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Temperature, Salinity, Turbidity, and Light Attenuation in the Great Bay Estuary System 1974-1978

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Temperature, Salinity, Turbidity, and Light Attenuation
in the Great Bay Estuary System
1974 - 1978

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February, 1979

A Jackson Estuarine Laboratory Contribution
85

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INTRODUCTION

The purpose of this study was to evaluate the temperature, salinity, turbidity, and light attenuation characteristics throughout the Great Bay Estuary System during 1974 - 1978. In contrast to previous studies within the Estuary (Norall and Mathieson, 1976, Daly and Mathieson, in preparation) only physical parameters were measured and they were measured at more frequent (1 meter) vertical intervals. Such information is important to future coastal zone management and to an ultimate understanding of the estuarine ecosystem. The Great Bay Estuary System is a dynamic habitat with pronounced spatial and temporal variations of hydrographic factors. Accordingly, locations furthest from the coast experience the most freshwater influence and the least oceanic influence. In some sites there are "salt wedges" resulting in physical variability with depth. Seasonality is apparent in the amount of freshwater input, detrital input, and temperature variation. The volume of freshwater entering the Estuary is greatest during spring runoff when the snowpack melts and least during the summer when precipitation is low and evaporation high. As the volume of water in the Estuary changes tidal currents, the amount of fresh water input may affect turbidity and light attenuation, as well as salinity.

The present study evaluates three sources of physical variation in the Estuary: 1) location, 2) season, and 3) depth. Data collected between July, 1974 and June, 1978, along with some simple statistical interpretations, are presented herein.

SAMPLE COLLECTION

The sample sites extended from the open coast to Great Bay and included: 1) Fort Stark on the open coast, 2) the Piscataqua River in front of the Portsmouth Navy Yard, 3) Dover Point, 4) Cedar Point, 5) Durham Point, 6) Adam's Point, and 7) Great Bay (Figure 1). Precise locations are summarized in Table I, after Norall and Mathieson (1976). Measurements were taken monthly except during extreme winter months when cold air temperatures caused instrument failures (Table II).

Temperature ($^{\circ}\text{C}$) and salinity ($^{\circ}/\text{oo}$) were measured with a Calhisco Salinometer (Model RS5-3). Light attenuation was measured in footcandles using an InterOcean Systems, Inc. Marine Illuminance Meter Model 510 (San Diego, Cal.) with the underwater probe. Turbidity was measured as percent transmission with an InterOcean Turbidometer Model 513Tr (San Diego, Cal.), after calibration to 100% in distilled water. Instrument probes were lowered from the deck of the R/V Jere Chase during low water and measurements taken at 1 meter intervals between the water surface and the channel bottom.

DATA PRESENTATION

The mean salinity, temperature and turbidity values for each station on each sampling date were computed with a Texas Instrument SR-51 calculator and are presented in Appendices A, B, and C. As the amount of incident light (footcandles) varies with weather and time of day as well as with season, the absolute numbers were not meaningful for comparison. Therefore, the 1% light levels, or the depth where light intensity is equal to 1% of surface light intensity, are reported in Appendix D. A designation of greater than (>) indicates that the bottom was reached with more than 1% of incident light still being available. One percent light levels for 1976 are also presented graphically to compare stations versus time (Fig. 2 and 3).

Temperatures and salinities for each depth on each sampling date were graphed using SYMAP (Dougenik and Sheehan, 1975) contour maps (Fig. 4-17). The vertical axes are depth in meters, while the horizontal axes represent time (months). The SYMAP program grouped the temperature data into five 5°C levels between 0° and 25°C and the salinity data into eight 5‰ levels between 0‰ and 40‰. The program determines the locations of contour lines by interpolating adjacent sample points. Actual sample points are indicated on the graphs

by the level numbers. Mapping difficulties arise when the bottom depths differ greatly from month to month. Interpolation between lower depths may result in erroneous contours and apparent temperature or salinity stratification (Fig. 6, 1975 and Fig. 13, 1975). Therefore, in using these maps, one should be aware that some contours were interpolated between long periods of time and that other contours represent "real" monthly changes. A primary asset of the SYMAP presentation is that it allows observation of temperature and salinity with regards to time and depth. While sacrificing absolute values, SYMAP graphing accentuates the extremes of temperature and salinity which occur in the Estuary over time, in different locations, and at different depths.

ACKNOWLEDGEMENTS

A large number of people helped with the completion of this project. Ned McIntosh and Paul Pelletier were not only captains of the research vessel, but also aided in sample collection and instrument repairs. Dr. Franz Anderson introduced us to the SYMAP program; Leslie Dolan spent many hours entering data into the computer. Morgan Hardwick-Witman, Chris Emerich, and Wendy Elcome Harris have been faithful crew members throughout the project. Many others have also helped with data collection

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Dave Lloyd, Cindy Mathieson, Jerz Mitchko, Judy Nevins, Clayton
Penniman, Ann Pistel, Mike Riggs, and Joyce Tugel.

REFERENCES CITED

- Daly, M.A. and A.C. Mathieson, 1978. Tidal fluctuations of nutrient and hydrographic data in rivers of the Great Bay Estuarine System.
- Dougenik, J.A. and D.E. Sheehan, 1975. SYMAP user's reference manual. Laboratory for Computer Graphics and Spatial Analysis, Harvard University. Graduate School of Design, Harvard University, Cambridge, Mass. 02138.
- Norall, T.L. and A.C. Mathieson, 1976. Nutrient and hydrographic data for the Great Bay Estuarine System and the adjacent open coast of New Hampshire - Maine. Jackson Estuarine Laboratory, University of New Hampshire, Durham, N.H. 03824.

TABLE I

Sample Sites (after Norall and Mathieson, 1976):

- 1) Fort Stark (Jaffrey Point) - approximately 275m offshore of Fort Stark, N. of Odiornes Pt. and Little Harbor, 14m depth.
- 2) Portsmouth Naval Shipyards (Seavey Island) - 140m offshore from Seavey Island, Pier #2, 18m depth.
- 3) Piscataqua River at Dover Point - between channel markers C"15" and N"16", 6m depth.
- 4) Bellamy River mouth - 90m from bridge span in channel, 3m depth.
- 5) Oyster River mouth - 90m offshore from Half Tide Rock in channel, 6m depth.
- 6) Furber Straits - mid-channel and opposite the Jackson Estuarine Laboratory, 12m depth.
- 7) Great Bay - 180m W. of marker buoy C"7", 4.5m depth.

The above station number designations are those referred to in subsequent figures and appendices.

TABLE II
 Sampling Dates

<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
7/26	1/20	3/09	3/31	4/03
8/27	2/05	4/10	5/20	5/02
9/25	5/07	5/12	6/08	5/26
10/25	6/04	6/08	7/07	6/27
11/22	7/15	7/06	8/09	7/25
12/21	8/14	8/04	9/07	
	10/29	9/02	10/05	
	11/26	10/14	11/09	
	12/12	11/12	12/06	
		12/01		

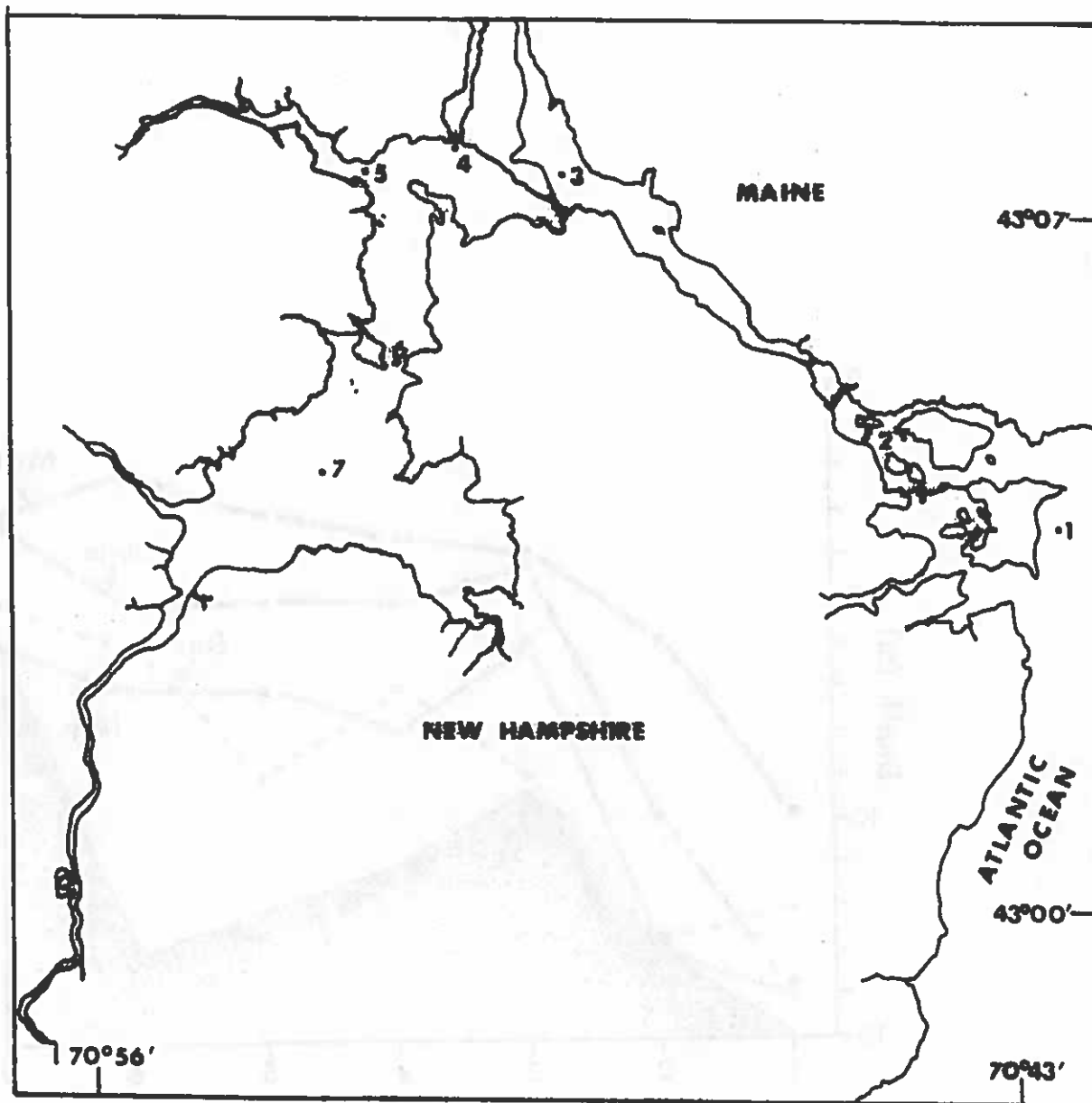


Figure 1. Map of Great Bay Estuary System showing sample locations. Station numbers refer to Table I.

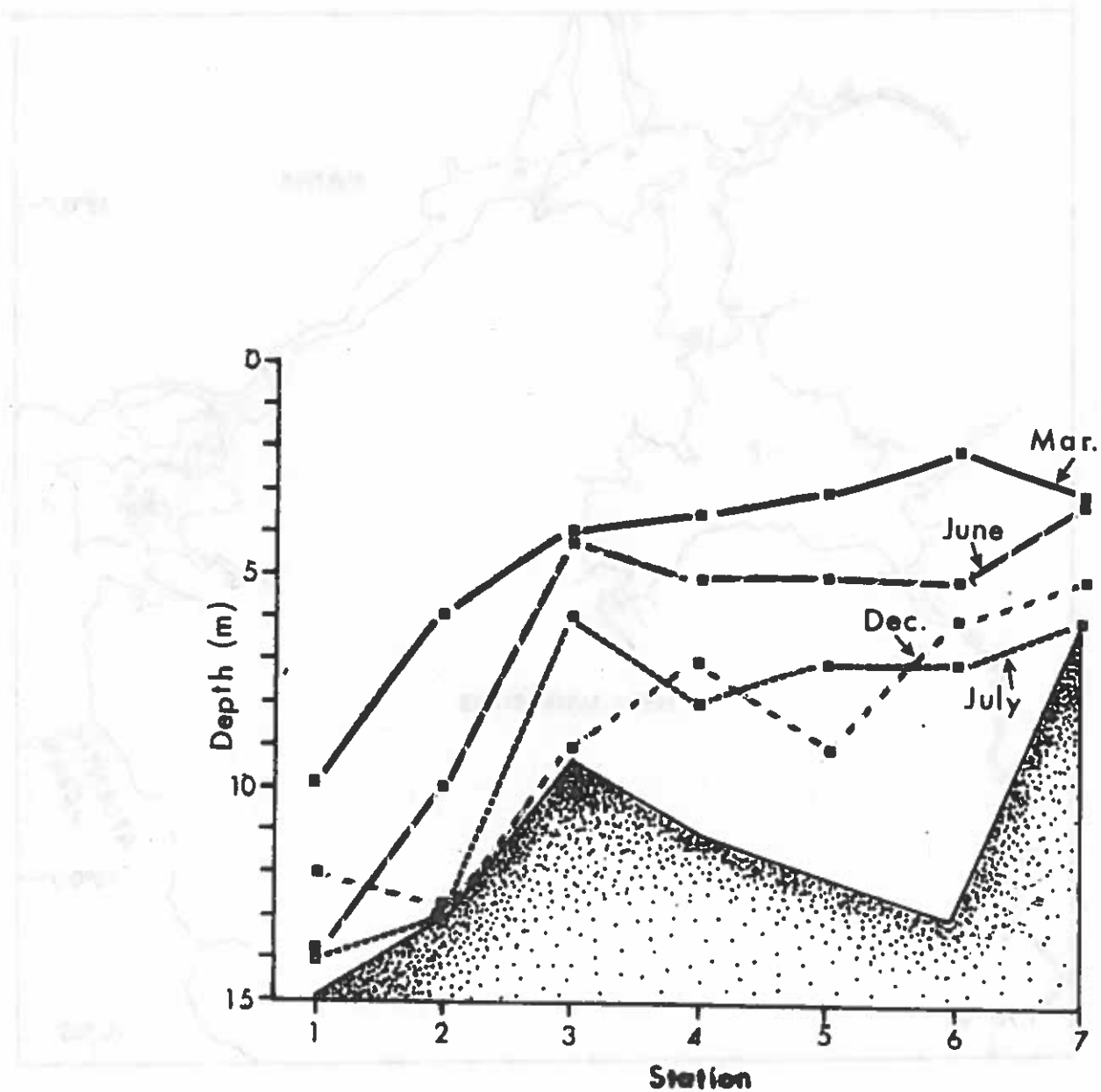


Figure 2. 1% light levels during March, June, July, and December, 1976 at the 7 stations. Station numbers refer to Table I. Shaded area is approximate bottom contour. It represents the maximum depth recorded at each station for 1976. Open squares are bottom depths and indicate that greater than 1% of the incident light reached the bottom.

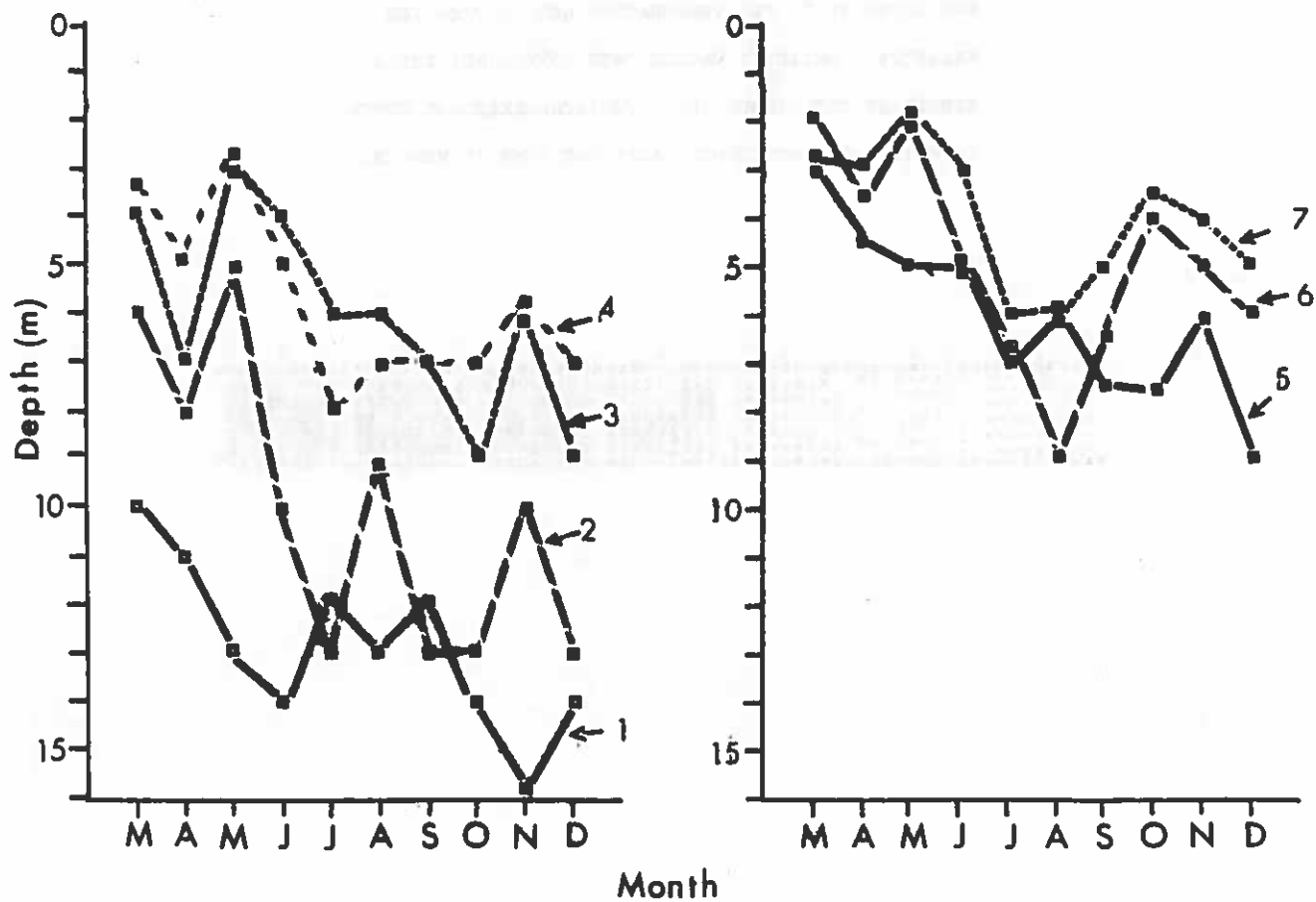


Figure 3. 1% light levels versus months in 1976 for the 7 stations. Station numbers refer to Table I. Open squares are bottom depths and indicate that greater than 1% of the incident light reached the bottom.

KEY FOR FIGURES 4-17. MAXIMUM AND MINIMUM VALUES ARE GIVEN IN °C FOR TEMPERATURE AND IN ‰ FOR SALINITY. SALINITY VALUES OVER 35‰ ARE REPRESENTED BY THE SYMBOL "H". VERTICAL AXES ARE DEPTH IN METERS AND HORIZONTAL AXES ARE TIME IN MONTHS.

1	2	3	4	5	6	7
.....	+++++++	XXXXXXXX	00000000	00000000	00000000
.....	+++++++	XXXXXXXX	00000000	00000000	00000000
.....	+++++++	XXXXXXXX	00005000	00006000	00007000
.....	+++++++	XXXXXXXX	00000000	00000000	00000000
.....	+++++++	XXXXXXXX	00000000	00000000	00000000
.....	+++++++	XXXXXXXX	00000000	00000000	00000000

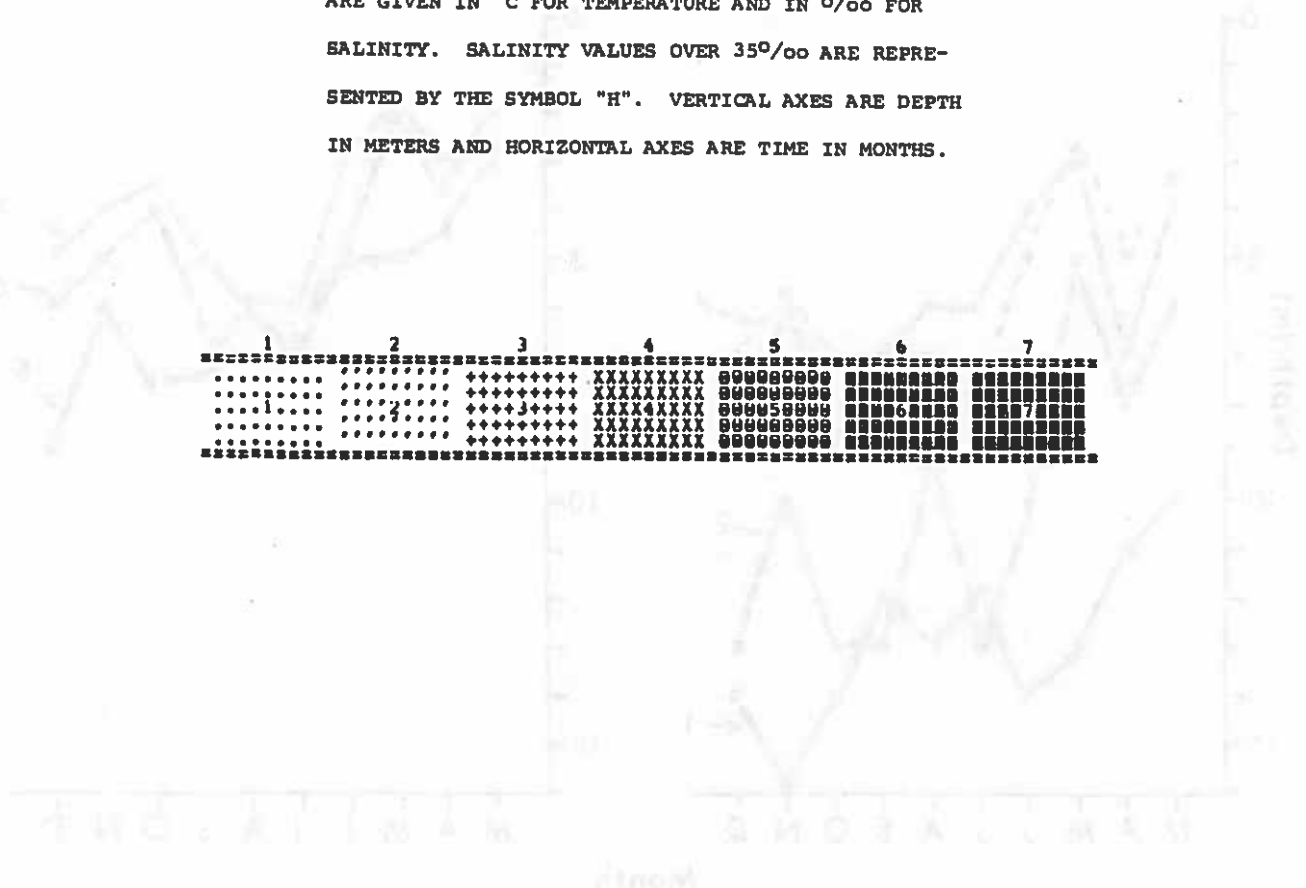
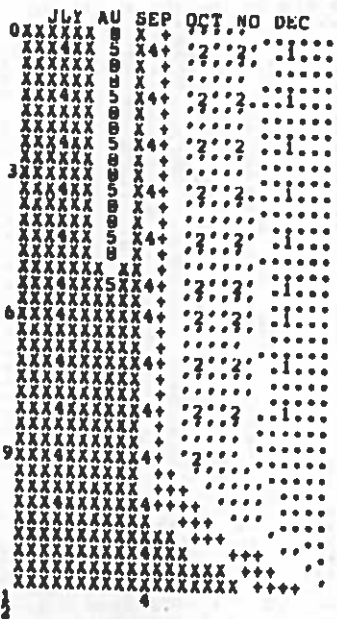


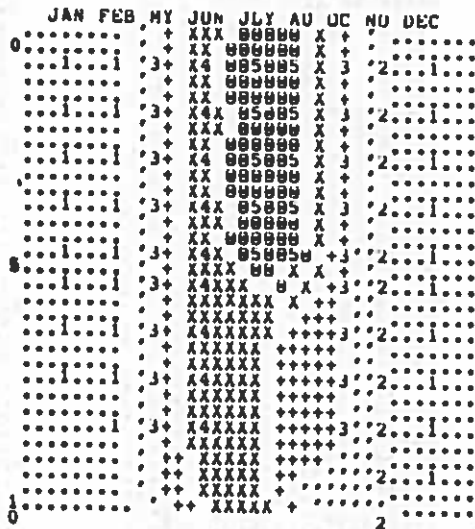
Figure 4-17. Salinity profiles (S) and temperature profiles (T) for the period of maximum ice extent in the Arctic Ocean. The profiles are shown for the months of February, March, April, May, June, July, and August. The vertical axis represents depth in meters, and the horizontal axis represents time in months. The salinity profiles show a minimum value of approximately 34.5‰ at the surface, which increases with depth. The temperature profiles show a maximum value of approximately 10°C at the surface, which decreases with depth.

Fig. 7
Temperature
Station 4

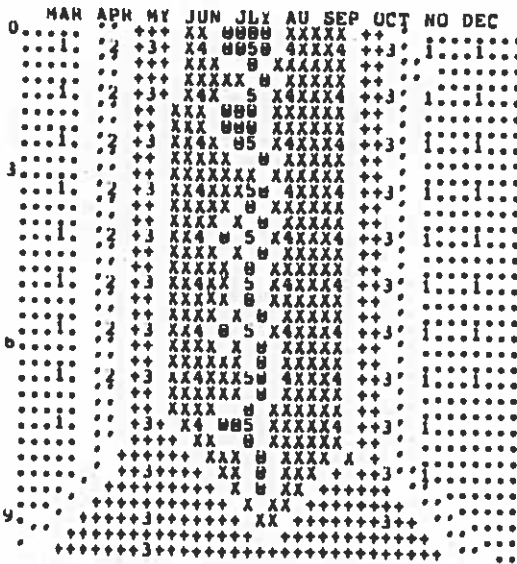
1974



1975



1976



1977

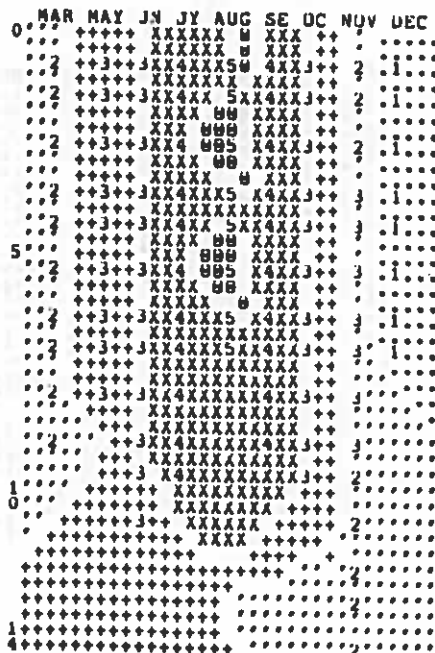


Fig.10
Temperature
Station 7

1974

```

JLY AU SEP OCT NO DEC
00000000 X + .....
00050005 X4+ '2' 1.....
00000000 X + .....
10000000 X + .....
00050005 X4+ '2' 1.....
00000000 X + .....
00000000 X + .....
00050005 X4+ '2' 1.....
00000000 X + .....
30000000 X + .....
00050005 X4+ '2' 1.....
00000000 X + .....
00000000 X + .....
00050005 X4+ '2' 1.....
00000000 X + .....
50000000 X + .....
00000000 X4+ '2' 1.....
00000000 X + .....
00000000 XXX + .....
00000000 XXX + .....
00000000 XXX + .....
00000000 XXX + .....
70000000 XXX4X + .....
  
```

1975

```

JAN FEB MY JUN JLY AU UC NU DEC
0..... + XXX 00000 X + .....
..... + XXX 00000 X + .....
..... 1..... 3+ X4X 00005 X 3 1.....
..... + XX 0000000 X 1.....
..... 1..... 3+ X 00000000 X .....
..... 1..... 3+ X400050050 XJ 1.....
..... + X 00000000 X .....
..... 1..... 3+ X 00000000 X .....
..... 1..... 3+ X400050050 XJ 1.....
..... 1..... 3+ X 00000000 X .....
..... 1..... 3+ X400050050 XJ 2.....
..... + X 00000000 X + .....
..... 1..... 3+ X400050 X X J 2.....
..... + XX 0000 X + .....
..... 1..... 3+ X4XX 000 +...J 2.....
..... + XXXX 000 +...J 2.....
0..... + XXXXX +...+J 2.....
..... 1..... XXXXX +...+J 1.....
  
```

1976

```

MAR APR MY JUN JLY AU SEP UC NO DEC
0..... + XXX 0000000 XXX + .....
..... 1..... 2+ JXX 40005005 XXX4 + 3 1.....
..... + XX 00000000 XXX + .....
..... 1..... 2+ JXX 40005005 XXX4 + J 1.....
..... + XX 00000000 XXX + .....
..... + XX 00000000 XXX + .....
..... 1..... 2+ JXX 40005005 XXX4 + 3 1.....
..... + XX 00000000 XXX + .....
..... 1..... 2+ JXX 40005005 XXX4 + 3 1.....
..... + XX 00000000 XXX + .....
..... 1..... 2+ JXX 40005005 XXX4 + 3 1.....
..... + XX 00000000 XXX + .....
..... + XX 00000000 XXX + .....
..... 1..... 2+ JXX 40005005 XXX4 + 3 1.....
..... + X 00000000 XXX + .....
..... + X 00000000 XXX4 + 3 1.....
..... + X 00000000 XXXX + .....
..... + X 00000000 XXXX + .....
..... + X 00000000 XXX + .....
..... + X 00000000 XXX + .....
..... + X 00000000 XXX + .....
..... + X 00000000 XXX + .....
  
```

1977

```

MAR MAY JJ JLY AUG SE UC NU DEC
0..... + X + XX 00000000 X +...
..... 2 + 4 + 3X 050005005 X 3+2
..... + X + X 000000000 X +...
1..... + X + X 000000000 X +...
..... 2 + J + 3X 050005005 X 3+2
..... +...+ X 000000000 X +...
..... 2 +...+ X 000000000 X +...
..... 2 +...+ X 050005005 X 3+2
..... 3..... +...+ X 000000000 X +...
..... 2 +...+ X 050005005 X 3+2
..... +...+ X 000000000 X +...
..... 2 +...+ X 000000000 X +...
..... 5..... +...+ X 000000000 X +...
..... 2 +...+ X 050005005 X 3+2
..... +...+ X 000000000 X +...
..... 2 +...+ X 000000000 X +...
..... 7..... +...+ X 00000000 X +...
..... 2..... +...+ XXXX 0000000 X +...
..... 5 5 3 1
  
```

Station 1

1974

```

JLY AJ SEP OCT NO DEC
0
1
2
3
4
5
6
7
8
9
1
2
3

```

1975

```

JAN FEB MY JN JLY AU OC NOV DE
0
1
2
3
4
5
6
7
8
9
1
2
3
4
5
6
7
8
9
1
2
3
4
5
6
7
8
9
1
2
3
4

```

1976

```

MAR APR MY JUN JLY AU SEP OCT NO DEC
0
1
2
3
4
5
6
7
8
9
1
2
3
4
5
6
7
8
9
1
2
3

```

1977

```

MAR MY JUN AU SE OCT NO DEC
0
1
2
3
4
5
6
7
8
9
1
2
3
4

```


Fig. 17
Salinity
Station 7

1974

1977

```

JLY AU SEP OCT NO DEC
0000000000 0000 0000 XXXX
0007000700070000 0500 4XXX
0000000000 00000 000 XXXX
1000000000 00000 000 XXXX
0007000700070000 50004XXX
0000000000 000000 000 XXX
0000000000 000000 000 XXX
0007000700070000 004XXX
0000000000 000000 00 XXX
3000000000 0000000 00 XXX
0007000700070000 604XXX
0000000000 0000000 00 XXX
0000000000 0000000 000 XX
0007000700070000 050 X
0000000000 0000000 000 X
5000000000 0000000 000 X
0000000000 0000000 0500
0000000000 0000000 0000
0000000000 0000000 000
0000000000 0000000 00
0000000000 0000000 0
7000000000070000 00000000

```

```

JAN FEB MY JUN JLY AU OC NOV DEC
0X 00000000 00000 00000 0 X ++++++++
XX 0000000 X 000 00000 0 X ++++++++
X X500050 4 0050 00000 0 4 +3+++3+++
0 0000000 X 00000 0000 0 XX ++++++++
000000000 X 00000 0000 0 XX ++++++++
0005000050 4 0050 06000 0 4XX4+++3+++
000000000 X 000 000000 0 XXXX +++++
000000000 X 000 000000 0 4XX4X +3+++
0005000050 4 0050000000 0 XXXXX +
3000000000 X 00 00000000 0 XXXXX +
0005000050050005000000 0 4XX4XX4 +
0000000 000000 0000000 0 XXXXXXXXX
000000 0 00000 000000 0 XXXXXXXXX
000500 6 0500 500000 0 0 4XX4XX4XXX
00000 0 000000 0000 0 X XXXXXXXXX
00000 0 0000000 000 0 XXXXXXXXX
00050 060050005 000 0 XXX4XX4XX4XXX
00000 0 00000000 0 0 XXXXXXXXX
00000 00 0000000000 0 XXXXXXXXX
000 0000 00000000000 XXX4XX4XX4XXX

```

1976

1977

```

MAR APR MY JUN JLY AU SE OC NOV
0+++3+++ XX 00 0000000000 0 0000000000
++ +++++ X 00 0000000000 0 0000000000
XX +++ X 00 0000000000 0 0000000000
XXXXX J+ 4 005000000000 0 0000000000
XXXXX ++ X 00 0000000000 0 0000000000
XXXXX + XX 00 0000000000 0 0000000000
XXXXXJ+ 4 005000000000 07000000000
00 XX + X 00 0000000000 00
0005 XJ+ 5 005000000000 070007000000
0000 X + X 00 0000000000 0000000000
00000 X X 000 0000000000 0000000000
00050 J X50000 0000000000 070007000000
00000 X X 000 0000000000 0000000000
500000 X X 00 0000000000 0000000000
00050 J X50 00000000000 070007000000
00000 XXX 0 00000000000 0000000000
000500 X 000 00000000000 70007000000

```

```

MAR MAY JU JLY AUG SE OC NO DEC
0000 + X 0 0000 000000 00 0 ++ '000
0000 + X 0 0000 000000 00 0 ++ '000
0002 + 4 06000600070007 060 J+ '200
0000 + X 0 000 00000000 0 ++ '000
0002 + 4 060006 0070007 060 J+ '200
0000 + X 0 0000 00000000 0 ++ ++
0000 + X 0 0000 00000000 0 ++++++++
0002 + 4 060006 0070007 060 3+++3+++
0000 + X 0 000 00000000 0 X +++++
0002 + 4 060006 0070007 060 4 +++3+++
0000 + X 0 0000 00000000 0 X +++++
0002 + 4 06000600070007 060 4X +3+++
50000 + X 0000 00000000 0 0 XX +++++
0002 + 4 060006 0070007 060 4X +3+++
0000 + X 0000 00000000 0 0 XX +++++
0002 + X 0000 00000000 0 A XX +++++
0000 + 4 060006 0070007 060 4X +3+++
0000 + X 0000 00000000 0 0 XX +++++
0002 ++ X 0 000 00000000 0 0 XX +++++
0000 ++ X 000 0000000000 0 0 4XX J+++
0000 ++ X 00 00000000000 0 A XXXX ++
0000 ++ X 00 00000000000 0 XXXXX ++
0000 ++ X 0 00000000 0 00 4XXXXX +
0000 ++ X 0 00000000 0 00 XXXXXXXX
0000 ++ X 0 0000 0 00 0 XXXXXXXX
0000 ++ X 0 0000 0 00 X X4 XXXXX
1000000000 + 0 0000 0 0000 0 000 X
0

```

APPENDIX A

Temperatures, Monthly Mean Values for Each Station - 1974

Station	07/26	08/27	09/25	10/25	11/22	12/21
1 \bar{X}	16.23	15.86	13.47	8.93	7.47	4.91
S.D.	.31	.37	.11	.03	.02	.10
2 \bar{X}	17.32	18.31	14.29	8.66	6.91	3.74
S.D.	.20	.12	.13	0.00	.02	0.00
3 \bar{X}	18.99	19.87	15.15	8.42	6.09	3.15
S.D.	.45	.71	.48	.13	.49	.56
4 \bar{X}	18.99	20.19	15.29	7.98	6.10	2.51
S.D.	.21	.07	.02	0.00	.04	.05
5 \bar{X}	19.33	20.79	15.31	7.96	5.89	2.45
S.D.	.05	.25	.07	.01	.09	.09
6 \bar{X}	20.34	21.78	15.46	7.81	5.42	2.19
S.D.	.07	.14	0.0	.07	.08	.10
7 \bar{X}	20.72	22.32	15.64	7.72	4.89	2.20
S.D.	.04	.17	0.0	.09	.36	.12

APPENDIX A

Temperatures, Monthly Mean Values for Each Station - 1975

Station	01/20	02/05	05/07	06/04	07/15	08/14	10/29	11/26	12/12
1 \bar{X}	3.87	2.58	7.45	12.38	13.39	17.78	11.44	7.00	6.14
S.D.	.09	.08	.06	.10	.46	.17	.12	0.00	.22
2 \bar{X}	2.10	.95	8.8	14.19	17.81	20.11	11.68	6.14	3.82
S.D.	0.00	0.00	0.00	.03	.10	.02	0.00	0.00	0.00
3 \bar{X}	.79	.45	10.03	15.70	21.04	21.71	11.65	5.34	2.49
S.D.	.37	.61	.53	.45	.79	.97	.08	.37	.57
4 \bar{X}	.52	0.00	10.12	16.52	21.8	22.41	11.73	5.34	2.39
S.D.	0.00	0.00	0.00	.10	0.00	.17	.05	0.00	.05
5 \bar{X}	.56	0.00	10.25	16.74	22.29	22.95	11.79	5.15	2.28
S.D.	.16	0.00	.25	.16	.31	.20	.05	.14	.13
6 \bar{X}	.07	0.00	10.84	17.24	24.99	23.84	11.91	4.86	2.14
S.D.	.06	0.00	.07	.06	1.87	.23	.24	.11	.11
7 \bar{X}	.02	0.00	11.34	17.38	24.37	24.74	12.06	4.98	2.04
S.D.	.04	0.00	0.00	.10	.12	0.00	.31	.15	.20

APPENDIX A

Temperatures, Monthly Mean Values for Each Station - 1976

Station	03/09	04/10	05/12	06/08	07/06	08/04	09/02	10/14	11/12	12/01
1 \bar{X}	2.31	4.97	6.99	12.89	16.25	16.29	12.36	12.05	6.46	6.28
S.D.	.06	.06	.13	.24	.08	.05	.16	0.00	.05	0.00
2 \bar{X}	1.48	6.35	9.14	14.59	18.15	17.56	14.59	12.69	5.29	5.47
S.D.	.04	.03	0.00	.02	0.00	.02	0.00	0.00	.05	0.00
3 \bar{X}	1.04	6.89	11.72	17.06	20.55	18.59	16.79	12.91	4.41	4.54
S.D.	.13	.24	1.04	.83	.98	.62	.84	.08	.56	.52
4 \bar{X}	.71	7.25	11.94	17.15	20.47	18.68	17.15	12.75	3.86	4.16
S.D.	.02	0.00	.06	.05	.14	.05	.08	0.00	.03	.06
5 \bar{X}	.73	7.42	12.31	18.26	21.25	18.83	17.47	12.69	3.41	3.82
S.D.	.08	.15	.31	.74	.85	.48	.40	0.00	.13	.32
6 \bar{X}	.58	7.62	13.18	18.85	22.74	19.91	18.24	12.43	2.62	2.98
S.D.	.12	.19	.10	.26	.19	.08	.16	.04	.04	.03
7 \bar{X}	.59	7.78	13.89	19.55	23.64	21.49	18.79	12.39	2.79	2.26
S.D.	.14	.10	.19	.12	.11	2.69	.07	0.00	.27	.17

APPENDIX A

Temperatures, Monthly Mean Values for Each Station - 1977

Station	03/31	05/20	06/08	07/07	08/09	09/07	10/05	11/09	12/06
1 \bar{X}	3.17	9.31	10.04	12.02	13.35	12.48	11.84	9.97	6.52
S.D.	.10	.14	.03	.18	.47	.33	.06	.03	.03
2 \bar{X}	4.48	11.58	11.05	13.96	17.23	16.01	14.53	10.13	5.24
S.D.	.06	0.00	.01	.04	.10	.04	.04	.02	.08
3 \bar{X}	5.12	13.30	12.63	17.42	19.49	18.51	13.79	10.01	3.39
S.D.	.18	.44	.57	1.23	1.11	.65	.13	.12	.93
4 \bar{X}	6.26	13.95	12.99	17.63	20.57	18.79	14.67	9.98	2.64
S.D.	.16	.03	.06	.08	0.00	.08	.05	.03	.05
5 \bar{X}	6.65	14.11	13.24	18.23	21.02	19.59	13.62	10.07	2.20
S.D.	.17	.02	.26	.26	.09	.47	.12	0.00	.41
6 \bar{X}	7.38	14.45	13.83	19.82	22.50	20.70	14.17	9.88	1.16
S.D.	.29	.26	.05	.15	.23	.14	.09	0.00	.28
7 \bar{X}	7.60	14.84	14.06	21.07	23.22	21.43	13.93	9.86	.79
S.D.	.36	.45	.08	.21	.34	.12	.28	0.00	.19

APPENDIX A

Temperatures, Monthly Mean Values for Each Station - 1978

Station	04/03	05/02	05/26	06/27	07/25
1 \bar{X}	2.47	4.29	8.72	9.67	13.18
S.D.	.04	.09	.09	.38	.19
2 \bar{X}	2.49	6.38	10.86	12.56	15.58
S.D.	.01	.04	.08	.18	.11
3 \bar{X}	2.22	8.41	13.05	16.76	18.99
S.D.	.25	.64	.84	1.14	1.08
4 \bar{X}	2.76	8.62	13.28	17.16	19.25
S.D.	.03	.08	.08	0.00	.17
5 \bar{X}	2.95	8.82	13.49	17.52	19.98
S.D.	.12	.37	.20	.72	.67
6 \bar{X}	2.69	9.40	14.13	19.09	21.58
S.D.	.56	.19	.23	.11	.09
7 \bar{X}	2.25	9.72	14.55	20.09	22.33
S.D.	.30	.26	.36	.11	.33

APPENDIX B

Salinities, Monthly Mean Values for Each Station - 1974

Station	07/26	08/27	09/25	10/25	11/22	12/21
1 \bar{X}	31.40	31.59	32.14	32.46	34.16	32.79
S.D.	.17	.06	.12	0.00	0.00	.21
2 \bar{X}	30.94	31.29	31.57	31.08	31.38	27.35
S.D.	.18	.06	.09	0.00	0.00	.11
3 \bar{X}	30.23	30.53	29.87	29.49	26.18	23.51
S.D.	.38	.57	1.08	1.49	4.73	4.14
4 \bar{X}	30.66	31.04	30.63	29.37	29.4	21.64
S.D.	.06	.03	.06	.14	.13	.22
5 \bar{X}	30.65	31.05	30.73	29.11	29.35	21.27
S.D.	.09	.04	0.00	.24	.09	.58
6 \bar{X}	30.34	30.93	30.67	28.29	28.03	19.89
S.D.	.07	.27	0.00	.25	.73	1.25
7 \bar{X}	30.32	31.06	30.54	27.89	26.61	19.59
S.D.	.08	.06	.11	.38	1.88	1.68

APPENDIX B

Salinities, Monthly Mean Values for Each Station - 1975

Station	01/20	02/05	05/07	06/04	07/15	08/14	10/29	11/26	12/12
1 \bar{X}	34.94	34.06	29.60	29.87	30.28	30.49	29.55	31.43	29.46
S.D.	.36	.24	.14	.06	.12	.01	.28	2.13	.95
2 \bar{X}	30.03	28.53	25.54	29.00	29.51	30.05	24.39	22.48	20.45
S.D.	.27	.05	.04	0.00	.01	.02	.32	.31	.31
3 \bar{X}	21.25	27.22	21.00	24.89	27.12	29.31	18.61	16.10	12.14
S.D.	4.96	2.65	3.09	.26	1.39	.96	3.19	3.78	5.75
4 \bar{X}	25.10	27.23	22.41	27.00	27.99	29.42	19.11	17.28	15.98
S.D.	.13	.19	.07	0.00	0.00	.17	.10	.94	.13
5 \bar{X}	25.72	27.35	22.58	27.26	27.82	29.42	18.93	19.50	15.57
S.D.	.65	.34	.29	.13	.12	.17	.94	.95	1.13
6 \bar{X}	24.21	25.68	21.32	26.49	27.29	29.08	18.50	17.68	20.42
S.D.	.62	.68	.16	.01	.32	.24	.60	1.43	1.53
7 \bar{X}	22.27	24.21	20.11	24.40	26.34	28.46	17.68	17.16	14.40
S.D.	1.63	1.55	.59	0.00	1.05	0.00	1.47	1.88	2.08

APPENDIX B

Salinities, Monthly Mean Values for Each Station - 1976

Station	03/09	04/10	05/12	06/08	07/06	08/04	09/02	10/14	11/12	12/01
1 \bar{X}	29.78	27.69	30.41	29.87	31.06	30.93	31.74	32.87	33.85	31.96
S.D.	.29	2.09	.13	.08	.13	.08	.07	.28	.46	1.01
2 \bar{X}	24.43	20.52	27.53	27.93	30.59	30.30	31.32	31.76	30.90	31.21
S.D.	1.30	.02	.22	.08	.08	.08	.05	.25	.31	0.00
3 \bar{X}	23.6	14.18	20.72	24.09	28.79	27.43	29.45	28.99	27.69	27.86
S.D.	3.99	3.60	4.30	2.25	1.13	2.44	1.13	2.29	2.72	2.93
4 \bar{X}	21.77	14.49	22.86	25.18	30.27	29.47	30.29	30.40	28.89	32.41
S.D.	.34	.09	.05	.09	.07	.08	.05	.19	.14	.35
5 \bar{X}	20.85	14.07	22.31	24.80	29.90	29.59	30.33	30.39	28.37	33.28
S.D.	1.97	.71	.56	.23	.11	.17	.21	.14	.22	1.03
6 \bar{X}	20.77	14.88	21.18	24.16	29.62	29.49	30.11	30.42	28.75	33.54
S.D.	3.06	.73	.30	.14	.16	.10	.03	.03	.48	1.83
7 \bar{X}	19.95	13.94	19.74	23.46	29.51	29.08	29.40	30.17	29.98	-
S.D.	4.60	.94	1.04	.35	.20	.23	.26	.06	.83	-

APPENDIX B

Salinities, Monthly Mean Values for Each Station - 1977

Station	03/31	05/20	06/08	07/07	08/09	09/07	10/05	11/09	12/06
1 \bar{X}	29.26	30.27	32.15	-	31.72	32.77	32.50	30.14	31.87
S.D.	.63	.15	.10	-	.17	.34	.25	.33	.18
2 \bar{X}	19.48	25.34	31.52	31.03	31.78	32.70	29.66	25.47	25.71
S.D.	0.65	.10	.04	.10	.14	.52	.18	0.00	.47
3 \bar{X}	11.06	20.32	28.17	28.43	30.18	30.30	27.04	18.83	18.23
S.D.	4.64	2.02	1.67	1.20	.89	.56	2.18	5.21	4.11
4 \bar{X}	10.83	20.19	29.61	29.73	31.27	31.97	28.28	20.88	16.92
S.D.	0.16	.08	.29	.08	.45	.48	.19	.37	.16
5 \bar{X}	10.10	19.45	28.99	29.51	31.44	31.3	27.96	19.56	16.05
S.D.	.84	.04	.27	.15	.06	3.49	.22	1.7	1.14
6 \bar{X}	7.64	18.71	28.53	28.77	31.23	31.97	27.25	17.06	14.18
S.D.	.80	.26	.06	.13	.07	.31	.24	3.06	.65
7 \bar{X}	7.27	18.29	27.60	28.84	31.03	33.15	27.21	17.39	12.30
S.D.	1.21	.62	.36	.07	.13	.16	.55	3.12	1.72

APPENDIX B

Salinities, Monthly Mean Values for Each Station - 1978

Station	04/03	05/02	05/26	06/27	07/25
1 \bar{X}	30.14	30.70	28.58	31.13	31.47
S.D.	.39	.26	.21	.23	.06
2 \bar{X}	21.79	25.59	23.20	30.61	31.16
S.D.	.39	.32	.26	.13	.09
3 \bar{X}	12.69	18.74	16.10	26.41	29.88
S.D.	4.73	3.14	3.85	1.85	.77
4 \bar{X}	11.30	19.06	17.90	27.40	30.65
S.D.	.24	.09	.08	.18	.12
5 \bar{X}	10.55	19.06	17.38	27.95	30.51
S.D.	.78	.62	.10	.36	.18
6 \bar{X}	8.93	17.05	15.86	26.59	30.26
S.D.	1.60	.47	.37	.14	.11
7 \bar{X}	7.20	16.07	14.83	25.49	30.08
S.D.	2.41	.79	1.30	.36	.24

APPENDIX C

Turbidities, Monthly Mean Values for Each Station - 1974

Station	07/26	08/27	09/25	10/25	11/22	12/21
1 \bar{X}	97	-	91	-	-	90
S.D.	1	-	1	-	-	0
2 \bar{X}	90	-	88	-	-	89
S.D.	2	-	2	-	-	0
3 \bar{X}	85	90	95	91	-	90
S.D.	2	0	1	1	-	0
4 \bar{X}	87	87	79	87	-	88
S.D.	1	1	1	1	-	0
5 \bar{X}	86	87	81	84	-	90
S.D.	1	1	0	0	-	0
6 \bar{X}	85	85	82	86	-	89
S.D.	1	0	1	1	-	1
7 \bar{X}	84	86	83	85	-	87
S.D.	0	1	1	0	-	1

APPENDIX C

Turbidities, Monthly Mean Values for Each Station - 1975

Station	01/20	02/05	05/07	06/04	07/15	08/14	10/29	11/26	12/12
1 \bar{X}	88	92	93	88	93	95	85	-	-
S.D.	1	0	0	0	0	0	0	-	-
2 \bar{X}	86	90	89	95	85	94	82	-	-
S.D.	0	0	0	1	0	1	1	-	-
3 \bar{X}	85	88	87	88	82	93	79	-	-
S.D.	1	1	1	1	1	0	1	-	-
4 \bar{X}	87	87	85	86	82	93	80	-	-
S.D.	0	0	0	1	1	0	0	-	-
5 \bar{X}	87	88	85	86	81	93	86	-	-
S.D.	0	0	1	0	0	0	0	-	-
6 \bar{X}	86	90	87	84	75	92	84	-	-
S.D.	1	0	0	0	1	0	0	-	-
7 \bar{X}	81	89	82	85	77	91	77	-	-
S.D.	1	1	0	1	2	1	3	-	-

APPENDIX C

Turbidities, Monthly Mean Values for Each Station - 1976

Station	03/09	04/10	05/12	06/08	07/06	08/04	09/02	10/14	11/12	12/01
1 \bar{X}	94	94	95	96	-	99	-	-	-	-
S.D.	0	0	0	1	-	1	-	-	-	-
2 \bar{X}	89	94	90	94	-	98	-	-	-	-
S.D.	0	0	0	1	-	0	-	-	-	-
3 \bar{X}	86	95	81	88	-	98	-	-	-	-
S.D.	0	0	1	1	-	0	-	-	-	-
4 \bar{X}	82	92	78	89	-	98	-	-	-	-
S.D.	0	0	0	0	-	1	-	-	-	-
5 \bar{X}	84	92	76	89	-	98	-	-	-	-
S.D.	2	1	1	0	-	1	-	-	-	-
6 \bar{X}	81	89	71	87	-	98	-	-	-	-
S.D.	3	1	1	1	-	0	-	-	-	-
7 \bar{X}	81	84	68	85	-	98	-	-	-	-
S.D.	1	3	10	1	-	0	-	-	-	-

APPENDIX C

Turbidities, Monthly Mean Values for Each Station - 1977

Station	03/31	05/20	06/08	07/07	08/09	09/07	10/05	11/09	12/06
1 \bar{X}	-	-	96	93	7100	99	97	97	99
S.D.	-	-	0	0	0	0	0	0	0
2 \bar{X}	94	-	98	97	99	100	96	97	99
S.D.	1	-	0	0	0	0	0	0	0
3 \bar{X}	60	-	96	96	97	98	95	95	98
S.D.	1	-	0	0	1	0	1	3	1
4 \bar{X}	91	-	97	97	97	98	97	92	99
S.D.	1	-	0	1	1	0	0	0	0
5 \bar{X}	93	-	96	97	98	99	98	90	96
S.D.	1	-	0	1	0	0	0	4	1
6 \bar{X}	90	-	95	97	96	99	96	89	84
S.D.	2	-	0	0	0	0	0	4	1
7 \bar{X}	72	-	92	95	96	98	97	87	75
S.D.	10	-	0	1	1	0	0	5	7

APPENDIX C

Turbidities, Monthly Mean Values for Each Station - 1978

Station	04/03	05/02	05/26	06/27	07/25
1 \bar{X}	100	99	100	98	98
S.D.	0	1	0	0	0
2 \bar{X}	97	100	98	98	>100
S.D.	1	1	0	0	0
3 \bar{X}	94	96	93	95	96
S.D.	1	0	1	1	1
4 \bar{X}	86	94	92	97	99
S.D.	1	1	1	1	1
5 \bar{X}	87	93	93	97	97
S.D.	1	0	0	0	1
6 \bar{X}	75	87	94	27	96
S.D.	7	2	1	0	1
7 \bar{X}	73	84	89	95	95
S.D.	6	6	1	1	1

APPENDIX D

1% Light Levels for each Month & Station - 1974

Station	07/26	08/27	09/25	10/25	11/22	12/21
1	7.5M	>10.0 M	>16.0 M	no data faulty meter	no data faulty meter	10.0 M
2	6.0	>8.0	8.0	8.0	8.0	6.0
3	4.0	4.0	6.0	6.0	6.0	4.0
4	5.0	3.5	6.0	6.0	6.0	4.0
5	5.0	4.5	7.0	7.0	7.0	4.0
6	3.5	2.5	5.0	5.0	5.0	3.5
7	2.8	3.0	5.0	5.0	5.0	3.5

APPENDIX D

1% Light Levels for each Month & Station - 1975

Station	01/20	02/05	05/07	06/04	07/15	08/14	10/29	11/26	12/12
1	8.0M	>13.0M	11.0M	>12.0M	12.0M	>13.0M	>13.0M	10.5M	8.0M
2	7.0	9.0	4.5	7.0	7.0	11.0	5.0	7.5	5.0
3	4.0	6.0	3.5	4.5	5.0	8.0	3.0	5.5	2.5
4	6.0	6.0	3.0	5.0	4.0	11.0	3.0	5.5	3.0
5	5.0	6.0	3.5	5.0	4.0	10.0	5.0	3.0	3.0
6	5.0	6.0	3.0	4.0	5.0	>9.0	5.5	2.5	3.0
7	3.0	5.0	2.0	3.5	>5.0	>2.0	4.0	2.0	3.0

APPENDIX D

1% Light Levels for each Month & Station - 1976

Station	03/09	04/10	05/12	06/08	07/06	08/04	09/02	10/14	11/12	12/01
1	>10.0M	>11.0M	>13.0M	>14.0M	>12.0M	>13.0M	>12.0M	>14.0M	>16.0M	>14.0M
2	6.0	8.0	5.0	10.0	>13.0	11.0	>13.0	13.0	10.0	>13.0
3	4.0	7.0	3.0	4.0	6.0	>6.0	>7.0	>9.0	>6.0	9.0
4	3.5	5.0	3.0	5.0	>8.0	7.0	>7.0	7.0	6.0	>7.0
5	3.0	4.5	5.0	5.0	7.0	>6.0	7.5	7.5	6.0	9.0
6	2.0	3.5	2.0	5.0	7.0	9.0	6.5	4.0	5.0	6.0
7	3.0	3.0	2.0	3.0	6.0	>6.0	5.0	3.5	4.0	5.0

APPENDIX D

1% Light Levels for each Month & Station - 1977

Station	03/31	05/20	06/08	07/07	08/09	09/07	10/05	11/09	12/06
1	11.0M	10.0M	>15.0M	>16.0M	>12.0M	>14.0M	>14.0M	7.0M	8.0M
2	4.0	5.0	12.0	>16.0	>12.0	>16.0	>12.0	5.0	6.0
3	2.5	4.0	6.0	>7.0	>8.0	>9.0	>9.0	1.5	3.0
4	3.0	3.5	7.0	>9.0	>7.0	>10.0	10.0	2.5	3.0
5	3.0	3.5	8.0	>3.0	9.0	>6.0	>12.0	<1.0	3.0
6	2.0	4.0	5.0	8.0	7.0	9.5	8.0	-	1.5
7	2.0	4.5	3.0	>5.0	<1.0	>7.0	>7.0	-	2.0

APPENDIX D

1% Light Levels for each Month & Station - 1978

Station	04/03	05/02	05/26	06/27	07/25
1	>10.0 M	>14.0 M	>19.0 M	>8.0 M	>13.0 M
2	6.0	-	6.0	>15.0	14.0
3	3.0	7.0	3.5	6.0	5.0
4	2.5	6.0	4.0	>10.0	9.0
5	3.0	5.0	3.0	9.0	6.0
6	6.5	2.8	3.0	>7.0	7.0
7	2.0	3.2	2.5	6.0	5.0