

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

Arthur P. Chesmore, David J. Brown
and Barry A. Ketschke

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1.0 INTRODUCTION

The following is the sixth quarterly progress report of research performed by personnel of the Division of Marine Fisheries operating under contract DMF-2-72 with the New England Power Company. Included are data collected from 1 January through 31 March 1973.

Amendments to our original contract of 7 October 1971 will be executed in April. Modifications include intensified subsurface temperature and current monitoring; C_{14} and ATP tests to determine effects of plant operation on entrainment, primary production, and total biomass; expanded entrapment and impingement studies; increased benthic sampling; and extension of project duration by three months to facilitate two full years of increased sampling intensity and frequency outlined in Progress Report No. 5.

Delivery of one Endeco 110 remote reading current meter and two Endeco 109 recording thermographs was accepted. Two General Oceanic thermographs were returned for full credit due to mechanical failure.

Through the auspices of the Cooperative Fisheries Unit, University of Massachusetts, automatic data processing is being incorporated into our project routine. Initial entry includes summarization of 1972 sport finfish data, but will expand to include all chemical and biological collections.

2.0 PHYSICAL INVESTIGATIONS

2.1 Current

Personnel are familiarizing themselves with a newly procured Endeco 110 current meter. Transects have been established throughout Salem Harbor in preparation of determining tidal current patterns in the vicinity of the plant intake and discharge. Sampling will be initiated during April.

2.2 Temperature

Average surface water temperatures for the quarter declined 6° to 4°C . Only routine monthly sampling was performed, with temperature profiles reflecting isothermic conditions. Endeco 109 continuous recording thermographs replaced the General Oceanic instruments at Stations C and D (Figure 2.1).

Daily recordings were collected at Station D from 2 March to 28 March. Wind and tide action upon the Station C mooring buoy caused the collection of illegible data. Temperature data at Stations A and B is monitored by power plant personnel. Figure 2.2 displays the average weekly surface water temperatures at Stations A - D.

Figure 2.1. Locations of water quality and finfish sampling stations in Salem Harbor.

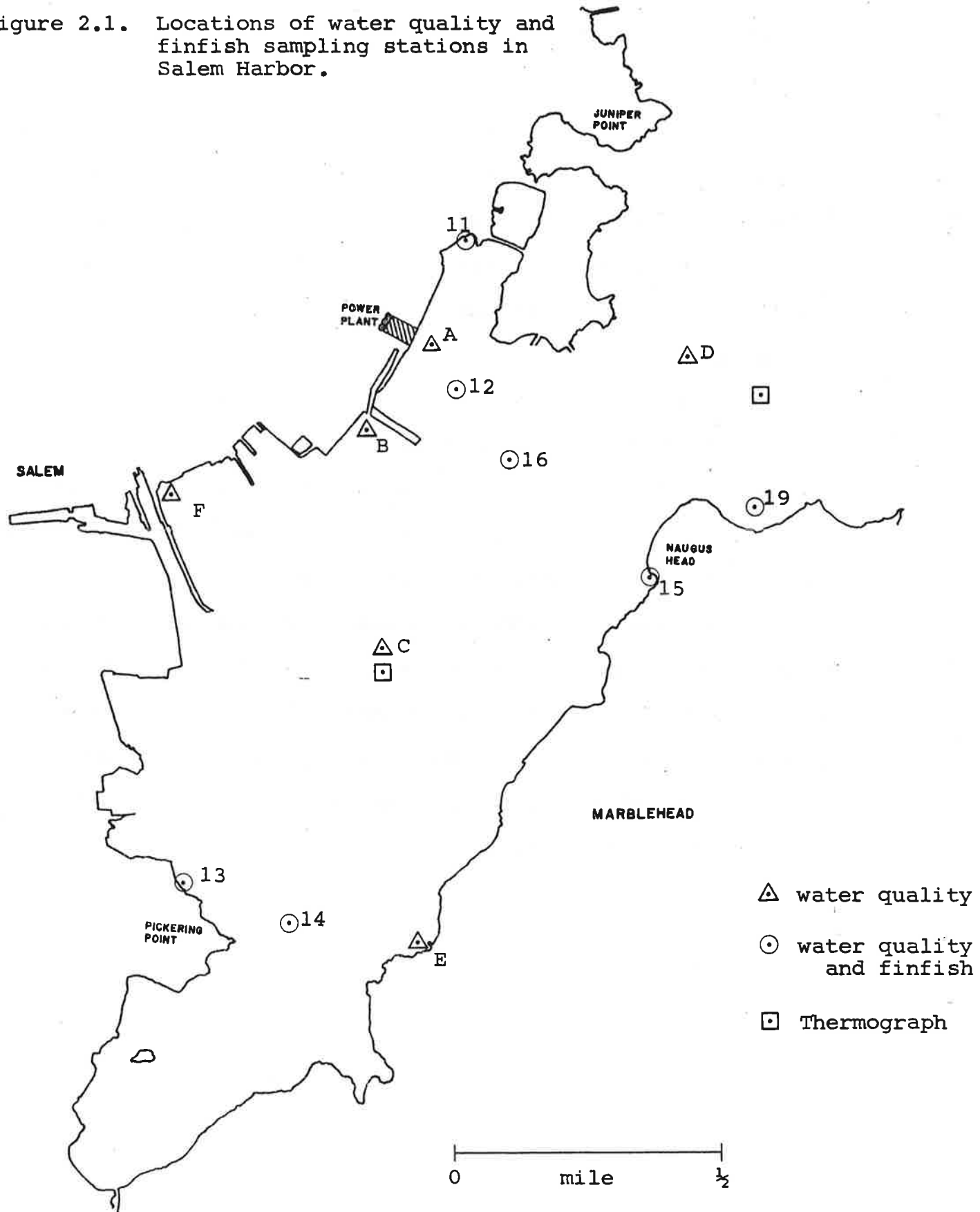
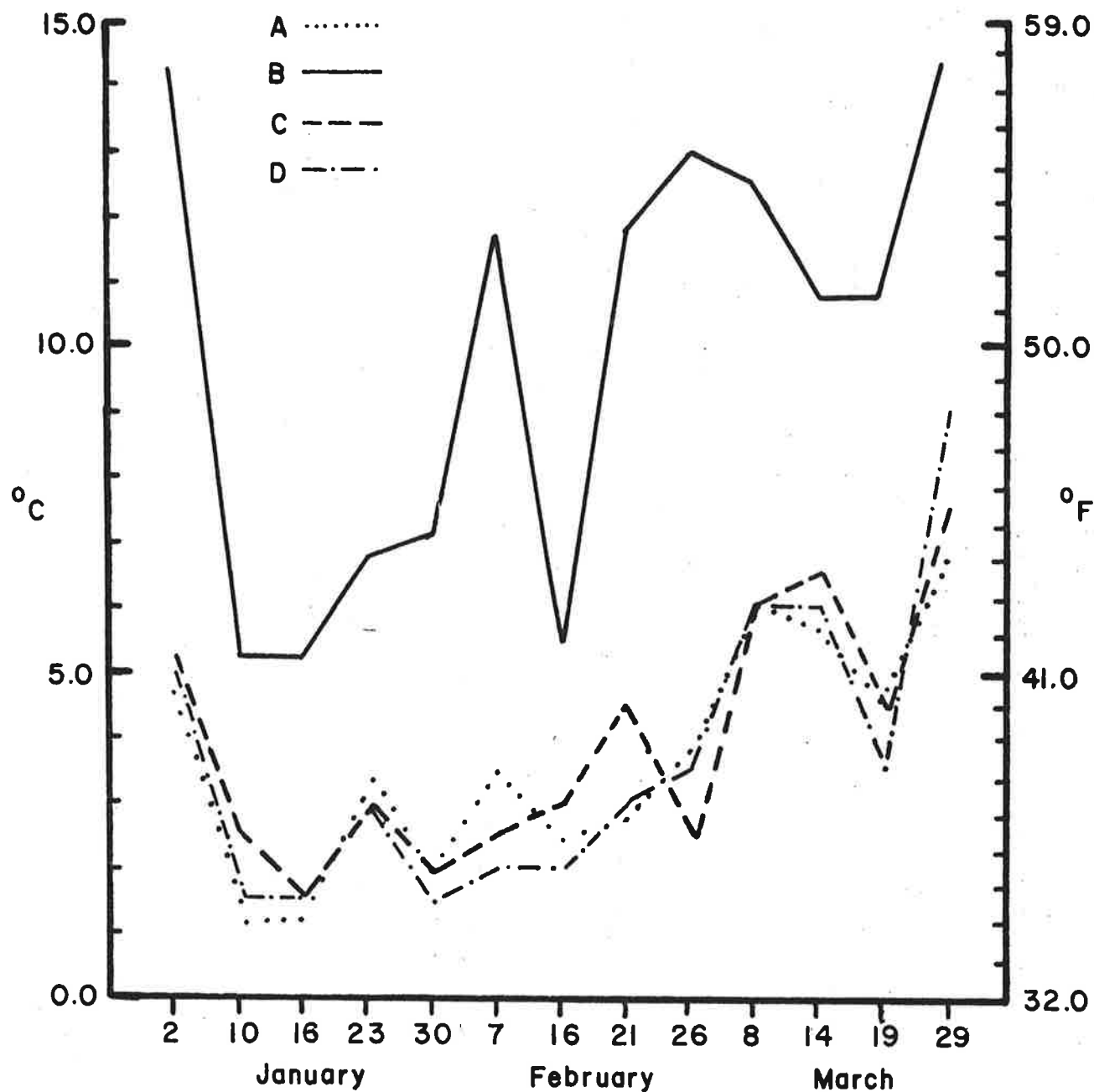


Figure 2.2. Surface water temperatures recorded at stations A - D in Salem Harbor, January - March, 1973.



Note: Units 1 - 4 generated less than full MW capacity during January while NEPEX hydro plants met system demands. Unit 2 received annual overhaul from 13 January to 24 February, and Unit 4 was shut down for maintenance during mid-February.

3.0 CHEMICAL INVESTIGATIONS

3.1 Water Quality

Weekly sampling was initiated at Stations E and F, located on the Marblehead and Salem shores, respectively. Water quality throughout the study area ranged accordingly: surface water temperature, -2.0 - 16.0 C; surface salinity, 17.4 - 33.0 0/00; pH, 8.0 - 8.5; carbon dioxide, 5.0 - 10.0 ppm; dissolved oxygen, 9.2 - 13.1 ppm; biological oxygen demand, 0.5 - 7.8 ppm; nitrite, 0.1 - 3.4 $\mu\text{g-atom/l}$; nitrate, 6.5 - 129.0 $\mu\text{g-atom/l}$; and phosphate, 2.2 - 59.2 $\mu\text{g-atom/l}$ (Table 3.1).

Little variance is noted in water quality when compared to data collected from January through March 1972 (Table 3.2). Surface water temperatures indicate the influence of slightly colder water, and the lower salinity reading (17.4 0/00) reflects excessive storm drainage at the recently established Station E on 15 January. All other salinity recordings for the quarter were above 26.0 0/00. Minimum and maximum nitrite and phosphate values for October through December 1972 have been converted from ppb to $\mu\text{g-atom/l}$. Water quality values recorded during the past 18 months have not been limiting factors to marine life in Salem Harbor.

3.2 Heavy Metals

Copper concentrations in soft shell clams, Mya arenaria, ranged from 2.2 - 6.7 ppm; northern lobsters, Homarus americanus, varied from 12.0 - 50.6 ppm; and water ranged from 0.001 to 0.014 ppm (Table 3.3). Duplicate samples, collected

Table 3.1. Continued

DATE	SAMPLE NUMBER	TIME (EST)	TIDAL STAGE (HOURS)	WIND DIR/VEL (MPH)	CLOUD COVER (%)	DEPTH (FEET)	TEMP °C		SALINITY (0/00)	CO2 pH (ppm)	O2 (ppm)	BOD (ppm)	NO2-N ug-aton/L	NO3-N ug-aton/L	PC4-P ug-aton/L	
							AIR	WATER								
Station C																
1/2	000797	1200	high +2½	SW/15	100	S	2.5	5.5	31.6	8.5	10.0	9.8	1.9	1.23	40.3	28.7
1/10	000811	1250	low +4	SW/18	0	S	-2.0	2.5	31.2	8.5	10.0	11.0	2.3	0.10	43.6	24.5
1/16	000825	1415	high +5½	SW/10	10	S	7.0	1.5	32.6	8.5	10.0	11.3	2.6	2.00	46.8	22.3
1/23	000840	1455	high + ½	NW/16	90	S	8.0	3.0	31.8	8.5	10.0	10.7	2.5	1.38	45.2	59.2
1/30	000845	1100	high +3	SW/10	10	S	-9.0	2.0	31.1	8.5	10.0	10.6	2.4	0.23	32.3	17.8
2/7	000867	1245	low +5	NE/8	100	S	2.0	2.5	31.2	8.5	10.0	11.2	2.7	0.41	33.9	19.4
2/16	000879	0930	low +5½	NW/14	100	S	-0.5	3.0	30.4	8.5	10.0	11.1	2.4	0.57	41.9	2.2
2/21	000864	1105	low +3	0	100	S	5.0	4.5	31.0	8.5	10.0	10.9	2.9	0.67	35.5	16.0
2/26	000898	1100	high +5½	0	100	S	-1.0	2.5	31.2	8.5	10.0	10.6		0.82	16.1	21.9
3/8	000915	1250	low +5½	S/6	100	S	11.5	6.0	30.8	8.5	10.0	10.4	2.2			
3/14	000656	1015	high +3	0	100	S	6.0	6.5	30.8	8.5	5.0	11.1	2.5	0.60	31.3	11.4
3/19	000668	1115	high	NW/9	20	S	5.0	4.5	30.5	8.5	10.0	10.6	2.0	0.61	34.3	13.0
3/29	000688	1305	low	E/5	70	S	5.0	7.5	30.5			10.8	3.8			
Station D																
1/2	000798	1230	high +3	SW/14	100	S	2.5	5.0	31.4	8.5	10.0	9.4	1.2	1.13	43.6	27.4
1/10	000814	1350	low +5	SW/12	0	S	-2.0	1.5	31.1	8.5	10.0	11.1	2.6	0.10	45.2	27.7
1/16	000824	1400	high +5½	SW/17	0	S	6.5	1.5	31.6	8.5	10.0	11.3	2.4	1.43	50.0	21.0
1/23	000838	1400	low +5½	NW/15	70	S	7.5	3.0	31.4	8.5	10.0	10.6	2.7	0.92	45.2	29.6
1/30	000846	1120	high +3	SW/12	10	S	-8.5	1.5	30.7	8.5	10.0	10.7	2.2	0.47	33.9	3.5
2/7	000866	1230	low +4½	NE/8	100	S	2.5	2.0	31.4	8.5	10.0	10.7	2.6	0.33	37.1	17.9
2/16	000880	0945	high	N/9	100	S	-1.0	2.0	30.6	8.5	5.0	10.9	2.6	0.72	46.8	3.5
2/21	000887	1030	low +2½	0	100	S	6.0	3.0	31.3	8.5	5.0	11.3	2.9	0.67	33.9	17.4
2/26	000899	1120	high +5½	0	100	S	-2.0	3.5	31.5	8.5	10.0	10.5		1.25	25.8	20.3
3/8	000916	1240	low +5	S/5	100	S	10.0	6.0	30.6	8.5	10.0	10.4	1.8			
3/14	000655	1005	high +3	0	100	S	6.0	6.0	30.7	8.5	5.0	11.1	2.6	0.60	31.4	10.9
3/19	000669	1140	high	NW/13	10	S	4.0	3.5	31.0	8.5	5.0	10.3	1.8	0.53	32.9	14.3
3/29	000687	1250	low	0	70	S	5.5	9.0	30.5			12.3	1.7			

Table 3.1. Water quality data for Salem Harbor, January - March, 1973.

SAMPLE	TIME	TIDAL	WIND	CLOUD	DEPTH	TEMP °C	SALINITY	CO2	O2	BOD	NO2-N	NO3-N	PC4-P		
DATE	NUMBER	(EST)	STAGE	DIR/VEL	COVER	AIR WATER	(0/00)	pH	(ppm)	(ppm)	(ppm)	μg-atom/L			
Station A															
1/2	000796	1245	high +2	0	100	S	2.5 5.5	31.6	8.5	10.0	10.9	2.9	0.82	38.7	27.4
1/10	000813	1420	low +5½	0	0	S	-1.0 2.5	31.2	8.5	10.0	10.8	2.0	0.10	41.9	23.2
1/16	000823	1340	high +5	SW/7	0	S	8.0 1.5	31.6	8.5	10.0	11.4	2.2	1.78	47.6	19.4
1/23	000841	1520	high +1	NW/5	100	S	6.5 3.0	31.8	8.5	10.0	10.8	3.4	0.92	45.2	38.1
1/30	000847	1145	high +3½	0	10	S	-6.0 1.5	31.0	8.5	10.0	10.4	2.4	0.47	38.7	14.2
2/7	000865	1200	low +4	NE/13	100	S	2.0 3.5	31.1	8.5	10.0	11.7	3.3	0.34	33.9	13.2
2/16	000877	0905	low +5	NW/5	100	S	-0.5 3.0	30.7	8.5	10.0	10.8	2.7	0.72	45.2	2.9
2/21	000862	1115	low +3	0	90	S	7.0 4.5	31.3	8.5	10.0	11.0	2.3	0.54	35.5	16.0
2/26	000897	1045	high +4½	0	100	S	-1.0 2.0	31.4	8.5	10.0	10.8		0.66	19.4	18.7
3/8	000913	1130	low +4	0	100	S	15.5 6.5	29.8	8.5	10.0	9.9	2.9			
3/14	000654	1000	high +3	0	100	S	9.0 5.0	31.1	8.5	5.0	10.8	2.7	0.50	30.7	14.9
3/19	000666	1015	low +5	S/5	40	S	7.5 4.0	30.7	8.5	10.0	10.7	2.2	0.61	33.6	13.0
3/29	000686	1210	high +5	0	90	S	7.0 7.0	30.7			13.0	5.0			
Station B															
1/2	000795	1145	high +1½	SW/7	100	S	2.5 13.0	31.5	8.5	10.0	9.7	1.8	1.16	40.3	27.4
1/10	000812	1320	low +4½	SW/8	100	S	1.0 6.0	30.8	8.5	5.0	11.0	2.5	0.30	48.4	24.5
1/16	000826	1430	low	SW/12	10	S	4.5 4.5	31.4	8.5	10.0	11.1	2.1	1.22	53.7	18.1
1/23	000839	1430	high	NW/5	70	S	7.0 5.0	31.5	8.5	10.0	11.3	3.3	1.38	48.4	25.4
1/30	000844	1015	high +2	0	0	S	-8.5 6.5	31.2	8.5	10.0	10.4	2.1	0.23	33.9	10.7
2/7	000868	1310	low +5½	0	100	S	2.0 12.5	31.1	8.5	10.0	12.2	3.8	0.93	33.1	11.3
2/16	000878	0920	low +5½	0	100	S	-0.5 5.5	30.7	8.5	10.0	10.6	2.7	0.57	35.5	2.9
2/21	000863	1135	low +3½	0	90	S	5.0 14.5	31.3	8.5	10.0	10.7	2.7	0.54	35.5	16.0
2/26	000896	1000	high +4	0	100	S	-1.0 10.0	31.4	8.5	10.0	10.6		1.32	6.5	18.7
3/8	000914	1345	high	0	100	S	14.0 16.0	30.9	8.5	10.0	10.1	2.0			
3/14	000657	1020	high +3½	0	100	S	6.0 8.5	31.0	8.5	5.0	10.7	2.7	0.91	34.3	13.6
3/19	000667	1040	low +5½	NW/9	40	S	8.5 15.0	30.6	8.5	10.0	10.6	2.4	0.61	32.1	13.0
3/29	000685	1120	high +4½	0	100	S	3.5 14.0	30.2			10.8	3.8			

Table 3.1. Continued

DATE	SAMPLE NUMBER	TIME (EST)	TIDAL STAGE (HOURS)	WIND DIR/VEL (MPH)	CLOUD COVER (%)	DEPTH (FEET)	TEMP °C AIR WATER	SALINITY (0/00)	pH	CO ₂ (ppm)	O ₂ (ppm)	BOD (ppm)	NO ₂ -N (µg-atoms/L)	NO ₃ -N (µg-atoms/L)	PO ₄ -P (µg-atoms/L)
Station E															
1/15	000818	0950	high +2½	NW/5	100	S	1.5 2.0	17.4	8.0	10.0	11.7	0.5	1.93	55.3	19.4
1/19	000833	1050	high	0	0	S	11.0 3.5	33.0	8.5	10.0	10.8	3.2	1.61	46.8	50.8
1/26	000842	0910	high +4½	NW/6	0	S	0.0 -0.5	26.1	8.0	10.0	11.6	2.8	0.34	96.8	49.7
2/1	000851	0940	high	0	100	S	-12.0 0.0	30.4	8.5	10.0	11.5	2.4	0.67	33.9	18.7
2/8	000869	0950	low +1½	0	100	S	3.0 3.0		8.5	10.0	11.0	5.3	0.93	129.0	
2/12	000872	1500	low +2½	N/9	100	S	-5.5 0.5	29.3	8.5	10.0	11.6	2.8	0.65	12.9	17.8
2/22	000892	1410	low +5½	0	100	S	4.5 3.0	30.4	8.5	10.0	11.0		0.98	12.9	31.2
2/27	000900	1010	high +3½	0	70	S	-4.5 2.0	31.0	8.5	10.0	11.6		0.49	12.9	21.8
3/7	000911	1150	low +5	0	100	S	4.0 6.0	30.7	8.5	10.0	10.4	1.6	0.41	57.1	23.8
3/15	000662	1015	high +2	0	100	S	6.0 6.0	30.0	8.5	5.0	11.0	2.4	0.40	42.9	21.4
3/23	000678	1310	low +5	N/12	10	S	9.5 3.5	29.4	8.5	10.0	11.3	4.3	0.30	44.3	27.2
3/27	000680	1340	low +½	N/5	0	S	8.5 7.0	30.2	8.5	10.0	10.8	7.8		31.4	16.1
Station F															
1/15	000819	1020	high +3	0	100	S		31.5	8.5	10.0	11.1	3.1	3.36	60.5	21.0
1/19	000834	1110	high	S/7	0	S	10.0 5.0	31.1	8.5	10.0	10.7	3.8	1.38	45.2	28.8
1/26	000843	0950	high +5	NW/8	0	S	4.0 3.0	31.8			11.4	3.3	0.34	35.5	14.2
2/1	000852	1425	high +4½	0	100	S	-6.5 0.0	30.7	8.5	10.0	11.4	2.3	0.53	32.3	16.1
2/8	000870	1010	low +1½	0	100	S	3.0 4.5	29.4	8.5	5.0	11.0	2.4	0.73	31.5	12.4
2/12	000871	1430	low +2	N/5	100	S	-4.0 3.5	29.6	8.5	10.0	11.6	2.5	0.91	16.1	14.3
2/22	000893	1525	high +½	0	100	S	4.5 3.0	31.2	8.5	10.0	11.1		1.32	6.5	25.0
2/27	000901	1030	high +4	NW/5	100	S	-4.5 4.0	31.4	8.5	5.0	10.7		0.82	6.5	20.3
3/7	000912	1250	high	0	100	S	3.5 6.5	31.2	8.5	10.0	10.5	2.6	0.54	35.7	8.9
3/15	000661	1115	high +3	S/6	100	S	4.5 7.5	30.4	8.5	5.0	10.6	6.7	0.70	51.4	24.8
3/23	000679	1330	low +5½	N/9	10	S	9.5 5.5	30.8	8.5	10.0	10.3	3.9	0.26	32.1	17.6
3/27	000681	1400	low +1	0	0	S	6.0 8.5	30.8	8.5	10.0	10.9	4.7		25.0	13.4

Table 3.1. Continued

DATE	SAMPLE NUMBER	TIME (EST)	TIDAL STAGE (HOURS)	WIND DIR/VEL (MPH)	CLOUD COVER (%)	DEPTH (FEET)	TEMP °C AIR	TEMP °C WATER	SALINITY (0/00)	pH	CO ₂ (ppm)	O ₂ (ppm)	BOD (ppm)
<u>Station 5</u>													
1/11	000808	0915	high +3	SW/12	0	S	-6.0	0.5		8.5	5.0	11.3	2.0
1/24	000837	0900	low	SW/10	100	S	5.5	3.0	32.5	8.5	10.0	11.3	3.3
2/14	000874	0930	high +1½	NW/12	0	S	0.0	1.5	33.0	8.5	10.0	11.2	2.6
3/1	000903	0930	high +1	0	10	S	1.0	2.0	32.5	8.5	10.0	11.3	3.8
3/13	000923	0930	high +3½	W/6	0	S	6.0	4.5	31.5	8.5	10.0	11.1	1.2
3/29	000682	0930	high +2½	0	100	S	0.5	3.0	29.5	8.5	5.0	12.5	4.0
<u>Station 11</u>													
1/2	000792	0845	low +5	SW/7	10	S	5.0	5.0	30.0	8.5	10.0	10.2	2.0
1/3	000799	0930	low +5½	W/6	0	S	-1.0	3.5	29.5	8.5	10.0	10.2	2.1
1/15	000815	0810	high +1	0	100	S	2.0	1.0	32.5	8.5	10.0	10.7	2.0
1/16	000820	0815	high	0	0	S	1.0	0.5		8.5	10.0	11.4	3.6
2/1	000849	1310	high +3½	0	100	S	-7.5	-1.0	31.5	8.5	5.0	11.5	2.7
2/2	000853	0950	low +5½	0	100	S	4.5	2.0	30.0	8.5	10.0	10.7	3.6
2/21	000888	1330	low +5½	S/8	10	S	5.0	4.5	31.5	8.5	5.0	11.2	
2/22	000895	1300	low +4½	0	100	S	5.0	3.0	31.0	8.5	10.0	11.8	
3/1	000905	0920	high +1	0	60	S	1.0	4.5	31.6	8.5		11.0	2.0
3/7	000908	1020	low +3½	0	100	S	4.0	4.5	30.5	8.5	10.0	10.6	2.2
3/15	000658	0915	high +1	S/5	100	S	5.0	6.5	30.5	8.5	10.0	11.0	2.9
3/16	000665	0920	high	0	100	S	10.5	7.0	31.5	8.5	5.0	9.8	2.5
<u>Station 12</u>													
1/5	000803	1030	low +5	0	100	S	3.0	5.5	30.5	8.5	5.0	9.7	1.2
1/18	000828	0900	low +5	NW/5	100	S	8.5	2.0	32.0	8.5	5.0	10.5	2.6
2/5	000860	1030	low +4	0	70	S	3.0	3.5	32.0	8.5	5.0	10.4	2.4
2/20	000881	1150	low +5	S/6	20	S	5.0	2.5	32.0	8.5	5.0	11.4	2.5
3/8	000919	1115	low +4	S/7	100	S	14.5	7.5	31.5	8.5	10.0	10.4	2.0
3/21	000673	1215	low +5½	N/5	90	S	2.5	4.0	31.0	8.5	10.0	11.1	2.2

Table 3.1. Continued

DATE	SAMPLE NUMBER	TIME (EST)	TIDAL STAGE (HOURS)	WIND DIR/VEL (MPH)	CLOUD COVER (%)	DEPTH (FEET)	TEMP °C AIR	TEMP °C WATER	SALINITY (0/00)	pH	CO ₂ (ppm)	O ₂ (ppm)	BOD (ppm)
Station 15 (Continued)													
3/1	000906	1010	high +2	0	30	S	4.5	3.0	31.1	8.5		11.0	2.7
3/7	000909	1120	low +4½	0	100	S	4.0	5.0	30.5	8.5	10.0	10.3	1.9
3/15	000659	0945	high +2	0	100	S	6.0	6.0	30.5	8.5	10.0	11.0	3.0
3/16	000664	1025	high +1	NW/7	100	S	12.0	8.0	29.0	8.5	5.0	10.6	3.2
Station 16													
1/11	000809	1120	low +5½	SW/16	0	S	-3.0	2.0		8.5	10.0	11.4	3.3
1/24	000836	1105	low +2	SW/15	10	S	5.5	4.0	33.0	8.5	10.0	10.6	2.6
2/14	000875	1130	high +3½	NW/8	0	S	4.0	4.5	32.5	8.5	10.0	11.0	2.6
3/1	000904	1130	high +3	S/10	10	S	3.5	4.5	32.5	8.5	5.0	11.2	2.7
3/13	000924	1130	high +5½	0	10	S	9.0	6.0	31.0	8.5	10.0	11.1	2.9
3/29	000683	1100	high +4	0	100	S	3.0	9.0	29.5	8.5	5.0	11.5	
Station 17													
1/11	000810	1310	low +3	SW/15	0	S	-2.5	2.0		8.5	10.0	11.3	3.2
1/24	000835	1330	low +4½	NW/10	100	S	4.0	3.0	32.5	8.5	10.0	10.7	2.5
2/14	000876	1255	high +4	0	0	S	6.0	2.0	33.0	8.5	5.0	11.2	1.6
3/1	000902	1300	high +4½	SW/12	0	S	4.0	2.0	32.0	8.5	5.0	11.4	3.3
3/13	000925	1300	low +1	0	0	S	8.0	4.5	30.5	8.5	5.0	11.1	2.8
3/29	000684	1240	low	0	40	S	5.0	4.0	30.0	8.5	10.0	13.1	6.4
Station 19													
1/5	000804	1130	high	SW/10	60	S	2.0	5.0	31.0	8.5	10.0	10.4	1.9
1/18	000829	1100	high +1		100	S	12.0	2.5	32.5	8.5	10.0	11.0	3.2
2/5	000859	1100	low +4½	NW/9	30	S	5.5	3.0	31.0	8.5	5.0	11.1	2.5
2/20	000883	1215	low +5½	0	10	S	7.0	2.0	33.0	8.5	5.0	11.2	3.3
3/8	000918	1200	low +4½	S/5	100	S	13.5	6.0	31.0	8.5	10.0	10.4	2.4
3/21	000670	1130	low +5	N/6	90	S	3.0	4.0	31.0	8.5	10.0	11.2	2.0

Table 3.1. Continued

DATE	SAMPLE NUMBER	TIME (EST)	TIDAL STAGE (HOURS)	WIND DIR/VEL (MPH)	CLOUD COVER (%)	DEPTH (FEET)	TEMP °C AIR WATER	SALINITY (0/00)	pH	CO ₂ (ppm)	O ₂ (ppm)	BOD (ppm)
							<u>Station 13</u>					
1/2	000794	1015	high + ½	SW/5	30	S	2.5 5.0	29.5	8.5	10.0	10.4	2.6
1/3	000801	1130	high +1½	NW/6	0	S	-1.0 3.0	29.5	8.5	10.0	10.7	2.5
1/15	000817	1010	high +2½	0	100	S	2.5 1.5	32.0	8.5	10.0	11.5	2.4
1/16	000821	1000	high +1½	SW/6	10	S	2.5 1.0	32.5	8.5	10.0	10.7	1.8
2/1	000850	1400	high +4	0	100	S	-7.0 0.0	32.5	8.5	10.0	10.9	1.7
2/2	000855	1240	high +2	SW/5	100	S	8.5 2.5	32.0	8.5	10.0	11.2	3.2
2/21	000890	1430	high + ½	S/5	10	S	5.0 3.5	32.0	8.5	10.0	11.3	
2/22	000894	1500	high	0	100	S	4.0 2.5	31.0	8.5	10.0	11.1	
3/1	000907	1050	high +2½	0	10	S	5.0 5.0	31.6	8.5		11.4	4.6
3/7	000910	1230	high	N/7	100	S	4.0 5.5	30.0	8.5	10.0	10.2	4.5
3/15	000660	1040	high +2½	S/5	100	S	4.0 6.5	30.5	8.5	5.0	11.2	2.6
3/16	000663	1115	high +2	0	100	S	15.0 7.0	30.5	8.5	5.0	11.2	2.9
							<u>Station 14</u>					
1/5	000802	0945	low +4½	SW/8	80	S	3.0 5.0	29.5	8.5	5.0	9.2	2.5
1/18	000827	0820	low +4½	0	100	S	9.0 2.5	32.0	8.5	5.0	11.1	2.5
2/5	000861	1000	low +3½	N/5	70	S	4.0 3.5	31.5	8.5	10.0	11.2	3.3
2/20	000882	1100	low +4	S/10	70	S	4.0 2.5	32.5	8.5	10.0	11.5	2.7
3/8	000917	1300	low +5½	0	100	S	11.0 6.5	30.0	8.5	10.0	10.3	3.5
3/21	000671	1050	low +4	N/5	100	S	2.5 5.5	30.5	8.5	5.0	11.0	2.5
							<u>Station 15</u>					
1/2	000793	0935	high	SW/12	20	S	2.5 5.0	29.0	8.5	10.0	10.2	1.7
1/3	000800	1050	high +1½	W/8	0	S	-1.0 2.5	26.5	8.5	5.0	10.8	2.4
1/15	000816	0925	high +2	NW/6	100	S	2.0 0.0	31.0	8.5	10.0	11.6	2.4
1/16	000822	0930	high +1	SW/5	10	S	2.5 0.5	30.0	8.5	10.0	11.5	
2/1	000848	0915	low +5½	N/5	100	S	-12.5 -2.0	31.5	8.5	10.0	12.3	3.6
2/2	000854	1130	high +1	0	100	S	3.5 1.5	29.0	8.5	10.0	10.9	3.4
2/12	000873	1530	low +3	0	100	S	-4.5 1.5		8.5	10.0	11.6	3.4
2/21	000889	1405	high	S/5	10	S	7.5 2.0	31.0	8.5	10.0	11.6	
2/22	000891	1350	low +5½	0	100	S	5.5 3.0	30.5	8.5	5.0	11.0	

Table 3.2. Comparative water quality data for Salem Harbor, July 1971 - March 1973.

		1971	1972				1973
		July-Dec	Jan-Mar	Apr-June	July-Sept	Oct-Dec	Jan-Mar
Temperature (°C)	Min	4.5	0.0	4.5	11.5	4.5	-2.0
	Max	24.0	16.0	21.5	23.0	22.5	16.0
	Ave	13.1	4.7	11.5	19.0	11.2	4.4
Salinity (0/00)	Min	29.3	31.1	26.6	29.6	29.1	17.4
	Max	32.9	35.0	32.9	31.4	32.5	33.0
	Ave	30.8	32.7	30.0	29.8	30.3	30.8
pH	Min	8.0	8.0	8.0	8.0	8.0	8.0
	Max	8.0	9.0	8.0	8.0	8.5	8.5
	Ave	8.0	8.3	8.0	8.0	8.1	8.5
CO ₂ (ppm)	Min	5.0	5.0	5.0	5.0	5.0	5.0
	Max	10.0	10.0	10.0	10.0	10.0	10.0
	Ave	7.5	8.2	7.5	5.8	7.9	8.8
O ₂ (ppm)	Min	6.4	8.7	8.5	7.0	7.6	9.2
	Max	9.7	11.3	13.2	9.6	12.5	13.1
	Ave	8.1	10.5	9.8	8.3	8.8	10.9
BOD (ppm)	Min		1.4	1.2	1.0	0.8	0.5
	Max		4.7	5.1	3.3	4.0	7.8
	Ave		2.5	2.5	2.2	1.9	2.9
Nitrite - N (µg-atom/l)	Min						0.1
	Max						3.4
	Ave						0.8
Nitrate - N (µg/atom/l)	Min						6.5
	Max						129.0
	Ave						38.3
Phosphate - P (µg-atom/l)	Min						2.2
	Max						59.2
	Ave						19.8

The above table supersedes Table 3.2 of Quarterly Report #6, and reflects corrected nitrite, nitrate and phosphate values for January - March, 1973.

Copy of Table from Progress Report No. 7, April - June 1973.

Investigations of the Effects of Electrical Power Generation on Marine Resources in Salem Harbor, July 1973.

A.P. Chismore, D.T. Brown, B.A. Ketschke, and E.M. Sawin.

Table 3.3. Copper concentrations (ppm) in soft shell clams (Mya arenaria), lobsters (Homarus americanus) and water from Salem Harbor, January - March, 1973.

Date	Station	Soft shell clam	Lobster	Water
1/2	A			0.005
	B			0.014
	C			0.019
1/22	B	6.7	44.9	
	C	4.0	13.5	
1/30	A	4.5	40.7	
		2.2	41.9	
	B	3.6	50.6	
		3.5	49.6	
	C	4.3	17.0	
		3.7	12.0	
2/8	11	4.9		0.004
		3.7		0.002
	13	5.0		0.002
		5.0		0.002
2/26	A	3.1	21.5	0.002
	B	3.4	34.7	0.005
	C	3.6	19.0	0.001
2/28	11	4.1		0.003
		4.0		
	13	5.6		0.004
		5.0		

on January 30 and February 28, indicated insignificant variability in copper concentrations. Detected concentrations in soft shell clams remain below the proposed F.D.A. "alert level" of 25.0 ppm.

4.0 BIOLOGICAL INVESTIGATIONS

4.1 Benthic Survey

Figure 4.1 displays the zonation of the most abundant amphipod, Leptocheirus sp., in Salem Harbor during late winter and early summer 1972. Leptocheirus sp. were not identified at benthic stations above -10 ft MLW. Along transect A, 100 percent of the population was located at the 30 ft depth during March. An approximate equal distribution was observed at the 20 and 30 ft depth levels in July.

Along transect B, 100 percent of the March population was found at the two 20 ft depth stations with relative equal distributions at the -10 and -20 ft contours during July. Distribution along transect C was represented by 100 percent at the 10 ft depth station during both sampling periods.

Kite diagrams (Figures 4.2 and 4.3) show relative diversity of invertebrates sampled during March - April and July, 1972. Each station is represented by a 100 percent population and is compared to other stations along the same transect to show relative percentage overlap of species at various depths.

Late winter sampling was conducted during March. Analysis of November 1972 and March 1973 samples is underway at the William F. Clapp Laboratory.

4.2 Plankton

Phytoplankton and zooplankton analyses is complete through October and August 1972, respectively. Identification was performed under contract by personnel at the William F. Clapp Laboratory.

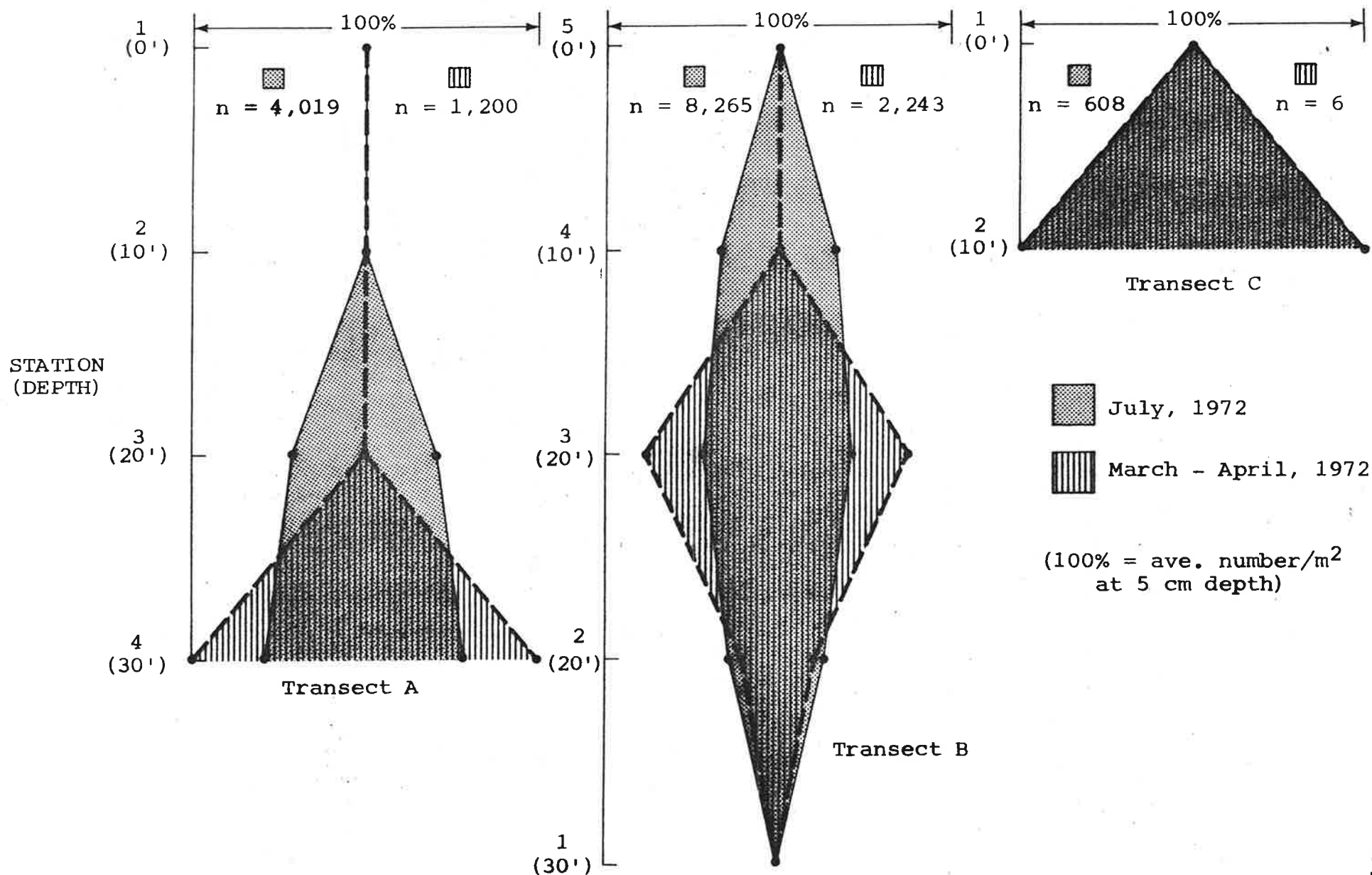


Figure 4.1. Zonation of Leptocheirus sp. along benthic transects in Salem Harbor, March - July, 1972.

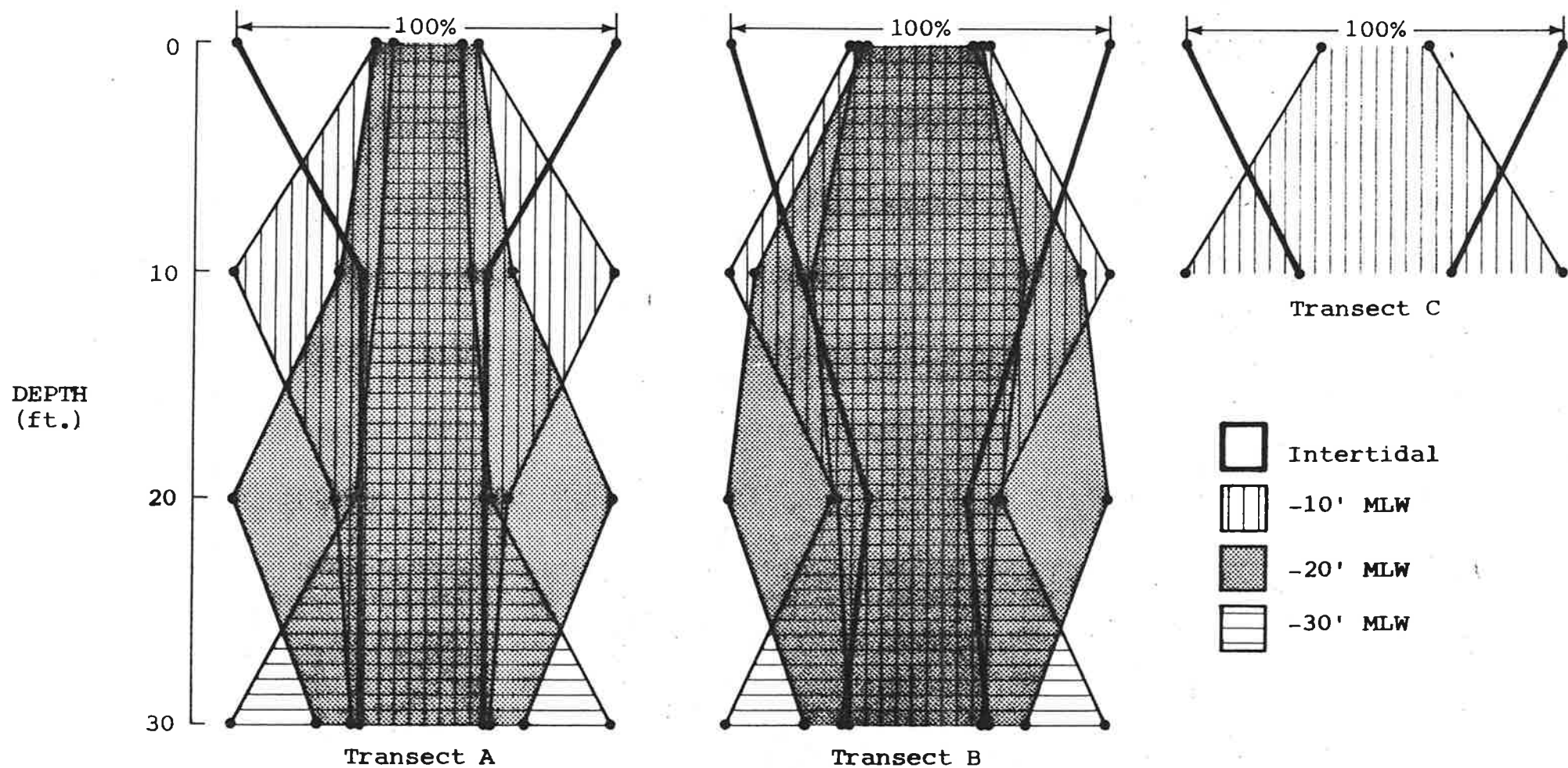


Figure 4.2. Relative diversity (%) of invertebrates along benthic transects in Salem Harbor, March - April, 1972.

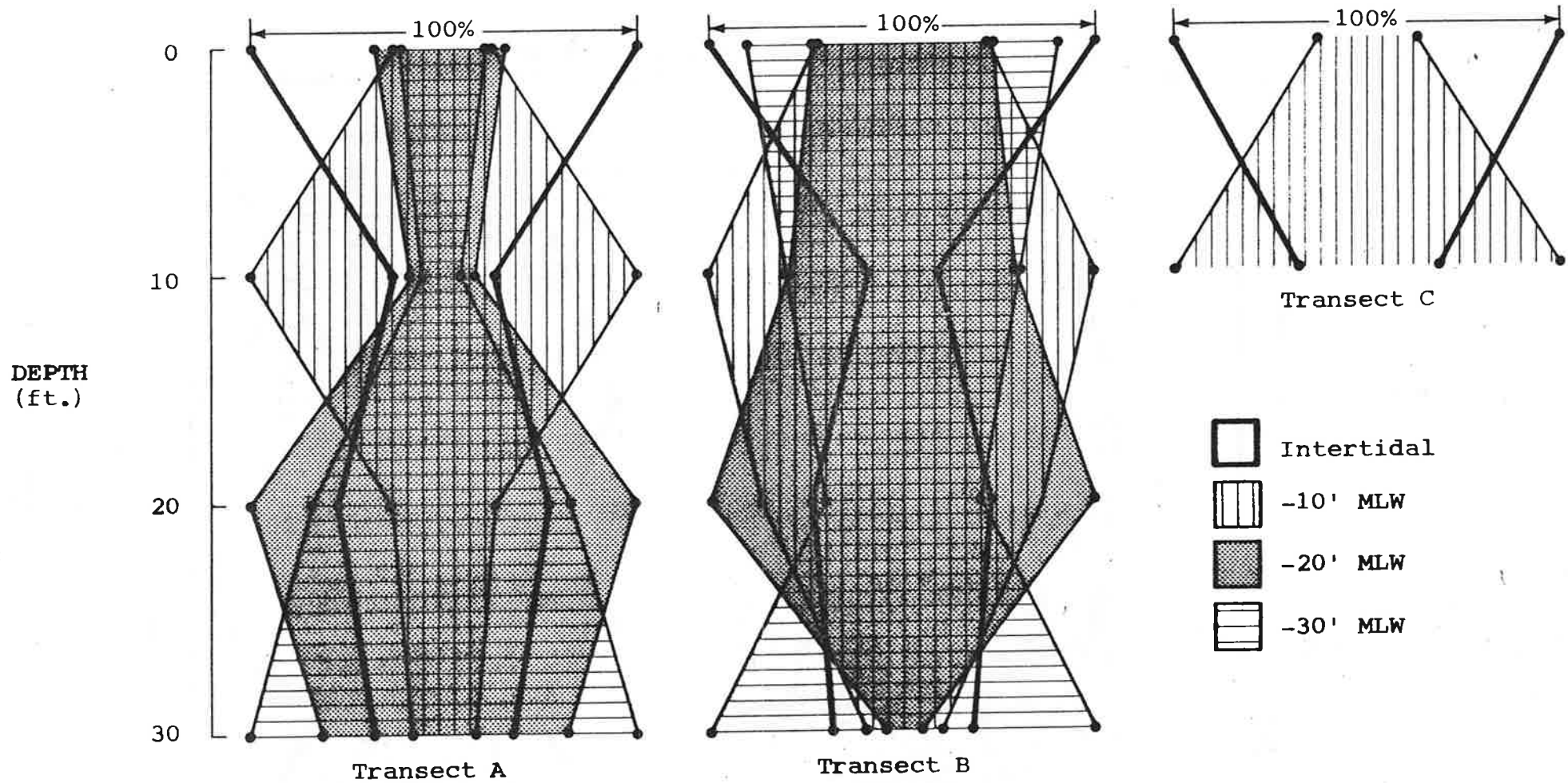


Figure 4.3. Relative diversity (%) of invertebrates along benthic transects in Salem Harbor, July, 1972.

4.2.1 Phytoplankton

Phytoplankton is now collected with a water sampler rather than with an 80 micron plankton net as previously reported. Eight families have been identified (Table 4.1). Future samples will be identified to species, or to the lowest taxon possible.

Bacteriastrea was reported only at Station B (discharge canal) and identified only during August and September. Bidulphiaceae, reported on 5 April at all stations, was reidentified on August 10 and 23 at Station B. Fragilariaceae was reported monthly at all stations except Station C in April and Stations A, C and D in September. Leptocylindraceae was identified only during October. Rhizosoleniaceae was not identified during April and July. Chaetoceraceae, Coscinodiscaceae and Naviculaceae were identified monthly at each station.

Figure 4.4 compares bi-monthly chlorophyll a levels to total phytoplankton at Stations A - D from 5 April through 20 September, 1972. Fluctuations correspond through 12 June. Inverse relationships through the summer period are attributed to clogging in the plankton net, resulting in low flow measurements and higher counts of organisms/m³. Similar inverse patterns were plotted for zooplankton at the William F. Clapp Laboratory.

4.2.2 Zooplankton

Thirty-one zooplankton organisms were identified from March through August (Table 4.2). The most common were

Table 4.1. Occurrence of phytoplankton in Salem Harbor, April - October, 1972.

	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	<u>September</u>	<u>October</u>
Bacteriastaceae					X	X	
Biddulphiaceae	X				X		
Chaetoceraceae	X	X	X	X	X	X	X
Coscinodiscaceae	X	X	X	X	X	X	X
Fragilariaceae	X	X	X	X	X	X	X
Leptocylindraceae							X
Naviculaceae	X	X	X	X	X	X	X
Rhizosoleniaceae		X		X	X	X	X

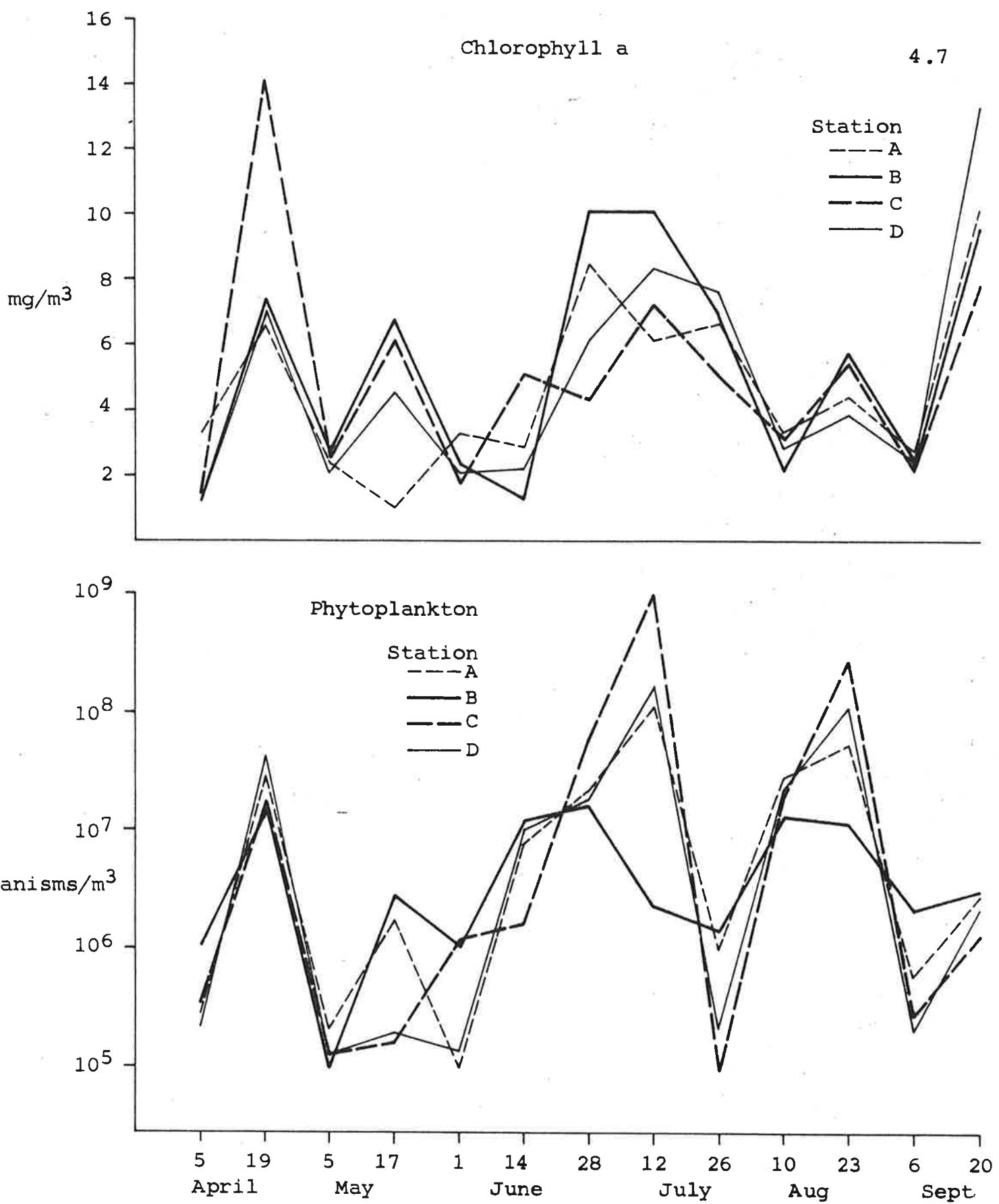


Figure 4.4. Comparison of chlorophyll a and total phytoplankton levels in Salem Harbor, April - September, 1972.

Table 4.2. Occurrence of zooplankton in Salem Harbor, March - August, 1972.

	March	April	May	June	July	August
<u>Acartia tonsa</u>						X
<u>Acartia clausi</u>	X	X	X	X	X	X
<u>Temora longicornis</u>						X
<u>Eurytemora sp.</u>		X				
<u>Eurytemora herdmani</u>	X	X	X	X		X
<u>Centropages hamatus</u>				X		
<u>Paracalanus parus</u>		X				
<u>Paracalanus sp.</u>				X		X
<u>Diaptomus sp.</u>		X		X		X
<u>Calanus finmarchicus</u>			X	X		
<u>Tortanus discaudatus</u>	X					
<u>Harpactius gracilis</u>		X				
<u>Harpactius sp.</u>	X		X	X		
<u>Cyclopoida</u>	X	X	X	X	X	X
Copepod unidentified	X	X	X	X		
Copepod nauplii	X	X	X	X	X	X
Copepod immature	X	X	X	X	X	X
<u>Cirripedia nauplii</u>	X	X	X	X	X	X
<u>Cirripedia cypris</u>		X	X	X		
<u>Malacostraca immature</u>		X	X	X		
Tunicate larvae			X	X		
<u>Nematoda</u>	X			X		
<u>Polychaeta</u>	X	X	X	X	X	X
<u>Medusoids</u>			X	X	X	
Gastropod larvae	X	X	X	X	X	X
Gastropod egg			X	X	X	
<u>Tintinid</u>					X	X
<u>Cladocera</u>		X	X	X	X	
<u>Podon sp.</u>						X
<u>Evadne sp.</u>						X
Bivalve larvae			X	X	X	X

Acartia clausi, Cyclopoida, Copepod nauplii, immature copepod, Cirripedia nauplii, Polychaeta, and gastropod larvae. C. nauplii, immature copepod, Tintinid and Polychaeta were most abundant, respectively. C. nauplii dominated populations monthly except in July when they ranked second to Tintinid. Figure 4.5 displays relative abundance of the four dominant copepods identified.

During March C. nauplii ranged from 622 to 42,677/m³. Eurytemora herdmanni, the second most abundant species, ranged from 82 to 8,320/m³; and Cirripedia nauplii, the third in population magnitude ranged from 22 to 8,245/m³. Thirteen organisms were identified during April.

Diversity increased to 17 in April with the identification of Eurytemora sp., Paracalanus parus, Diaptomus sp., Harpactius gracilis, Cirripedia cypris immature, Malacostraca and Cladocera. C. nauplii ranged from 9,399 to 35,040/m³. Second and third ranking organisms, immature copepods and Acartia clausi ranged from 2,003 to 20,677/m³ and 435 to 3,463/m³, respectively.

C. nauplii populations peaked in May and varied from 2,922 to 971,459/m³. Immature copepods were also more abundant, ranging from 1,470 to 37,509/m³. Tunicate larvae, identified for the first time, ranked third in abundance and ranged from 147 to 12,853/m³. Polychaeta, the fourth ranking organism, ranged from 228 to 7,051/m³. Calanus finmarchicus, Harpactius sp., Medusoides, gastropod eggs and bivalve larvae were also

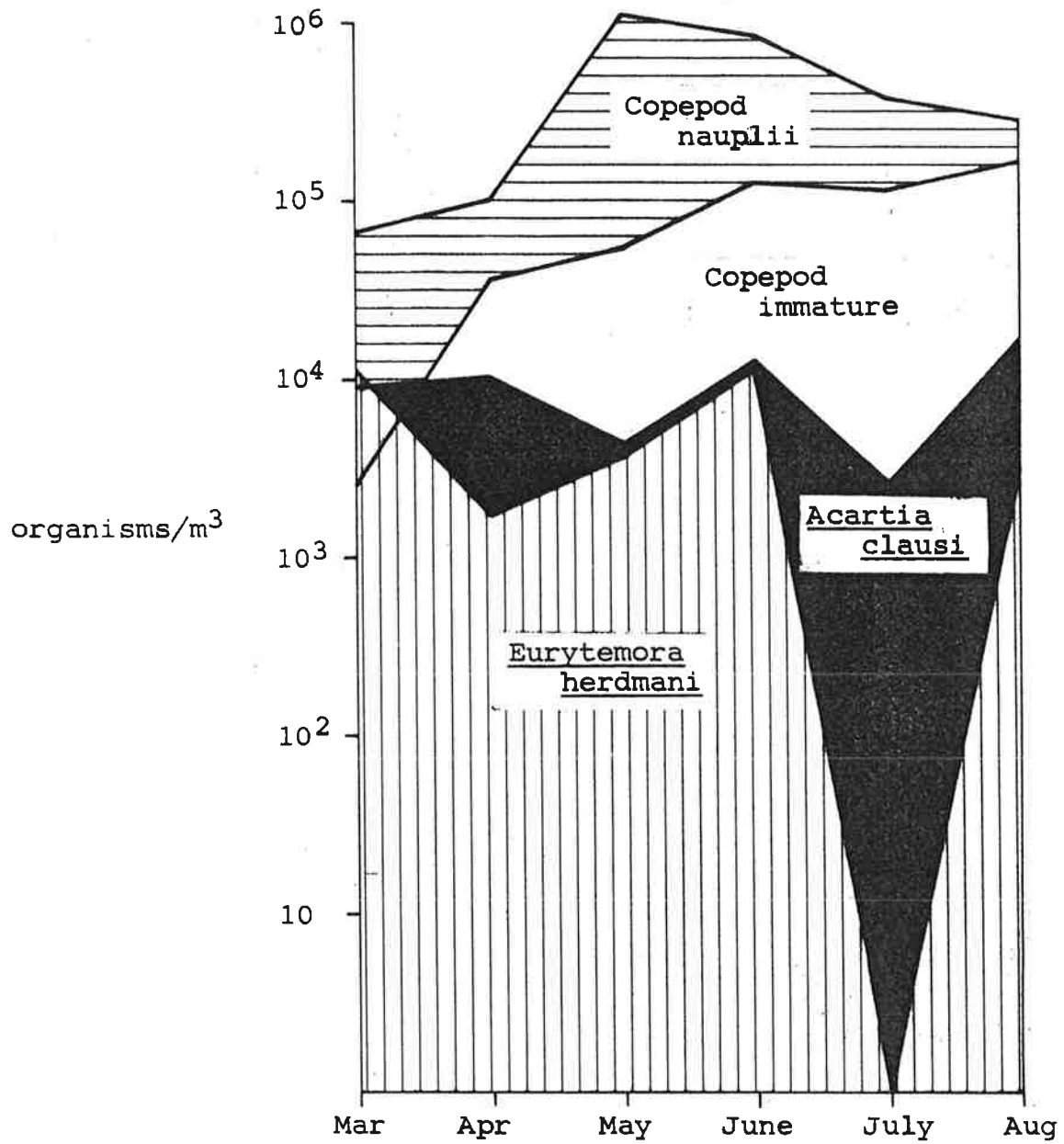


Figure 4.5. Relative abundance of dominant copepods sampled in Salem Harbor, March - August, 1972.

identified for the first time. Eighteen organisms were recorded during May.

C. nauplii and immature copepods continued as the dominant organisms during June, ranging from 92 to 191,812/m³ and 17 to 35,733/m³, respectively. Bivalve larvae increased to the third most abundant organism and ranged from 1 to 10,070/m³.

A. clausi, fourth in abundance, ranged from 1 to 6,446/m³.

Diversity increased to 22 with the identification of Centropages hamatus and Paracalanus sp.

July populations ranked Tintinid over C. nauplii and immature copepod. Tintinid ranged from 13,644 to 398,734/m³; C. nauplii ranged from 20 to 229,574/m³; and immature copepod ranged from 500 to 63,801/m³. Tintinid were identified for the first time during July when organism diversity was least at 13.

C. nauplii regained dominance during August and ranged from 3,943 to 197,730/m³. Immature copepod, the second most abundant organism, peaked during August and ranged from 1,473 to 108,549/m³. Podon sp., recorded for the first time, ranged from 451 to 74,015/m³ and bivalve larvae ranged from 48 to 94,282/m³. Acartia tonsa and Evadne sp. were also recorded for the first time. Sixteen organisms were identified.

4.2.3 Primary Production

Chlorophyll a levels increased slightly (Figure 4.6) while chlorophyll b, c and Carotenoids remained relatively stable (Table 4.3). Recorded ranges were:

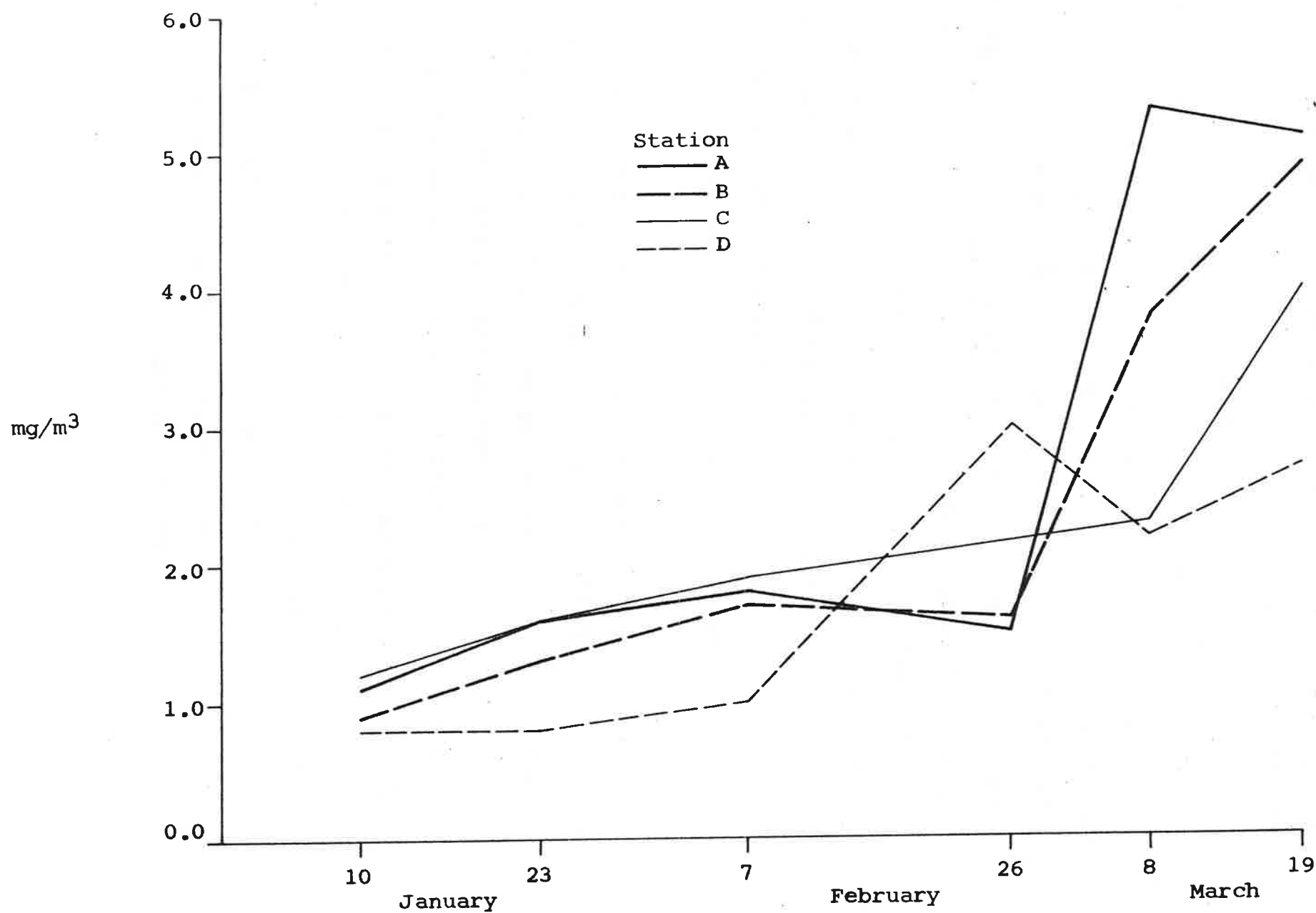


Figure 4.6. Chlorophyll a counts in Salem Harbor, January - March, 1973.

Table 4.3 . Chlorophyll counts (mg/m³) in Salem Harbor
January - March, 1973.

Date	Station	Chlorophyll a	Chlorophyll b	Chlorophyll c	Carotenoids
1/10	A	1.13	1.00	3.84	0.58
	B	0.94	0.95	2.10	0.29
	C	1.25	1.24	3.25	0.14
	D	0.77	0.57	1.55	0.37
1/23	A	1.55	0.22	1.92	0.33
	B	1.34	0.60	0.17	0.05
	C	1.56	0.43	1.08	0.52
	D	0.79	0.42	0.15	0.62
2/7	A	1.76	0.47	1.22	0.65
	B	1.74	0.64	2.39	0.68
	C	1.89	0.55	1.06	0.84
	D	1.05	0.56	2.00	0.27
2/26	A	1.50	0.28	1.89	0.78
	B	1.57	0.40	2.69	1.05
	D	2.97	0.84	3.25	0.68
3/8	A	5.26	1.08	1.36	1.97
	B	3.84	0.59	2.15	1.74
	C	2.33	0.35	1.53	0.67
	D	2.23	0.66	1.04	1.07
3/19	A	5.09	0.11	2.67	2.20
	B	4.92	0.40	3.23	2.37
	C	4.05	0.65	1.96	1.70
	D	2.70	0.23	1.36	1.36

Chlorophyll A	0.77 - 5.26 mg/m ³
B	0.11 - 1.24 mg/m ³
C	0.15 - 3.84 mg/m ³
Carotenoids	0.05 - 2.37 mg/m ³

4.3 Finfish

A total of 1,686 finfish were collected in Salem Harbor (Table 4.4). Winter flounder, Pseudopleuronectes americanus, were most abundant (49%) and were taken primarily at the 49-ft trawl station (Table 4.8). Atlantic silversides, Menidia menidia, dominated catches at the beach seine and 30-ft trawl stations and accounted for 22% of the total sampled (Tables 4.5 - 4.7). Atlantic herring, Clupea harengus harengus, were collected entirely by gill net and ranked third in abundance at 13% (Table 4.9). Length frequency histograms are displayed in Figure 4.7.

An additional 1,184 finfish were sampled outside Salem Harbor. Species composition at these stations was predominated by winter flounder (639) and yellowtail flounder (361). Species diversification was greatest at the 49-ft trawl station (Table 4.10).

4.4 Egg and Larvae

Eight species of fish eggs and seven species of fish larvae were identified during 1972 including cunner, Tautogolabrus adspersus; yellowtail flounder, Limanda ferruginea; tautog, Tautoga onitis; windowpane, Scophthalmus aquosus; witch flounder, Glyptocephalus cynoglossus; pollock, Pollachius virens; haddock, Melanogrammus aeglefinus; snake blenny,

Table 4.4. Rank of finfish collected in Salem Harbor,
January - March, 1973.

Species	Method of Capture						Totals
	50-ft Seine	120-ft Seine	30-ft Trawl	Mid- Water Trawl	49-ft Trawl	Gill Net	
1. winter flounder		9	12	1	783	17	822
2. Atlantic silverside	25	153	197				375
3. Atlantic herring						210	210
4. rainbow smelt					72	28	100
5. fourspine stickleback	1	20	59	2			82
6. threespine stickleback		24	1				25
7. Atlantic tomcod		1				16	17
8. Atlantic cod			1		12	3	16
9. skate*			1		11		12
10. yellowtail flounder					8		8
11. sea raven					6		6
12. windowpane					5		5
13. ninespine stickleback	1	1					2
ocean pout					2		2
pollock						2	2
14. blueback herring		1					1
grubby	—	—	—	1	—	—	1
Totals	27	209	271	4	899	276	1,686

*Not separated by species

Table 4.5. Dominant finfish species collected in Salem Harbor with the 50-ft seine, January - March, 1973.

Atlantic silverside (<u>Menidia menidia</u>)				
Date	Set No.	Total Collected	Size Range (mm)	Mean (mm)
<u>Station 15</u>				
1/2	1	3	70-105	92
2/12	1	3	75-90	84
3/1	2	19	75-114	94

Table 4.6. Dominant finfish species collected in Salem Harbor with the 120-ft seine, January - March, 1973.

Atlantic silverside (<u>Menidia menidia</u>)					threespine stickleback (<u>Gasterosteus aculeatus</u>)		
Date	Set No.	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)
<u>Station 11</u>							
1/3	2				1	-	62
3/16	1				1	-	37
	2				2	50-74	62
<u>Station 13</u>							
1/3	1	1	-	72			
2/22	1	65	70-134	84	1	-	65
3/7	2	24	70-124	103			
3/16	1	1	-	107			
	2				12	30-74	55
<u>Station 15</u>							
1/3	1				1	-	62
	2	2	90-104	97			
2/22	2	1	-	90			
3/7	2	39	75-144	105			
3/16	1	20	80-139	103	5	55-64	57
	2				1	-	57

Table 4.7. Dominant finfish species collected in Salem Harbor with the 30-ft trawl, January - March, 1973.

Atlantic silverside (<u>Menidia menidia</u>)					fourspine stickleback (<u>Apeltes quadracus</u>)		
Date	Set No.	Total Collected	Size Range (mm)	Mean (mm)	Total Collected	Size Range (mm)	Mean (mm)
<u>Station 12</u>							
1/5	1	197	65-139	85			
	2				1	-	52
1/18	1				1	-	52
<u>Station 14</u>							
1/5	1				1	-	47
	2				3	35-64	48
1/18	1				11	35-59	46
	2				7	35-59	46
2/5	2				10	35-59	45
2/20	1				9	30-54	40
	2				13	35-54	45
3/8	1				1	-	47
	2				1	-	52
3/21	2				1	-	40

Table 4.8. Dominant finfish species collected in Salem Harbor with the 49-ft trawl, January - March, 1973.

winter flounder (<u>Pseudopleuronectes americanus</u>)				
Date	Set No.	Total Collected	Size Range (mm)	Mean (mm)
<u>Station 16</u>				
1/11	1	2	280-314	297
	2	4	85-374	277
1/24	1	3	220-344	295
	2	3	275-374	312
2/14	1	3	280-344	305
	2	4	310-364	331
3/1	1	28	225-454	344
	2	24	200-424	313
3/13	1	230	240-474	345
	2	138	195-479	319
3/29	1	104	205-474	320
	2	240	230-474	329

Table 4.9. Dominant finfish species collected in Salem Harbor with gill nets, March, 1973.

Atlantic herring (<u>Clupea harengus harengus</u>)			
Date	Total Collected	Size Range (mm)	Mean (mm)
<u>Station 20</u>			
3/19	134	270-379	313
<u>Station 21</u>			
3/19	76	240-359	298

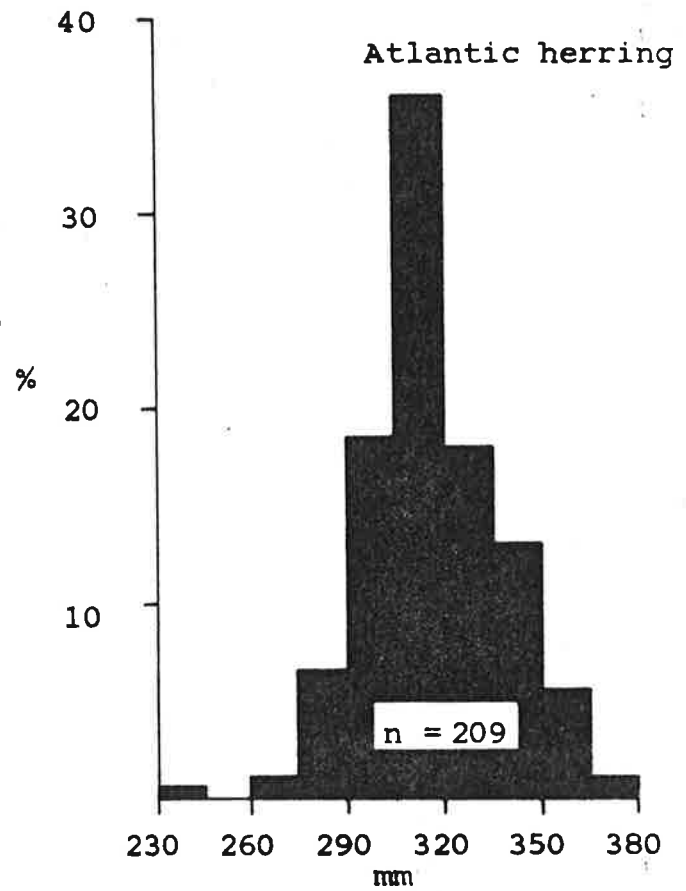
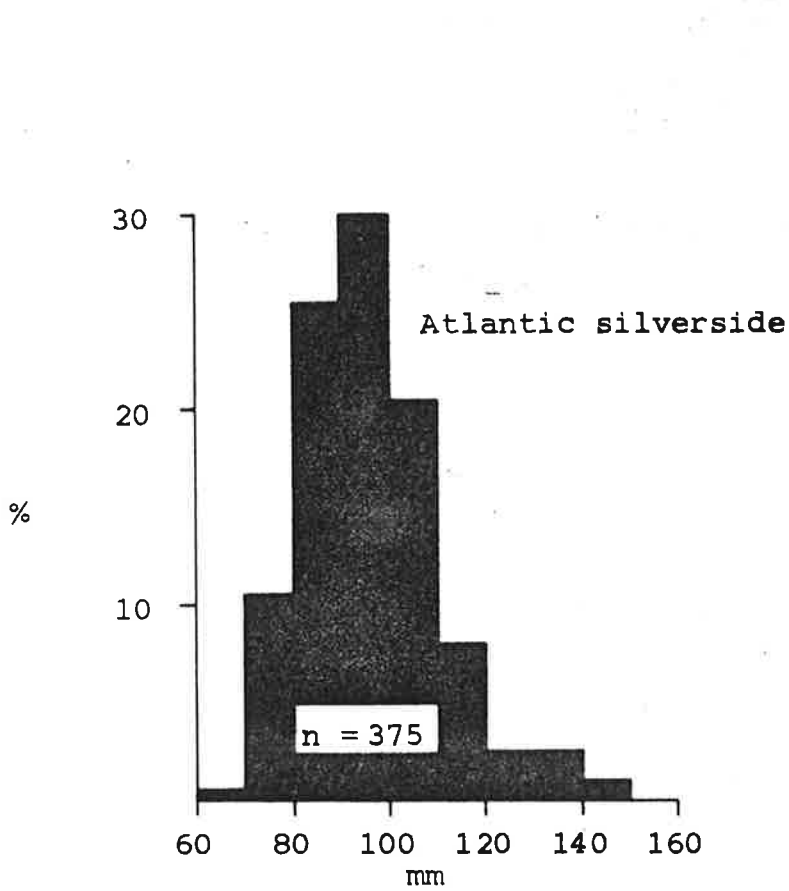
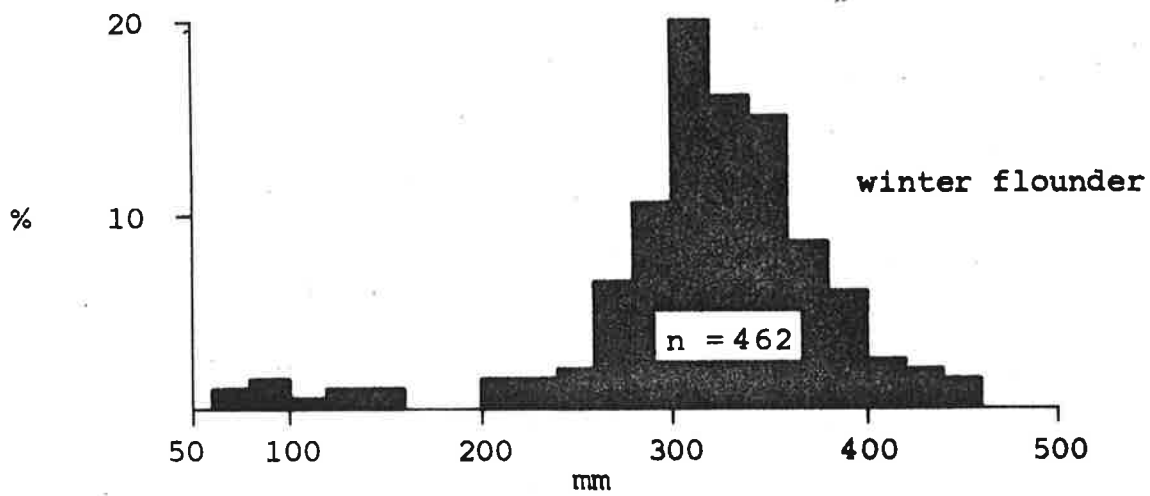


Figure 4.7. Length frequency histograms for dominant finfish species collected in Salem Harbor, January - March, 1973.

Table 4.10. Diversification index of finfish species by method of capture, Salem Harbor, January - March, 1973.

Date	50-ft Seine	120-ft Seine	30-ft Trawl	Midwater Trawl	49-ft Trawl	Gill Net
1/2	2					
1/3		4				
1/5			3	1		
1/11					7	
1/15	1					
1/18			3			
1/24					8	
2/1	1					
2/5			2	1		
2/14					9	
2/20			1			
2/22		2				
3/1	1				5	
3/7		3				
3/8			3			
3/13					9	
3/16		4				
3/20						6
3/21			2	1		

Lumpenus lumpretaeformis, sand lance, Ammodytes spp; longhorn sculpin, Myoxocephalus octodecemspinosus; American plaice, Hippoglossoides platessoides; and Atlantic herring, Clupea harengus harengus. Eggs were also identified from the families Gadidae and Labridae.

Distribution of egg and larvae appears to be similar at all sampling stations. Cunner eggs were identified most frequently and were observed from May through ^{August} October.

4.5 Entrainment and Entrapment

Intake waters to Units 3 and 4 were monitored for 64 hours (Table 4.11). Of 95 finfish captured (14 species) 62% were collected from Unit 4 and 38% were taken from Unit 3.

Winter flounder and threespine stickleback, Gasterosteus aculeatus, were most frequently collected. Mortality from entrapment and/or impingement upon travel screens was 22%. Mortality remains greater from Unit 4 than Unit 3; 31 and 6% respectively.

4.6 Sport Finfish Survey

Recreational fishing within the study area is carried on in about equal proportions from shore (53%) and boat (47%) (Figure 4.8). The majority of shore fishermen utilize the public pier on the north tip of Salem Neck, and to a lesser degree fish from the commercial and private wharves along the west shore of Salem Harbor. The Marblehead, or east shore of Salem Harbor is virtually inaccessible for sport fishing.

Table 4.11. Finfish species collected in the Unit 3 and 4
sluiceways, Salem Harbor, January - March, 1973.

	1/8	1/16	1/16	1/18	1/19	1/22	1/29	1/31
(EST)	0700	0700	1500	0700	0900	1100	0900	1500
	0900	0900	1700	0900	1100	1300	1100	1700
Tidal								
Stage	high	high	low +1	low +4	low +5	low +4½	high +3	low +½
(Hours)								

Species									TOTALS*
				<u>Unit 3</u>					
alewife			1						1 (1)
Atlantic silverside		1						1	2
fourspine stickleback				1					1
				<u>Unit 4</u>					
Atlantic silverside	1								1 (1)
fourspine stickleback					1				1
grubby	1			1					2 (2)
ninespine stickleback								1	1 (1)
striped killifish			1						1
threespine stickleback	4			1	1	2		5	13 (5)
winter flounder	1								1 (1)

Table 4.11. Continued

Species	(EST) Tidal Stage	February 6									February 7			TOTALS*	
		0600	0800	1000	1200	1400	1600	1800	2000	2200	2400	0200	0400		0600
		0800	1000	1200	1400	1600	1800	2000	2200	2400					
		Low			High			Low			High				
<u>Unit 3</u>															
Atlantic tomcod											1			1	
grubby							1	1	1	2				5	
northern pipefish								1						1	
shorthorn sculpin			1											1	
threespine stickleback		2												2	
winter flounder		1		1	1	1	2		3		2	2		13 (1)	
<u>Unit 4</u>															
Atlantic silverside		1												1 (1)	
fourspine stickleback									1					1	
grubby										2				2	
lumpfish						1					1		1	3	
ninespine stickleback			1											1	
rainbow smelt				1										1	
striped killifish											1			1	
threespine stickleback		2	1	3						1				7 (3)	
winter flounder			2	1				2		1	3	1		10 (2)	

Table 4.11. Continued

Species	(EST)	Tidal Stage (Hours)	2/14	2/15	2/23	2/27	2/27	2/28	TOTALS*
			1300	0900	1100	0700	0900	1100	
			1500	1100	1300	0900	1100	1300	
			low	high +1	low +2½	high +1½	high +3½	high +4½	
				<u>Unit 3</u>					
threespine stickleback			1						1
				<u>Unit 4</u>					
winter flounder								1	1

Table 4.11. Continued

	3/1	3/8	3/19	3/20	3/21	3/26	3/26	
	0900	1500	1500	0700	1300	1100	1300	
(EST)	1100	1700	1700	0900	1500	1300	1500	
Tidal Stage (Hours)	high +1½	high +2½	high +4½	low +2	high +1	low +1½	low +3½	
Species								TOTALS
			<u>Unit 3</u>					
threespine stickleback						1	6	7
winter flounder			1					1
			<u>Unit 4</u>					
Atlantic silverside		1						1 (1)
grubby						2		2 (2)
striped killifish				1				1 (1)
threespine stickleback				3				3 (3)
winter flounder	1		1		3			5 (4)

Table 4.11 . Continued

Species	(EST)	March 14										March 15			TOTALS*
		0600	0800	1000	1200	1400	1600	1800	2000	2200	2400	2400	0200	0400	
		0800	1000	1200	1400	1600	1800	2000	2200	2400	0200	0400	0600		
		Tidal													
		Stage	High	Low			High			Low					
<u>Unit 3</u>															
lumpfish											1			1	
threespine stickleback											1	1		2	
winter flounder								2		3			1	6	
<u>Unit 4</u>															
American eel													1	1 (1)	
fourspine stickleback			1							1	2		1	5 (1)	
grubby								1			1			2	
lumpfish							1							1	
ninespine stickleback					1									1	
rainbow smelt								1						1 (1)	
winter flounder								1						1	

*Number of dead finfish shown in parenthesis.

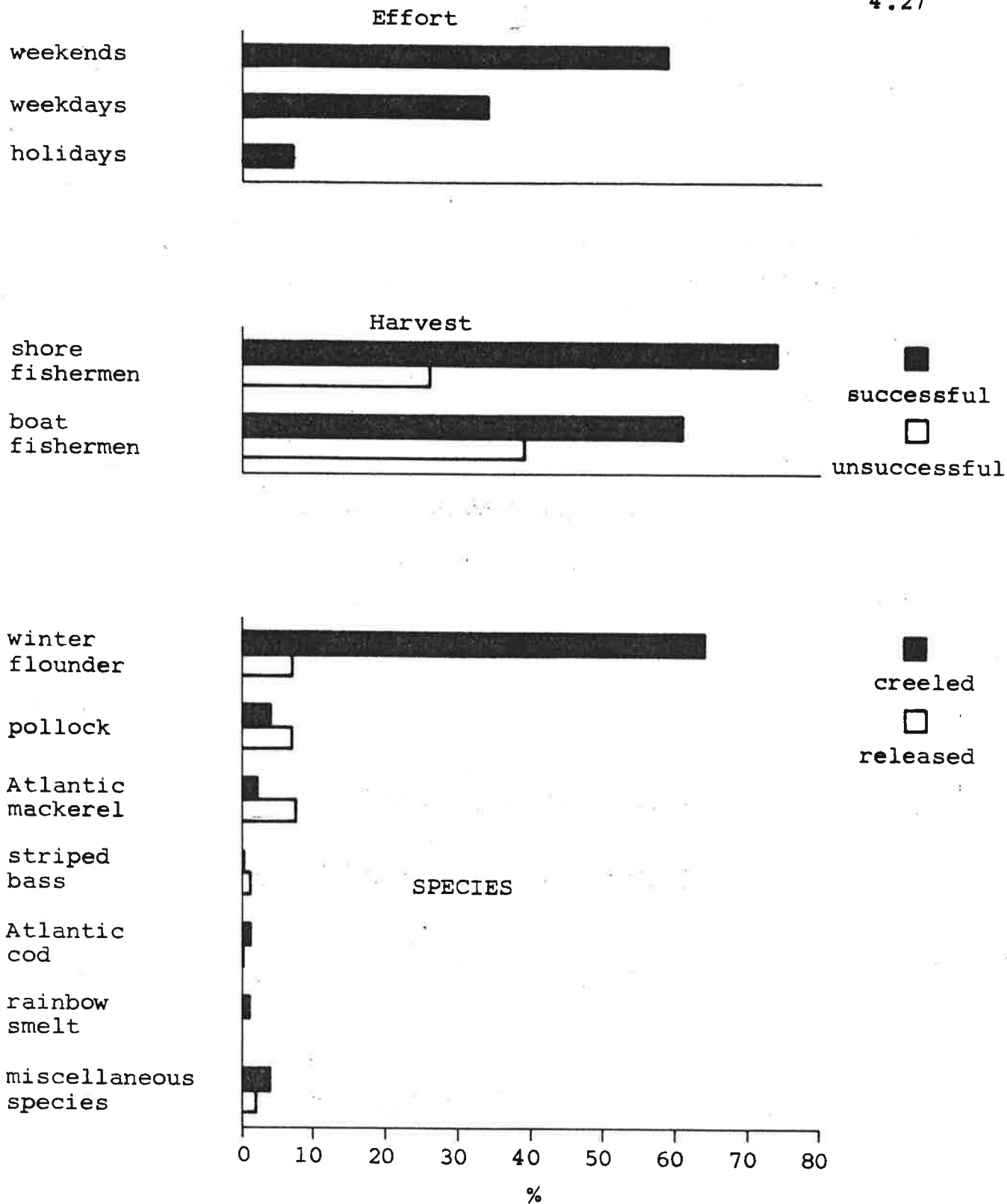


Figure 4.8. Effort and harvest statistics for sport fishermen in Salem Harbor, April - October, 1972.

Survey procedures are outlined in the appendix. Statistics collected from April through October 1972 were coded and placed on automatic data processing cards.

A total of 371 party interviews, representing 805 fishermen, were conducted on 57 randomly selected days. Thirty-one percent of the interviews were conducted during July. Weekend fishing effort was greatest (59%). Weekdays and holidays accounted for 34 and 7% of the fishing pressure, respectively. The average sport fishing trip was three hours.

Party success rates were highest amongst shore fishermen, 74:61%. Winter flounder dominated catches from shore (84%) while Atlantic mackerel, Scomber scombrus (31%), winter flounder (28%), and pollock, Pollachius virens (28%) were about equally creeled by boat fishermen. Striped bass, Morone saxatilis, were more frequently caught by boat fishermen, while Atlantic cod, Gadus morhua, harvest was greatest from shore. Clam worms, Nereis virens, were the most preferred bait.

4.8 Lobster Tagging

Of 446 sub-legal sized lobsters tagged and released during the summer of 1972, ^{127 (29%)} 139 (31%) have been recaptured by commercial lobster fishermen. Release points were located in Salem Harbor and at Bowditch Ledge in Salem Sound (Figures 4.9 and 4.10).

Migrations of up to 4.5 nautical miles (1.5 m. ave.) were noted for lobsters liberated in Salem Harbor. All lobsters from the Salem Sound releases were recaptured within 2.0

Figure 4.9. Recapture locations of tagged lobsters, Homarus americanus, liberated in Salem Sound through March, 1973.

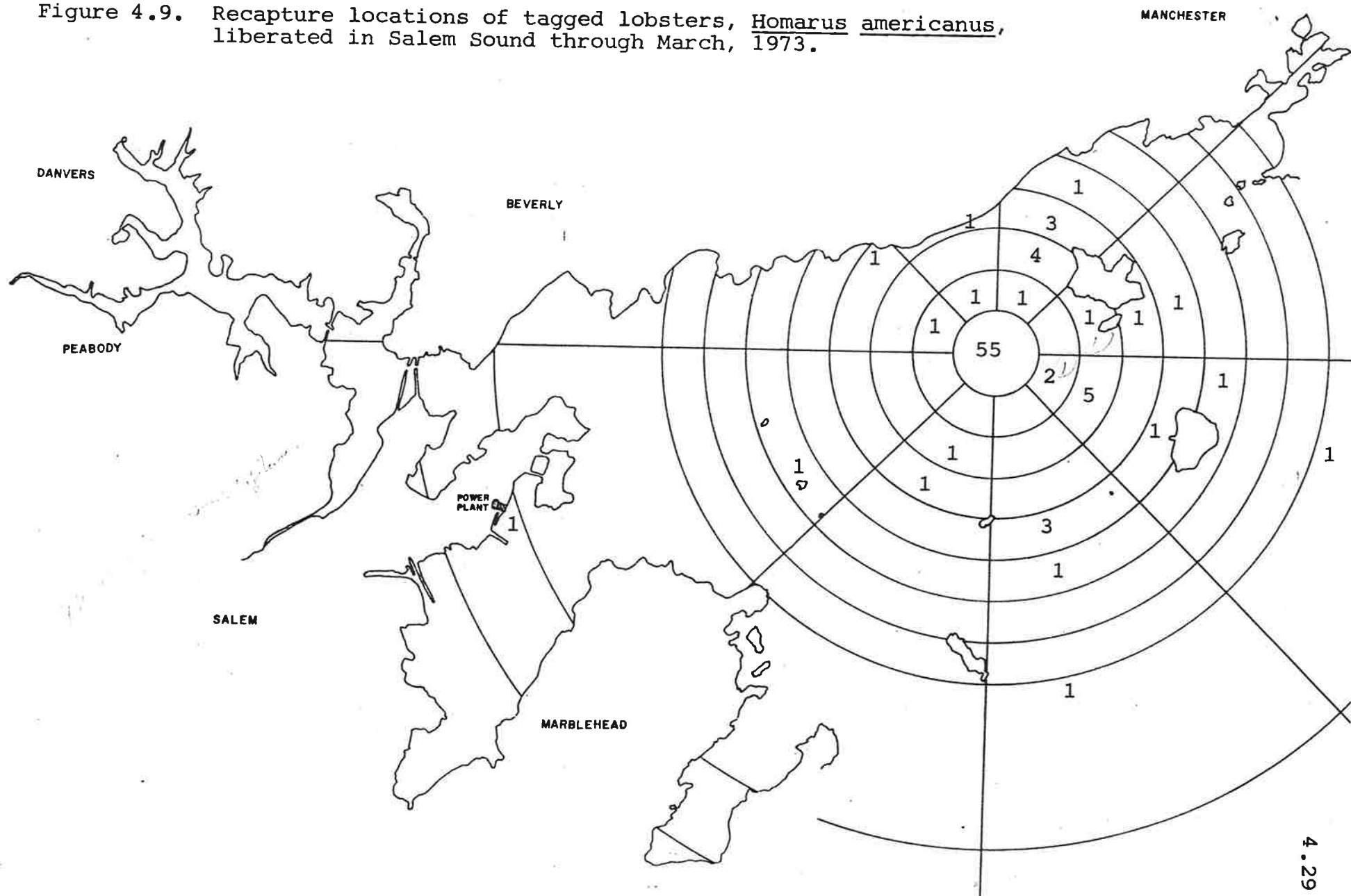
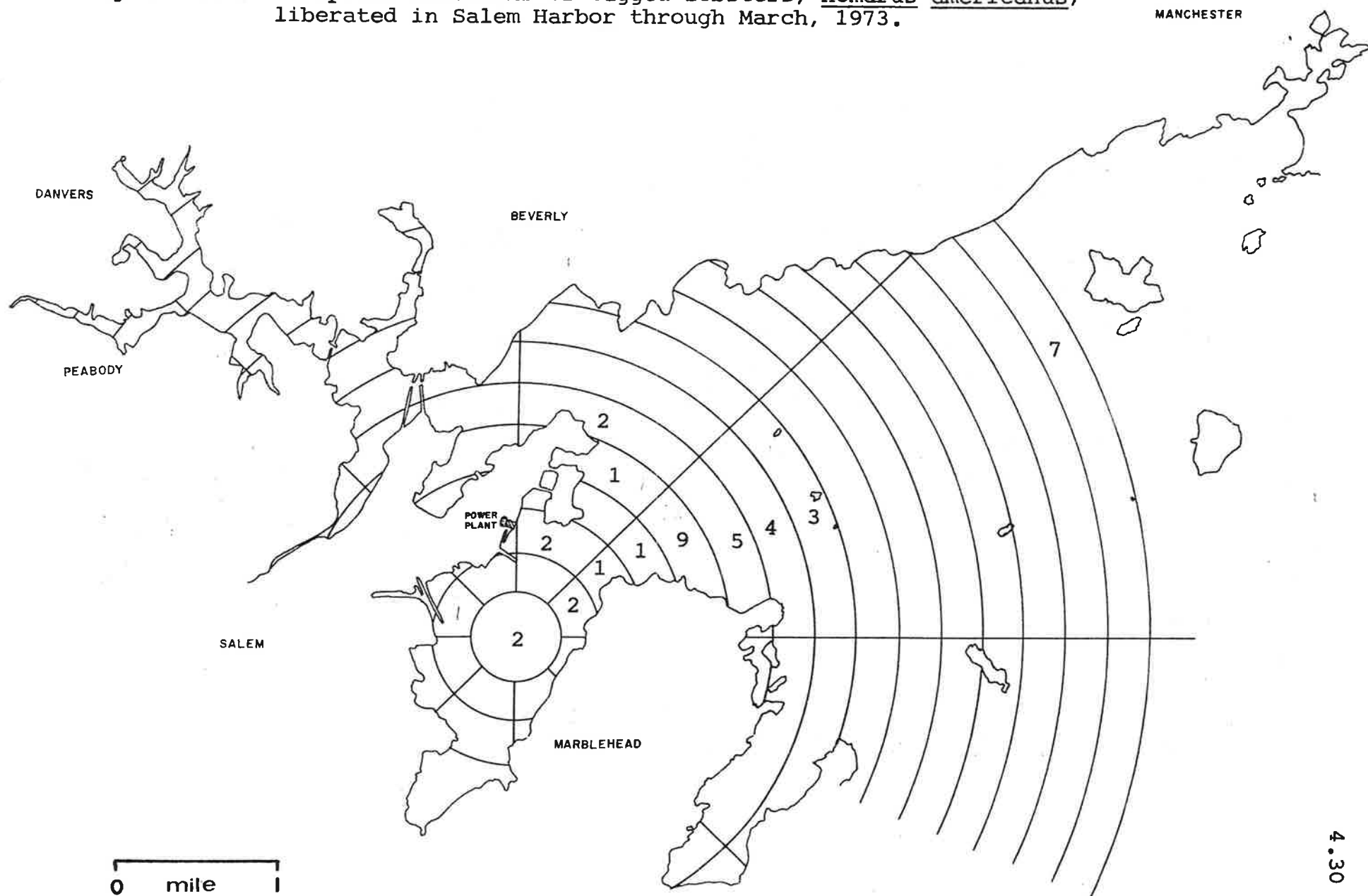


Figure 4.10. Recapture locations of tagged lobsters, Homarus americanus, liberated in Salem Harbor through March, 1973.



nautical miles (0.3 m. ave.). Recaptures experienced an average of 25 days of freedom.

Recapture points are indicative of fishing intensity and concentrations of lobster populations. It appears that our 1972 program was initiated late, resulting in post-molt tagging. We anticipate a greater percentage return of legal-sized lobsters ($\geq 3 \frac{3}{16}$ ") during 1973.

Announcements concerning the resumption of our tagging project were mailed to commercial and recreational lobstermen who cooperated during 1972. Their continued support is encouraged to achieve greater tag returns, and lobster movement and harvest data. Approximately 500 sub-legal sized lobsters will be tagged in 1973.

5.0 SUMMARY

Amendments to contract DMF-2-72 were agreed upon and submitted for execution. Intensified sub-surface temperature and current monitoring; C_{14} and ATP sampling; expanded entrainment and impingement studies; and additional benthic surveys will be initiated.

Resulting from instrumentation difficulties, Endeco continuous recording thermographs are now employed. Sport fishing statistics for 1972 have been incorporated into automatic data processing at the University of Massachusetts.

Two water quality stations were added for bi-weekly sampling. Negligible variances have been noted in water quality throughout Salem Harbor. Recorded values since project inception have not been limiting factors to marine life. Copper concentrations in soft shell clams remain below the F.D.A. "alert level" of 25.0 ppm.

The amphipod, Leptocheirus, appears to be a potential indicator species for monitoring environmental changes along benthic transects in Salem Harbor. Eighteen families of phytoplankton have been identified. Excellent correlation between chlorophyll a levels and number of phytoplankton organisms/ m^3 was achieved during the spring of 1972; however, later seasonal sampling produced inverse relationships that were attributed to clogging in the plankton net. Water bottles, now employed for phytoplankton collections, should eliminate subsequent errors and reduce damage to organisms. Future

analyses of phytoplankton will include identification to species or lowest taxon possible. Copepod nauplii were most abundant in zooplankton samples collected during 1972.

Winter flounder populations increased and dominated finfish sampling within Salem Harbor. Eight species of fish eggs and seven species of fish larvae have been identified. Distribution was similar at the four monitoring stations. Cunner eggs were identified most frequently. Finfish entrainment at the plant intakes is considered minimal. Mortality at Units 3 and 4 was 6 and 31%, respectively.

Winter flounder dominated 1972 sport fishing catches from shore, while mackerel, winter flounder and pollock were about equally creeled by boat fishermen. Three hundred seventy-one party interviews were conducted, representing 805 fishermen. Weekend fishermen reflected the greatest effort. Sport fisherman trips to Salem Harbor averaged 3 hours.

Thirty-one percent of the tagged lobsters liberated during 1972 have been returned. Migrations up to 4.5 nautical miles were recorded. Recaptured lobsters experienced an average of 25 days of freedom.

6.0 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 17-N.

Samples collected from May 15 - December 1, 1972 were analyzed with a Hach test kit, Model CA-10. Prior to May 15 a Kontes mini-pH meter was employed.

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.

COPPERField 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.

NITRATE

Field Collection: 300 ml/sample of seawater.

Laboratory Analysis: Ultraviolet spectrophotometric method from Standard Methods (1971).

NITRITE

Field Collection: 300 ml/sample of seawater.

Laboratory Analysis: Modified Griess Diazo reaction from Griess (1858).

INORGANIC PHOSPHATES

Field Collection: 300 ml/sample of seawater.

Laboratory Analysis: Colorimetric determination of reduced phosphomolybdate complex from Fiske and Subba Row (1925).

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 desing:

- 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;
- 30 x 25 ft trawl with 1-1/2 in mesh wings and 1 in mesh 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: mid-April

Ending Date: mid-October

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.

Project expenditures as of March 31, 1973 were:

	<u>Total Allotted</u>	<u>Total Expended</u>	<u>Balance</u>
Salaries	\$ 62,800.00	\$ 60,736.06	\$ 2,063.94
Travel	3,000.00	1,105.42	1,894.58
Office & Laboratory Supplies	8,000.00	3,488.43	4,511.57
Equipment	22,500.00	17,264.23	5,235.77
Maintenance	4,400.00	1,525.92	2,874.08
Overhead	<u>32,000.00</u>	<u>11,287.04</u>	<u>20,712.96</u>
Subtotal	\$132,700.00	\$ 95,407.10	\$37,292.90
Contracts	<u>74,340.00</u>	<u>16,900.00</u>	<u>57,440.00</u>
TOTAL	<u>\$207,040.00</u>	<u>\$112,307.10</u>	<u>\$94,732.90</u>