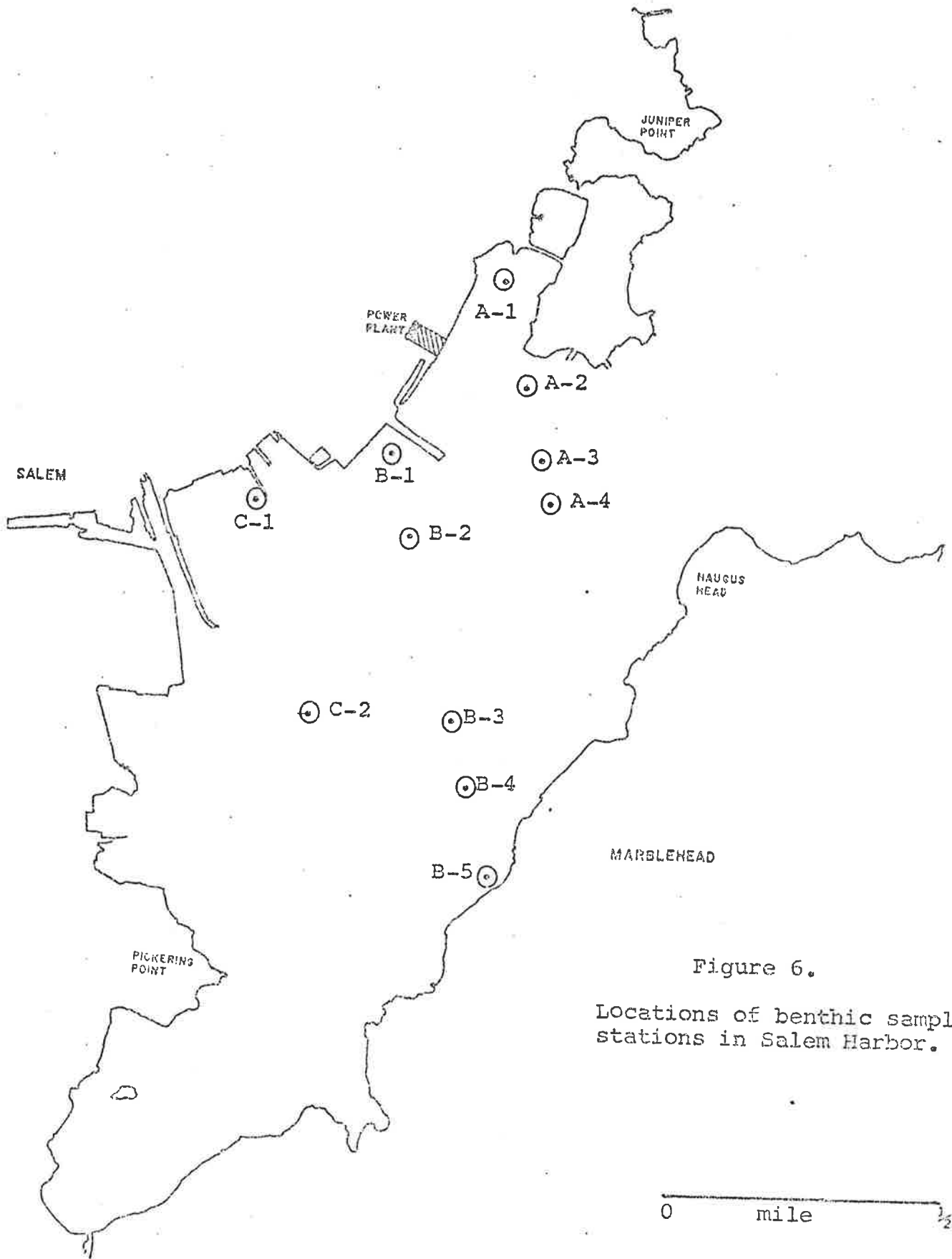


Figure 6.
Locations of benthic sampling
stations in Salem Harbor.

sub-contract awards for quadrat analyses.

Plankton and Chlorophyll Studies

Plankton and chlorophyll samples will be collected bi-weekly at Stations A, B, c and D (Fig.2).

Finfish

Finfish sampling is conducted monthly at Stations 1 - 18 (Figs. 3 and 4) employing 50 ft. and 120 ft. beach seines and 30 ft. and 49 ft. trawls. Of 32,203 finfish sampled, 17,660 were captured within Salem Harbor and 14,543 were collected outside Salem Harbor (Tables 3 and 4).

Atlantic silversides were most abundant within Salem Harbor (13,869) and alewives were most abundant outside the harbor (10,494). The majority of alewives (10,448) were seined October 15 at Station 3, approximately four miles from the Salem Harbor power station.

Finfish sampling in Salem Harbor was dominated by Atlantic silversides, mummichogs, winter flounder, threespine sticklebacks, and striped killifish. Size ranges and mean lengths of dominant species captured at each station are presented in Tables 5 - 8.

Sampling at Station 15 with the 50 ft. seine; Stations 12 and 14 with the 30 ft. trawl; and at Station 16 with the 49 ft. trawl commenced in September. No finfish were collected in December at Station 14.

Atlantic silversides predominated catches at the shore stations. Data suggests silverside movement within Salem Harbor, with alternate abundance fluctuations at Stations 11 and 13. Peak abundance within the harbor was noted in July.

Table 3. Numerical rank of finfish species collected in Salem Harbor, July - December, 1971.

Species	Method of Capture				Totals
	50-ft. seine	120-ft. seine	30-ft. trawl	49-ft. trawl	
1. Atlantic silverside	~~10,697~~ 11,047	2,728	94		13,519
2. mummichog	~~1,049~~	473			13,869
3. winter flounder		120	204	741	1,522
4. threespine stickleback	42	5	750		759
5. striped killifish	280	23			303
6. fourspine stickleback		1	56		57
7. Atlantic tomcod			27		27
8. skate*			1	19	20
9. bluefish	65				6
striped mullet	6				6
10. alewife	51				5
11. ninespine stickleback			4		4
12. windowpane				3	3
13. blueback herring		2			2
grubby			2		2
lumpfish			2		2
sea raven			1		2
shorthorn sculpin			1	1	2
14. American eel			1	1	1
cunner			1		1
northern pipefish			1		1
red hake			1		1
TOTALS	~~12,397~~	3,352	1,146	765	17,660
					17,879

* Not separated by species

* Data not include Magnus had finfish station

Table 4. Numerical rank of finfish species collected outside Salem Harbor
July - December, 1971.

Species	Method of Capture				Total
	50-ft. seine	120-ft. seine	30-ft. trawl	49-ft. trawl	
1. alewife	45	10,448	1		10,494
2. Atlantic silverside	1,535	655	77		2,267
3. winter flounder		26	360	565	951
4. mummichog	269	11			280
5. blueback herring	128			1	129
6. Atlantic herring	106				106
7. yellowtail flounder				79	79
8. threespine stickleback	1	1	73		75
9. Atlantic tomcod			34		34
10. striped killifish	29				29
11. windowpane			9	12	21
12. bluefish		17			17
13. Atlantic cod				15	15
14. red hake				9	9
15. skate*				8	8
16. cunner			4	1	5
ninespine stickleback	4		1		5
17. rainbow smelt	2		2		4
18. northern pipefish			3		3
19. crevelle jack		2			2
rock gunnel				2	2
20. American sand lance	1				1
ocean pout				1	1
flying gurnard			1		1
fourspine stickleback			1		1
goosefish				1	1
longhorn sculpin				1	1
mackerel scad		1			1
sea raven				1	1
TOTALS	2,120	11,161	566	696	14,543

* Not separated by species

Table 5. Dominant finfish species collected in Salem Harbor with the 50-ft. seine,
July - November, 1971.

Atlantic silverside (<u>Menidia menidia</u>)				mummichog (<u>Fundulus heteroclitus</u>)			striped killifish (<u>Fundulus majalis</u>)		
Date	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)
Station 11									
7/21	4,168	15-149	33	4	35-100	62			
8/18	232	35-94	79	470	20-94	47	42	25-79	39
9/15	3,432	60-109	82	246	25-109	63	238	50-119	76
10/19				204	30-79	43			
Station 13									
7/21	1	-	112						
8/18	2,044	25-79	44	48	25-49	37			
9/15	65	55-79	66	27	30-49	38			
10/19	134	65-159	84	5	30-49	40			
11/8	521	60-124	88	21	40-54	47			
Station 15									
9/22	340	20-94	62	23	20-59	40			
10/19	2	100-114	107	1	-	102			
11/8	8	65-114	93						

Table 6. Dominant finfish species collected in Salem Harbor with the 120 ft. seine,
July - December, 1971.

Atlantic silverside (<u>Menidia menidia</u>)				mummichog (<u>Fundulus heteroclitus</u>)			winter flounder (<u>Pseudopleuronectes americanus</u>)		
Date	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)
Station 11									
7/22	160	35-144	96	1	-	102	1	-	27
8/19	334	47-137	65	224	40-124	82	6	47-57	52
9/10	1	-	102	1	-	77			
10/15	301	70-124	96	218	30-94	48	62	40-104	66
11/15	7	100-119	106				11	55-104	75
12/7	64	60-114	83						
Station 13									
7/22	261	35-69	50	6	20-30	24	4	30-110	75
8/19	11	40-69	53	9	42-87	68	12	40-59	50
9/10	22	45-104	81				10	45-69	54
10/15	242	70-124	90	13	35-59	44	10	45-74	59
11/15	1,324	65-154	93	1	-	52	4	55-74	64
12/7	1	-	92						

Table 7. Dominant finfish species collected in Salem Harbor with the 30 ft. trawl,
September - December, 1971.

threespine stickleback (<u>Gasterosteus aculeatus</u>)			winter flounder (<u>Pseudopleuronectes americanus</u>)			Atlantic silverside (<u>Menidia menidia</u>)			
Date	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)
Station 12									
9/17	25	40-74	54	17	65-364	206			
10/20				10	75-334	1577			
11/5				33	50-354	118			
12/29	1	-	47	1	-	57	3	110-114	112
Station 14									
9/17				1	-	187			
10/20				138	55-324	86			
11/5	724	35-89	54	4	70-99	79	91	65-114	79

Table 8. Dominant finfish species collected in Salem Harbor with the 49 ft. trawl, September - December, 1971.

winter flounder
(Pseudopleuronectes americanus)

Date	Total Collected	Size Range (mm)	Mean (mm)
<u>Station 16</u>			
9/27	140	240-484	349
10/18	306	215-442	334
11/17	270	220-509	328
12/14	25	245-429	319

Mummichogs were recorded within Salem Harbor after mid-November, and striped killifish were sampled only during August and September.

Winter flounder were more abundant, and larger, at the deeper offshore stations. Juvenile blackbacks (30 - 110mm) were sampled through mid-November at 120 ft. seine Stations 11 and 13, while juvenile and adults (50 - 364mm) were taken from intermediate water depths at Stations 12 and 14 by 30 ft. trawl. Flounder collected from the deep water 49 ft. trawl station (Station 16) ranged from 215 - 509 mm.

Species diversification was greatest at the trawl stations from mid-October to mid-November (Table 9). Sampling by all methods indicated total species decline through December.

Table 10 classifies the 35 finfish species collected since project inception.

Personnel monitor the power plant intake daily for juvenile and adult finfish and invertebrates. Sluiceway traps will be designed and installed in the intake flows to units 3 and 4. Marine organisms and marine vegetation recorded in the sluiceways are listed in Table 11.

ADMINISTRATION

Although contract agreements were signed October 7, 1971, personnel appointments and equipment requisitions were

Table 9. Diversification index of finfish species
by method of capture, Beverly-Salem Harbors,
July - December, 1971.

Date	50' Seine Total Species	120' Seine Total Species	30' Trawl Total Species	49' Trawl Total Species
7/21	5			
7/22		4		
8/18	3			
8/19		5		
9/10		6		
9/15	7			
9/17			8	
9/22	2			
9/27				4
10/15		5		
10/18				6
10/19	6			
10/20			10	
11/5			15	
11/8	4			
11/9	5			
11/15		4		
11/17				13
12/6	2			
12/7		2		
12/8		1		
12/10	1			
12/14				5
12/29			4	

Table 10. Classification of finfish species
collected in Beverly - Salem Harbor,
July - December, 1971.

Class: CHONDRICHTHYES

Order: RAJIFORMES

Family: Rajidae - Skate

Class: OSTEICHTHYES

Order: ANGUILLIFORMES

Family: Anguillidae - freshwater eels

Anguilla rostrata (Lesueur) - American eel

Order: CLUPEIFORMES

Family: Clupeidae - herrings

Alosa aestivalis (Mitchill) - blueback herring

Alosa pseudoharengus (Wilson) - alewife

Clupea harengus harengus Linnaeus - Atlantic herring

Order: SALMONIFORMES

Family: Osmeridae - smelts

Osmerus mordax (Mitchill) - rainbow smelt

Order: LOPHIIFORMES

Family: Lophiidae - goosefishes

Lophius americanus Valenciennes - goosefish

Order: GADIFORMES

Family: Gadidae - codfishes

Gadus morhua Linnaeus - Atlantic cod

Microgadus tomcod (Walbaum) - Atlantic tomcod

Urophycis chuss (Walbaum) - red hake

Family: Zoarcidae - eelpouts

Macrozoarces americanus - (Bloch and Schneider) - ocean pout

Order: ATHERINIFORMES

Family: Cyprinodontidae - killifishes

Fundulus heteroclitus (Linnaeus) - mummichog

Fundulus majalis (Walbaum) - striped killifish

Family: Atherinidae - silversides

Menidia menidia (Linnaeus) Atlantic silverside

Order: GASTEROSTEIFORMES

Family: Gasterosteidae - sticklebacks

Apeltes quadracus (Mitchill) - fourspine stickleback

Gasterosteus aculeatus Linnaeus - threespine stickleback

Pungitius pungitius (Linnaeus) - ninespine stickleback

Family: Syngnathidae - pipefishes and seahorses

Syngnathus fuscus Storer - northern pipefish

Table 10. continued

Order: PERCIFORMES

Family: Pomatomidae - bluefishes

Pomatomus saltatrix (Linnaeus) - bluefish

Family: Carangidae

Caranx hippos (Linnaeus) - crevalle jack

Decapterus macarellus (Cuvier) - mackerel scad

Family: Labridae - wrasses

Tautoglabrus adspersus (Walbaum) - cunner

Family: Mugilidae - mullets

Mugil cephalus Linnaeus - striped mullet

Family: Pholidae - gunnels

Pholis gunnellus (Linnaeus) - rock gunnel

Family: Ammodytidae - sand lances

Ammodytes americanus DeKay - American sand lance

Family: Cottidae - sculpins

Hemitripterus americanus (Gmelin) - sea raven

Myoxocephalus aeneus (Mitchill) - grubby

Myoxocephalus octodecemspinosus - (Mitchill)- longhorn sculpin

Myoxocephalus scorpius (Linnaeus) - shorthorn sculpin

Family: Cyclopteridae - lumpfishes and snailfishes

Cyclopterus lumpus Linnaeus - lumpfish

Family: Dactylopteridae - flying gurnards

Dactylopterus volitans (Linnaeus) - flying gurnard

Order: PLEURONECTIFORMES

Family: Bothidae - lefteye flounders

Scophthalmus aquosus (Mitchill) - windowpane

Family: Pleuronectidae - righteye flounders

Limanda ferruginea (Storer) - yellowtail flounder

Pseudopleuronectes americanus (Walbaum) - winter flounder

Table 11. Marine organisms and marine vegetation observed
in the Power Plant intake sluiceways, December, 1971.

FINFISH

<u>Brevoortia tyrannus</u> (Latrobe)	Atlantic menhaden
<u>Osmerus mordax</u> (Mitchill)	rainbow smelt
<u>Fundulus majalis</u> (Walbaum)	striped killifish
<u>Gasterosteus aculeatus</u> (Linnaeus)	threespine stickleback
<u>Moxocephalus scorpius</u> (Linnaeus)	shorthorn sculpin
<u>Menidia menidia</u> (Linnaeus)	Atlantic silverside
<u>Scophthalmus aquosus</u> (Mitchill)	windowpane
<u>Pseudopleuronectes americanus</u> (Walbaum)	winter flounder

INVERTEBRATES

<u>Metridium senile</u>	sea anemone
<u>Cerebratulus lacteus</u>	ribbon worm
<u>Mytilus edulis</u>	blue mussel
<u>Mya arenaria</u>	soft shell clam
<u>Glycera dibranchiata</u>	blood worm
<u>Gammarus</u> sp.	
<u>Cancer septemspinosa</u>	sand shrimp
<u>Cancer irroratus</u>	common rock crab
<u>Asterias forbesii</u>	common starfish

VEGETATION

<u>Ulva lactuca</u>	sea lettuce
<u>Fucus spiralis</u>	rock weed
<u>Laminaria rostrata</u>	kelp
<u>Spartina alterniflora</u>	salt water cord grass
<u>Zostera marina</u>	eel grass

delayed until a financial account was established for this project. On December 20 Arthur Chesmore and David Brown transferred from another Division project to the positions of Research Analyst and Marine Fisheries Biologist, respectively. Mr. James Kinch joined our staff on December 27 as Assistant Marine Fisheries Biologist. The half-time Laboratory Technician position was filled on January 10, 1972, by Miss Patricia Rule; and Howard Daigle began work as Mate on January 17. Mrs. Mary Ann Gachignard commenced employment on January 31 as Senior Clerk Stenographer.

Requisition and purchase of equipment and supplies took priority during the first quarter. Full sampling operation is planned for the second quarter.

Project expenditures as of December 31, 1971 were:

	<u>Total Allotted</u>	<u>Total Expended</u>	<u>Balance</u>
Salaries	\$12,250.00	\$ 1,003.15	\$11,246.85
Travel	400.00	-0-	400.00
Office & Laboratory Supplies	3,050.00	660.19	2,389.81
Equipment	20,000.00	12,916.10	7,083.90
Maintenance	200.00	-0-	200.00
Overhead	<u>2,850.00</u>	<u>506.50</u>	<u>2,343.50</u>
TOTALS:	\$38,750.00	\$15,085.94	\$23,664.06