MERRIMACK RIVER
MONITORING PROGRAM
1975

Prepared for

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE
MANCHESTER, NEW HAMPSHIRE

by

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MERRIMACK RIVER MONITORING PROGRAM - 1975

I. INTRODUCTION

The sixth year of the Merrimack River Monitoring Program was initiated in April 1975. The monitoring program, developed to fulfill requirements contained in NPDES permit number NH 0001465 issued to Public Service Company of New Hampshire, was designed to detect both spatial and temporal changes in the biotic communities of the Merrimack River and determine whether the thermal discharge from the Merrimack Generating Station resulted in any significant impacts on these communities. Types of studies conducted included water quality, temperature, entrainment, periphyton, benthic macroinvertebrate and fisheries studies. Additionally, during 1975 a special plume deflector study was conducted which assessed the effectiveness of an oil containment boom in deflecting the thermal plume to the west bank of the river. It was felt that containing the plume would lessen chances of interfering with upstream migration of anadromous fish species that are planned for reintroduction. The monitoring program emphasizes the section of the Merrimack River from Garvins Falls Dam in Concord to the Hooksett Dam in Hooksett, New Hampshire, a distance of 5.75 miles (Figure 1). This area of the river is generally referred to as Hooksett Pond. The Merrimack Generating Station is located near its center at river mile 84.

Sampling stations were established and marked on transects located north and south of the mouth of the discharge canal. These are numbered N-1 to N-10, and S-1 to S-24, respectively. Stations N-1 through N-6 are 500 ft apart while N-6 to N-10 are 1000 ft apart. Stations south of the discharge canal (S-1 to S-24) are located at 500 foot intervals. The north stations, particularly N-10, were used to characterize ambient river conditions as contrasted to the thermally

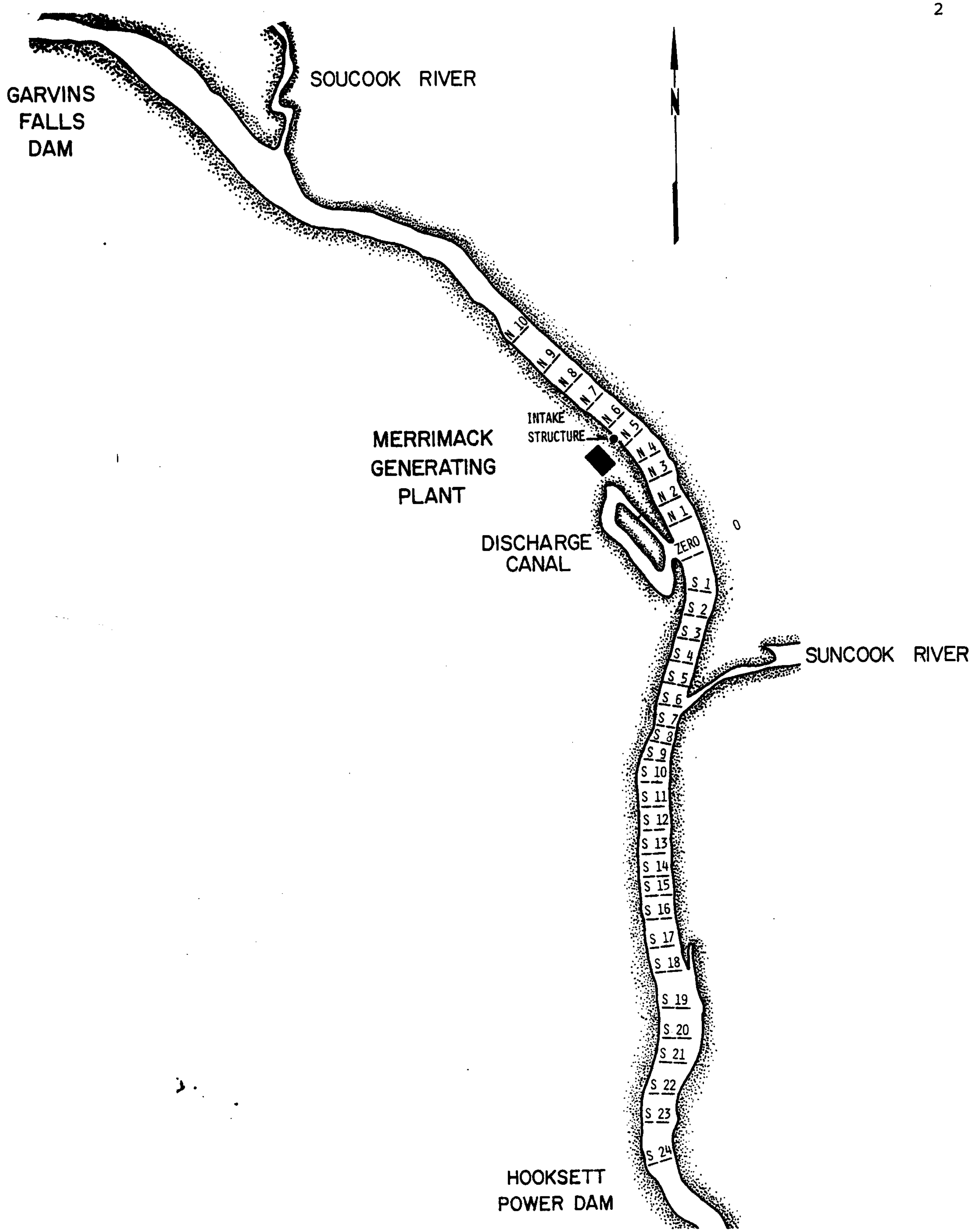


Figure 1. Location of sampling stations, Hooksett Pond, Merrimack River, New Hampshire.

affected zone south of the discharge. Station Zero-West was established at the mouth of the discharge canal (western extreme of Station Zero) and all samples taken at that location were within the direct influence of the thermal discharge. The portion of the river under study is fairly uniform, and has an average width of 500 to 700 feet. Much of the river is shallow, averaging less than ten feet in depth, although depths of over twenty feet are found in some sections.

II. PHYSICAL STUDIES

A. METHODS

1. Flows

Continuous river flow measurements were obtained from gauging station data collected at Garvins Falls (Figure 1) hydroelectric station by Public Service Company of New Hampshire. These data were reported as 6-hour mean discharge in cubic feet per second (cfs).

2. Depth of Visibility

Weekly Secchi disc visibility measurements were taken midstream at Stations N-10, S-4 and S-17 and at the mouth of the discharge canal (Zero-West). Depths at which the disc disappeared from view were recorded to the nearest one-half foot.

3. Temperature

Three types of temperature studies were conducted during the 1974-1975 project year: a) continuous monitoring of surface temperatures; b) weekly temperature profiles; and c) cross-sectional temperature profiles in conjunction with plume deflector studies. Supplementary temperature data were also collected in conjunction with biological studies.

a. Continuous Monitoring

Surface temperature monitoring was conducted by personnel of the Public Service Company of New Hampshire at Stations N-10, Zero-West and S-4. Instrumentation consisted of YSI thermivolt thermometers connected to Westinghouse (Hagen) signal converters and Sangamo digital pulse recorders. These units were linked by computer to the station control room and provided a nearly continuous (every 15 minutes) check of system operation. Calibration of the system was performed weekly.

b. Weekly Temperature Profiles

Weekly temperature profiles were taken at one-foot depth intervals at four stations (Zero, S-4, N-10, S-17). At Stations Zero and S-4, temperatures were taken at the mid-point and near the east and west banks of the river; at Stations N-10 and S-17 measurements were done only at mid-river. Periodic calibration of the field thermistor unit was accomplished with a precision-grade mercury thermometer.

c. Plume Deflector Temperature Profiles

The oil containment boom, tested for potential use as a plume deflector (NAI, 1975), extended from the discharge canal outwards approximately one-third of the distance across the river and then downstream to Station S-3 (Figure 1). The boom skirt (that part of the boom extending below water level) was 2 ft deep. The device was emplaced on July 2, 1975 and removed on July 9, 1975.

Prior to installation of the boom, thermal cross-sectional profile surveys were conducted on June 26, 1975 and on July 1, 1975. Post-installation surveys were conducted on July 3 and July 7, 1975. Water temperatures were recorded at 1-ft depth intervals at six stations across the following transects: N-10, N-5, N-1, Zero through S-10, S-14, S-18, S-22 and S-24 (transects are indicated in Figure 1). Temperatures were measured using the temperature portion of a Beckman RS5-3 portable salinometer (accuracy ±0.5 C). Relative humidity and air temperature data were provided by the U.S. Weather Service office located at the nearby Concord, New Hampshire airport.

Continuous temperature recorders were also used to monitor temperatures at fixed locations before and after emplacement of the boom. The monitors were located at mid-river on Transects Zero and S-3 as well as at three equidistant stations on Transect S-5 (mid-river and 135 ft from the east bank and 135 ft from the west bank). Each unit consisted of two thermistor probes at two different depths hard wired to a recording installation on shore. At Zero and S-3, the depths were 6 inches and 4 ft. At the three stations on S-5, the depths were 6 inches and 2.5 ft. These monitors were installed on June 30, 1975 and were removed on July 9, 1975.

B. RESULTS AND DISCUSSION

1. Flows

Mean monthly discharge ±1 standard deviation, and flow ranges during the 1975 survey period are presented in Figure 2. Mean monthly discharge at Garvins Falls ranged from 11,603 cubic feet per second (cfs) in April to 1,180 cfs in August. Similarly, average daily discharge ranged from 22,351 cfs on April 21 to 694 cfs on August 29. Due partly to the completion of the spring snow-melt, mean monthly discharge diminished by 41% (from 11,603 to 6,788 cfs) between April and May. As in 1974, August was the month of lowest flow, when 48% of the daily mean discharges were below 1000 cfs. In comparison to past seasons, 1975 flows were higher than those of 1971 (NAI, 1972) and 1974 (NAI, 1975) and lower than the flows of 1972 (NAI, 1973) and 1973 (NAI, 1974).

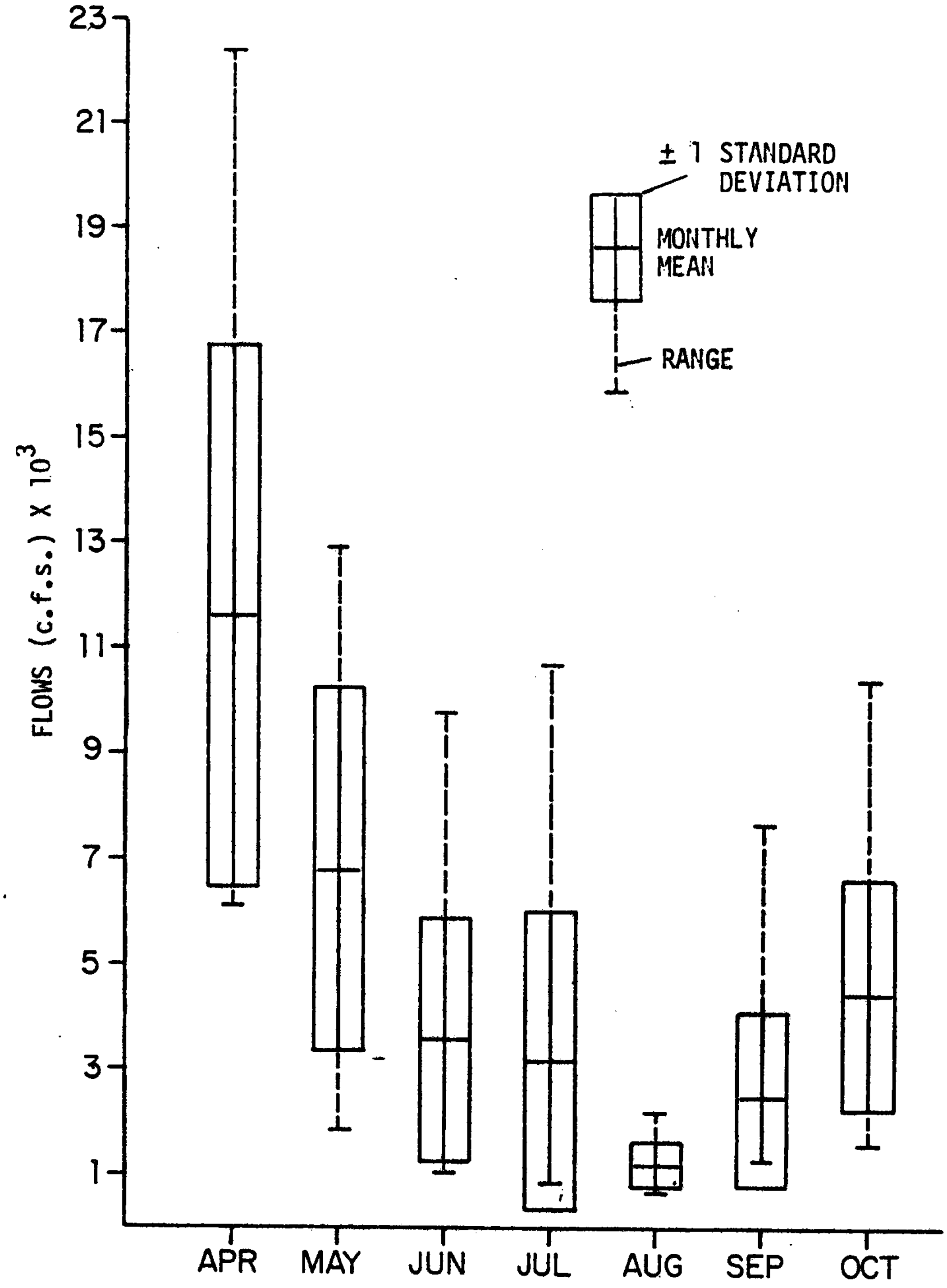


Figure 2. Mean monthly flows ±1 standard deviation, and flow ranges, Hooksett Pond, Merrimack River, 1975.

2. Depth of Visibility

Weekly depth of visibility measurements taken during the 1975 sampling season are listed by station in Table 1. As in previous study years, readings during the spring run-off period were reduced, with a minimum value of 2.5 feet recorded on April 21. However, due in part to frequent and heavy rainfall during October 1975, the autumnal depth of visibility values averaged less than those of the spring. Maximum visibility (10.5 ft) was recorded, as in past years, during late summer and early autumn, the period of lowest flows and lowest productivity. During April, May and June, Station Zero-West had lower depth of visibility values than did Station N-10. This trend has been observed in the past and may be the result of suspension of unconsolidated sediments associated with the mouth of the discharge canal. In general, depths of visibility for the 1975 study season differed little from the trends of previous years except during unusual circumstances such as the dredging operations of April 1972 and the severe flooding of July 1973.

3. Temperature

a. Continuous Temperature Monitoring

Continuous temperature monitoring data for Stations N-10, Zero and S-4 are shown in Appendix I. Data presented are average, maximum and minimum daily temperatures; time of recording is also indicated. The highest daily average ambient temperature, 77.9°F, occurred at Station N-10 in July. At Station S-4, the highest average temperature was 85.1°F and also occurred during July. Data for Station Zero was incomplete for the months of June and July due to difficulties with data tapes.

TABLE 1. WEEKLY DEPTH OF VISIBILITY MEASUREMENTS (FEET) BY STATION, HOOKSETT POND, MERRIMACK RIVER -- APRIL THROUGH OCTOBER 1975.

SAMPLING DATES 1975	N-10	ZERO-WEST	S-4	S-17
April 1	7.0	5.0	7.0	6.5
7	5.0	4.5	4.5	5.0
14	9.0	6.0	8.0	8.5
21	3.0	3.0	2.5	2.5
29	8.5	6.5	8.0	5.0
May 6	5.5	5.0	5.5	5.0
12	7.0	5.0	7.0	7.0
19	6.5	5.0	7.0	6.0
26	7.5	4.0	8.5	8.0
June 2	8.5	5.0	8.5	6.5
9	5.5	5.0	5.5	6.0
16	4.5	4.0	4.5	4.5
23	6.5		6.0	6.0(B)
30	5.5	4.5(B)	6.5	6.0
July 8	8.5(B)	5.5(B)	9.0	7.0(B)
14	8.0	6.5(B)	8.5	8.0
21	6.0	6.0	6.5	6.5
28	6.5	6.0(B)	7.0	7.0
August 4	8.0	5.0(B)	8.0	7.5
11	9.5	6.5(B)	8.5	9.5(B)
18	8.0	5.5(B)	9.0	7.0(B)
25	8.0	4.0(B)	10.0	7.5
Sept. 2	9.0	6.0(B)	9.0	7.0(B)
10	9.0(B)	5.5(B)	10.5	7.0(B)
15	9.0(B)	6.0(B)	9.5	7.0(B)
22	9.0(B)	6.0(B)	9.5	7.5(B)
30	3.0	3.0	3.5	3.0
October 6	5.5	5.5	6.0	6.0
16	4.0	4.0	5.0	5.0
20	3.5	3.5	3.5	3.5
30	6.0	5.0(B)	7.5	6.0

*(B) signifies Bottom

b. Weekly Temperature Profiles

Temperature data, taken in conjunction with weekly monitoring activities, are presented in Tables 2-4. Highest mean monthly surface temperatures (Table 2) occurred during August, the month of lowest flows (Figure 2). Values in Table 3 represent vertical temperature differences at each station throughout the season. These surface-to-bottom differences were most pronounced during months of highest ambient air and water temperatures, July, August and September. Vertical temperature differences at Station Zero-West during these months were small, due, in part, to relatively low flow and resulting lower level of encroachment by ambient water into the discharge canal mouth. Station Zero-West temperature profiles consistently yielded the highest average monthly Δt's when compared to N-10 (Table 4). Each mean peak temperature difference between Station N-10 and the thermally-affected stations (Zero, S-4 and S-17) during July, August and September was more than double that of April, May, June and October. Maximum dissimilarity of peak temperatures between N-10 and the other three stations occurred during August.

c. Plume Deflector Temperature Profiles

PRE-INSTALLATION TEMPERATURE SURVEYS

June 26, 1975 -- Figure 3

Both Units I and II and 208 spray modules were operational during the June 26th survey. Relative humidity ranged from 40 to 100% ($\bar{x}$ = 65%) and air temperature ranged from 50 to 84°F ($\bar{x}$ = 68°F). Discharge averaged 1902 cfs.

TABLE 2. WEEKLY TEMPERATURE POINT PROFILES: MEAN MONTHLY TEMPERATURES (°F) AND RANGES, HOOKSETT POND, MERRIMACK RIVER, 1975.

STATION		APRIL			MAY			JUNE		
		WEST	MID	EAST	WEST	MID	EAST	WEST	MID	EAST
N-10	Range		33.5-43.5			49.0-67.0			59.0-77.0	
	Mean		38.6			58.2			67.8	
Zero	Range	41.0-54.4	33.2-43.9	33.3-44.4	60.1-75.8	49.5-67.5	50.4-68.0	71.3-90.0	59.2-88.9	59.0-77.0
	Mean	46.6	39.0	39.4	69.3	58.6	59.0	76.6	87.8	68.0
S-4	Range	37.8-45.9	34.0-44.4	34.0-44.2	52.8-68.9	52.1-69.5	50.0-68.0	61.2-83.3	63.0-86.0	67.7-78.0
	Mean	41.7	39.5	39.4	60.9	62.5	60.5	70.7	72.0	69.7
S-17	Range		34.1-44.8			50.5-68.1			60.0-80.3	
	Mean		39.5			59.6			69.7	

STATION		JULY			AUGUST			SEPTEMBER			OCTOBER		
		WEST	MID	EAST	WEST	MID	EAST	WEST	MID	EAST	WEST	MID	EAST
N-10	Range		75.5-78.8			70.9-81.4			59.2-67.0			50.0-58.1	
	Mean		77.0			76.4			63.8			53.1	
Zero	Range	90.0-93.5	78.0-90.1	76.2-91.8	84.0-95.1	83.3-94.1	84.0-93.3	71.1-81.0	59.2-79.4	59.0-79.0	50.0-66.1	50.0-59.0	49.9-59.0
	Mean	91.5	85.4	80.8	90.6	88.8	88.8	76.0	73.0	67.2	61.0	53.6	53.6
S-4	Range	81.5-90.0	81.0-90.3	77.2-90.0	81.3-90.3	82.1-90.5	81.2-87.3	61.7-77.0	62.4-76.0	59.0-75.1	49.8-58.5	50.0-58.5	49.8-59.0
	Mean	85.2	85.5	82.8	86.8	87.0	84.5	69.5	70.5	69.4	54.6	55.8	54.2
S-17	Range		80.2-85.8			78.0-88.0			59.5-71.1			49.9-58.1	
	Mean		82.2			83.3			66.9			53.5	

TABLE 3. WEEKLY TEMPERATURE POINT PROFILES: MEAN MONTHLY SURFACE-TO-BOTTOM Δt'S (°F), HOOKSETT POND, MERRIMACK RIVER, 1975.

	APRIL			MAY			JUNE			JULY			AUGUST*			SEPTEMBER			OCTOBER		
STATION	West	Mid	East	West	Mid	East	West	Mid	East	West	Mid	East	West	Mid	East	West	Mid	East	West	Mid	East
N-10		0.1			0.3			0.3			0.5			1.0			0.3			0.0	
Zero	4.3	0.2	0.3	8.3	0.4	0.6	6.0	2.3	0.0	9.2	8.4	3.0	3.8	12.2	10.7	4.6	9.3	1.9	5.9	0.4	0.3
S-4	0.4	0.3	0.2	0.7	3.6	0.8	1.0	2.8	0.2	5.6	8.4	4.8	8.6	11.0	7.6	3.4	6.7	5.0	0.3	2.4	0.0
S-17		0.1			0.5			0.5			4.5			6.5			2.0			-0.1	

* Values represent the mean of three sampling dates.

(1) These data represent the monthly average of the weekly surface-to-bottom temperature difference at each profile.

TABLE 4. WEEKLY TEMPERATURE POINT PROFILES: MEAN MONTHLY Δt'S (°F) BY STATION, HOOKSETT POND, MERRIMACK RIVER, 1975.

STATION	APRIL						MAY						JUNE					
	West		Mid		East		West		Mid		East		West		Mid		East	
	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak
N-10			---						---						---			
Zero	5.6[1]	9.1[2]	0.4	0.4	0.6	0.8	6.6	9.9	0.3	0.4	0.7	1.0	6.7	8.9	1.3	2.6	0.4	0.5
S-4	2.9	3.1	0.8	0.9	0.8	0.8	2.4	2.5	1.4	4.1	1.9	2.3	2.6	2.9	1.7	4.2	2.2	2.2
S-17			0.8	0.9					1.3	1.4					1.7	1.9		

STATION	JULY						AUGUST*						SEPTEMBER					
	West		Mid		East		West		Mid		East		West		Mid		East	
	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak
N-10			---						---						---			
Zero	11.7	14.5	3.2	8.5	3.0	3.8	13.3	14.2	6.0	11.9	9.6	12.3	11.0	12.7	4.3	9.4	2.7	3.4
S-4	5.6	8.3	2.8	8.7	3.2	5.8	7.3	11.0	3.3	10.6	3.8	8.2	4.7	5.9	2.7	7.0	3.4	5.8
S-17			2.8	5.4					3.7	6.9					2.3	3.3		

STATION	OCTOBER					
	West		Mid		East	
	Mean	Peak	Mean	Peak	Mean	Peak
N-10			---			
Zero	5.1	7.9	0.2	0.5	0.2	0.4
S-4	1.3	1.5	0.7	2.7	1.1	1.2
S-17			0.5	0.6		

* Values represent mean of three sampling dates.

(1) These data represent the mean of all values recorded at a thermally-altered vertical point profile minus the mean of all similar readings taken at Station N-10 (ambient) during a month.

(2) These data represent the mean of the weekly peak temperature differences (only) between a thermally-altered station and Station N-10 (ambient) recorded during a month.

Figure 3. Isothermal cross-sections of Merrimack River sampling stations, Hooksett Pond, June 26, 1975.

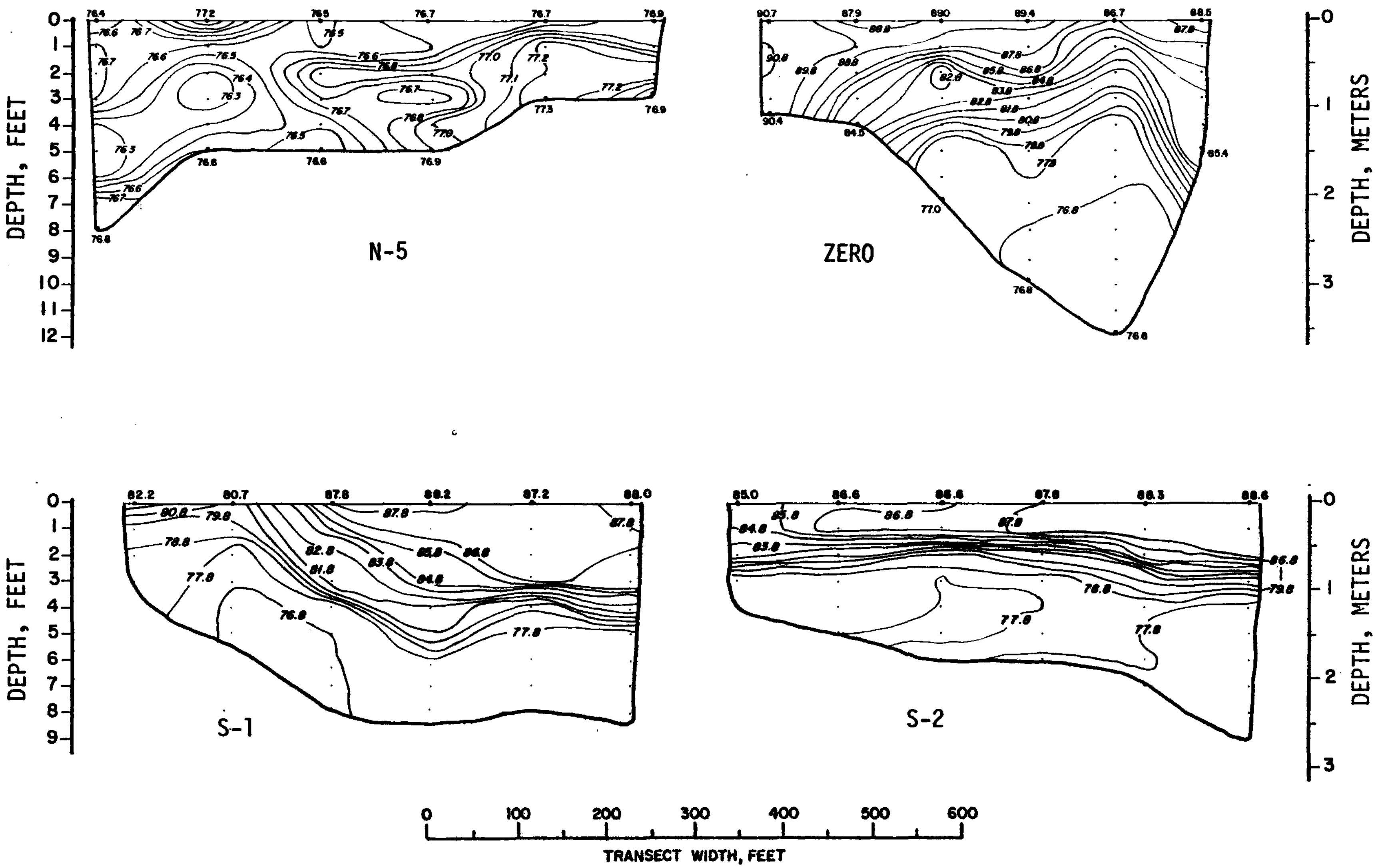
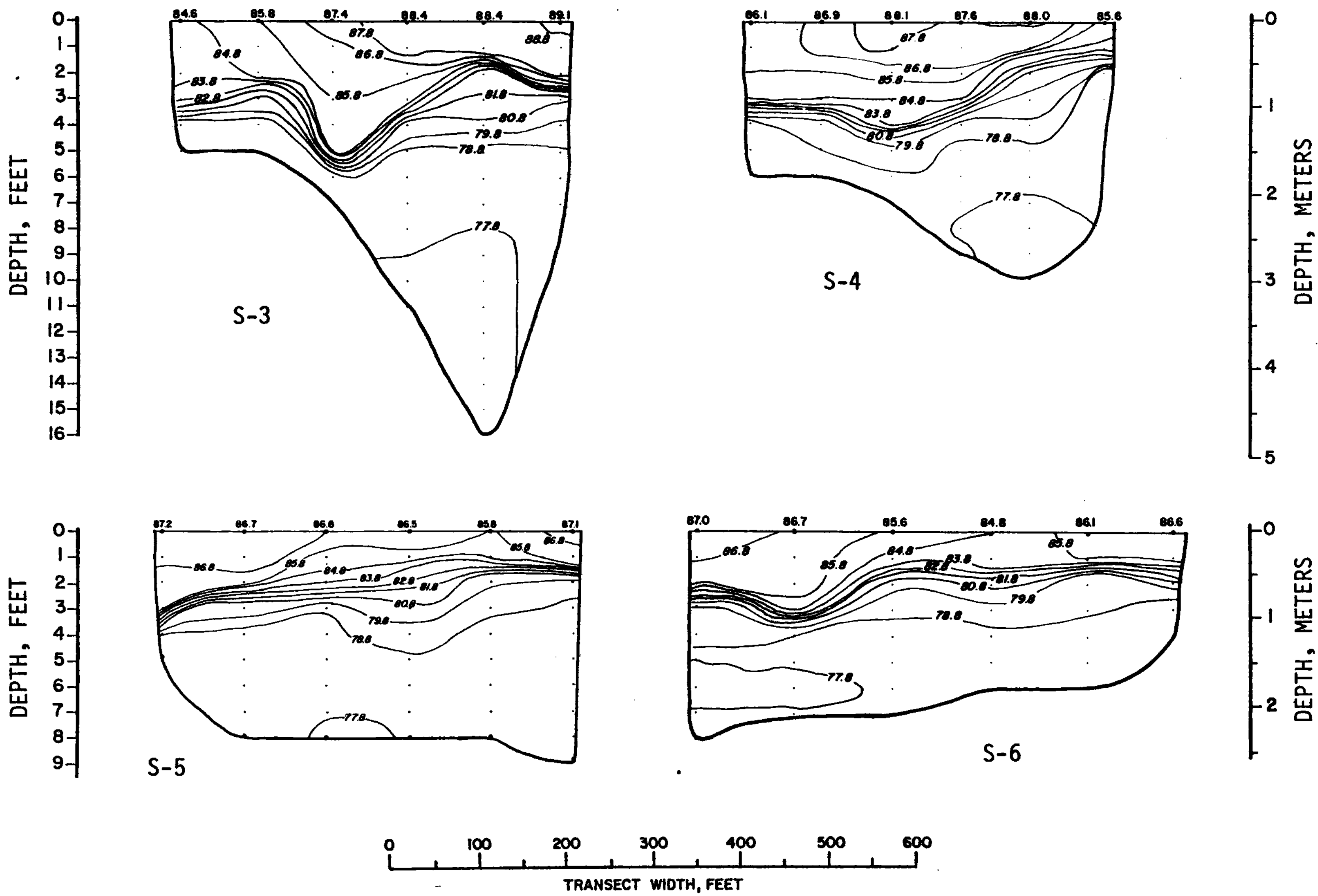

DEPTH, FEET
DEPTH, METERS
N-5
ZERO
S-1
S-2
0 100 200 300 400 500 600
TRANSECT WIDTH, FEET

Figure 3.



DEPTH, FEET
DEPTH, METERS
S-3
S-4
S-5
S-6
TRANSECT WIDTH, FEET
0
100
200
300
400
500
600

Figure 3.

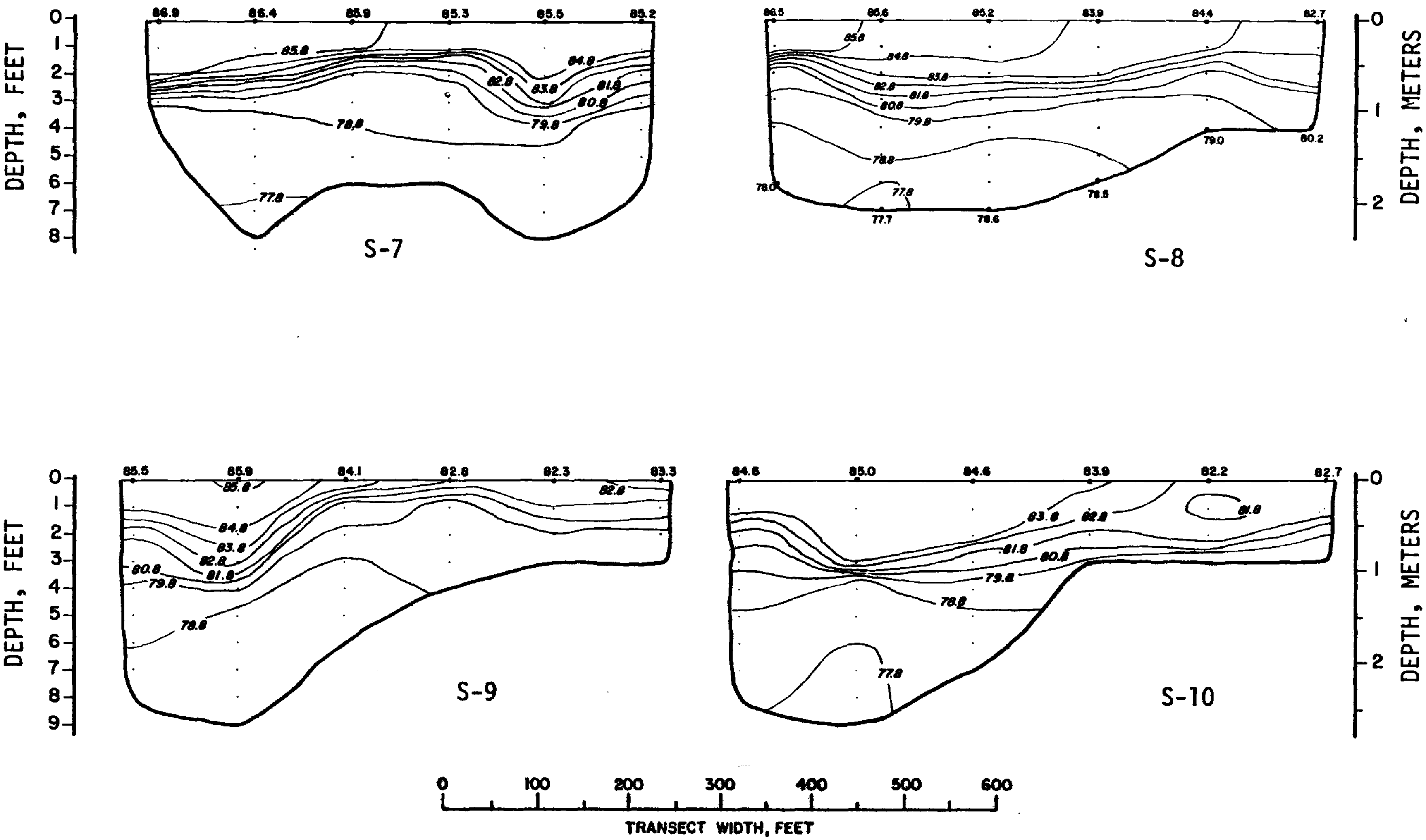
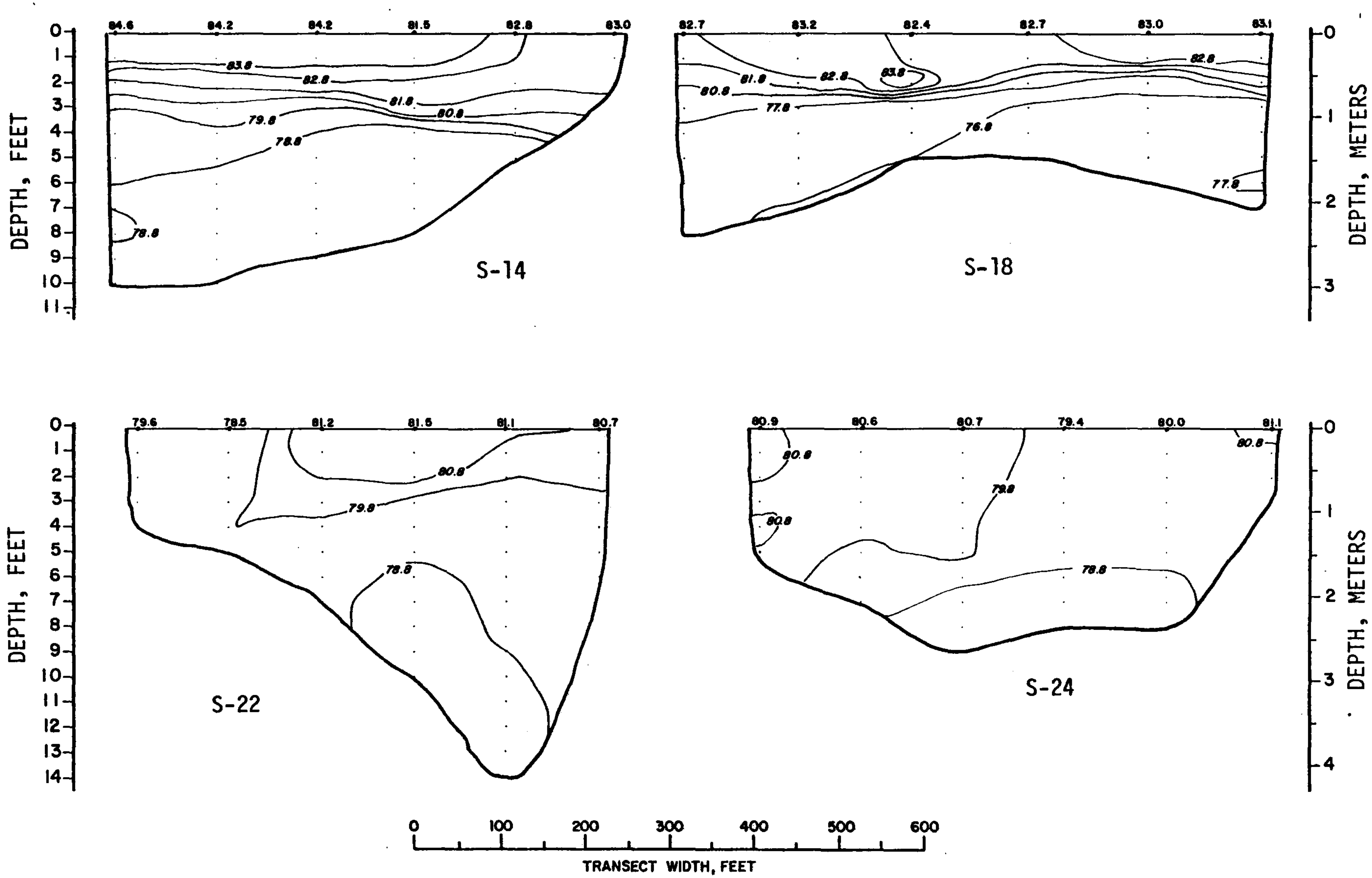

DEPTH, FEET
DEPTH, METERS
S-7
86.9
86.4
85.9
85.3
85.5
85.2
85.8
84.8
82.8
83.8
81.8
80.8
79.8
78.8
77.8
S-8
86.5
86.6
85.2
83.9
84.4
82.7
79.0
80.2
78.0
77.7
78.6
78.5
S-9
85.5
85.9
84.1
82.8
82.3
83.3
S-10
84.6
85.0
84.6
83.9
82.2
82.7
0
100
200
300
400
500
600
TRANSECT WIDTH, FEET

Figure 3.



S-14
S-18
S-22
S-24
DEPTH, FEET
DEPTH, METERS
TRANSECT WIDTH, FEET
0
100
200
300
400
500
600

Figure 3.

Water temperatures at the ambient station (N-5) ranged from 76.3°F to 78.8. At Station Zero, temperatures ranged from 76.8 to 90.8°F. At stations immediately below the canal, the heated water crossed the river to the east side with the highest temperatures along these transects occurring in the littoral zones at Stations S-1 to S-3 East. By Station S-4, the plume had spread quite evenly across the river surface. Nearly all of the thermally-altered discharge water appeared to be limited to within 4 feet of the surface at all transects. Water temperatures noted at Station S-1 (76.8 to 88.2°F) were not significantly different from those at Station S-8 (77.7 to 86.5°F), although by S-8 the depth at which higher Δt's were recorded began to decrease. Proceeding downstream from Station S-9 to S-24 water progressively cooled and a trend toward temperature homogeneity was observed.

July 1, 1975 -- Figure 4

Both Units I and II and 208 spray modules were operational during the July 1st survey. Relative humidity ranged from 30-97% ($\bar{x}$ = 65%) and air temperatures ranged from 45-90°F ($\bar{x}$ = 70°F). Discharge averaged 1546 cfs.

Water temperatures at Station N-5 ranged from 75.4 to 76.6°F, while at Station Zero, temperatures ranged from 76.8 to 89.6°F. As in the June survey, the heated water crossed the river to the east side with the highest temperatures on these transects occurring in the littoral zones at Stations S-1 to S-3 East. There was limited mixing of the plume with the deeper ambient water through Station S-7. Beginning with Station S-8, relative humidity increased until water column temperatures at S-24 resembled those at Station N-5.

Figure 4. Isothermal cross-sections of Merrimack River sampling stations, Hooksett Pond, July 1, 1975.

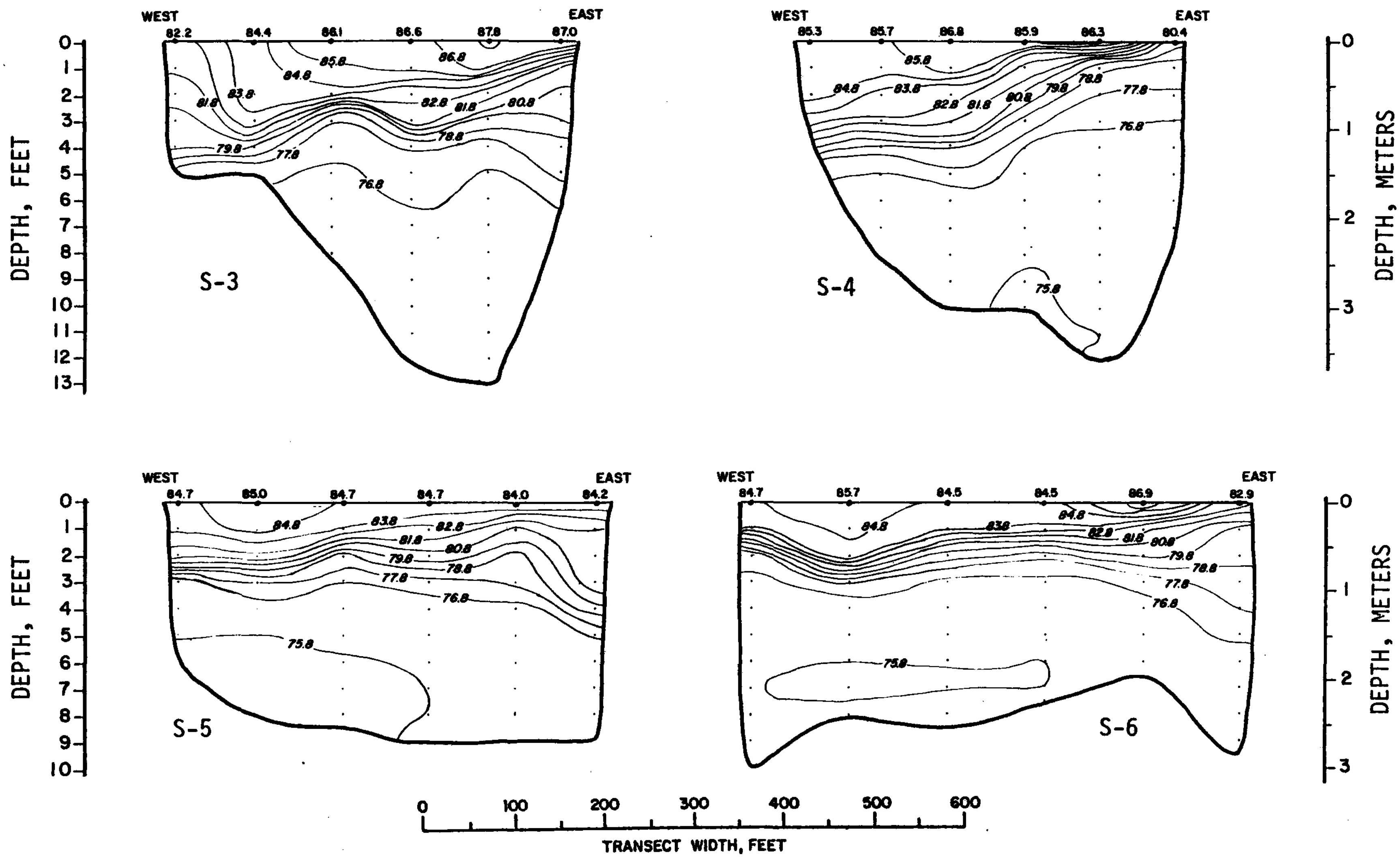

WEST
EAST
82.2
84.4
86.1
86.6
87.8
87.0
S-3
WEST
EAST
85.3
85.7
86.8
85.9
86.3
80.4
S-4
WEST
EAST
84.7
85.0
84.7
84.7
84.0
84.2
S-5
WEST
EAST
84.7
85.7
84.5
84.5
86.9
82.9
S-6
DEPTH, FEET
DEPTH, METERS
TRANSECT WIDTH, FEET
0
100
200
300
400
500
600

Figure 4.

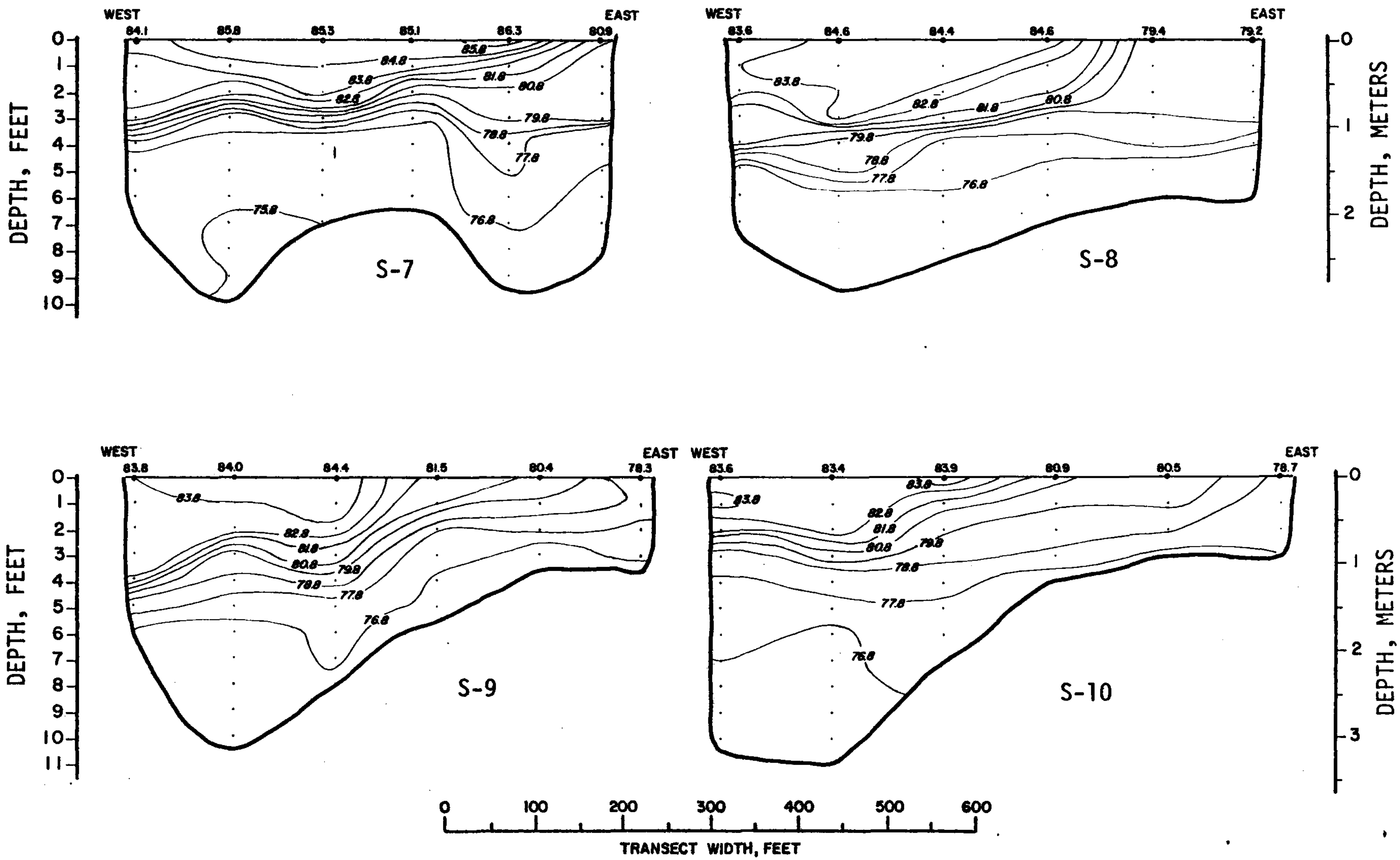

WEST
EAST
S-7
S-8
S-9
S-10
DEPTH, FEET
DEPTH, METERS
TRANSECT WIDTH, FEET

Figure 4.

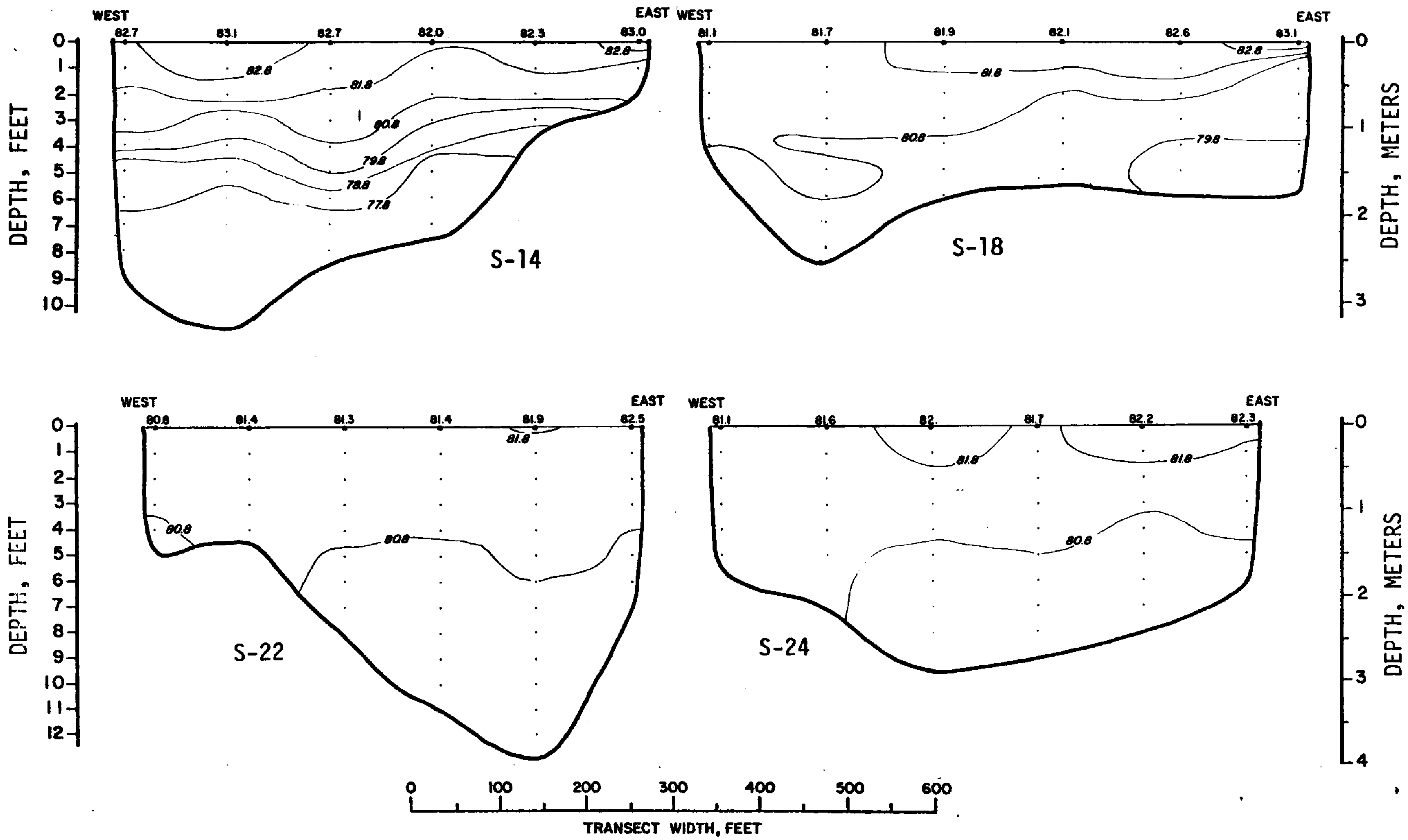

WEST
EAST
82.7
83.1
82.7
82.0
82.3
83.0
82.8
81.8
80.8
79.8
78.8
77.8
S-14
WEST
EAST
81.1
81.7
81.9
82.1
82.6
83.1
82.8
81.8
80.8
79.8
S-18
DEPTH, FEET
DEPTH, METERS
WEST
EAST
80.8
81.4
81.3
81.4
81.9
82.5
81.8
80.8
S-22
WEST
EAST
81.1
81.6
82.
81.7
82.2
82.3
81.8
80.8
S-24
TRANSECT WIDTH, FEET

Figure 4.

POST-DEPLOYMENT TEMPERATURE SURVEYS

July 3, 1975 -- Figure 5

The experimental plume deflector was emplaced on July 2, 1975 and a post-deployment temperature survey conducted on July 3. Both Units I and II and 208 spray modules were operational during the survey. Relative humidity ranged from 39 to 100% ($\bar{x}$ = 70%) and air temperature ranged from 55 to 86°F ($\bar{x}$ = 72°F). Flows averaged 1574 cfs.

Water temperatures at Station N-5 ranged from 77.5 to 78.1°F, while temperatures at Station Zero ranged from 78.5 to 92.8°F. Unlike the June 26 and July 1 pre-deployment surveys, the July 3 survey did not show a strong tendency for markedly higher water temperatures on the east bank at Station S-1 to S-3. This difference was primarily the result of the heated effluent undershooting the boom and mixing into the ambient water column to a greater extent than it had prior to boom deployment. At Stations S-18, S-22 and S-24, very little temperature stratification was evident.

July 7, 1975 -- Figure 6

Both Units I and II and 208 spray modules were operational during the July 7 survey. Relative humidity ranged from 57 to 100% ($\bar{x}$ = 87%) and air temperatures from 64 to 82°F ($\bar{x}$ = 71°F). Discharge averaged 1476 cfs.

Temperatures at Station N-5 ranged from 78.2 to 79.6°F, while temperatures at Station Zero ranged from 79.1 to 92.8°F. Once again the thermal plume appeared to undershoot the deflector and was not contained on the west bank of the river. Similar to the July 3 survey, greater mixing of the plume with ambient water was evident as exemplified by the decreased west to east surface temperature difference. Temperature stratification was, however, still strongly evident at Stations S-18, S-22 and S-24 and less temperature homogeneity existed at those stations than during the pre-deployment surveys.

Figure 5. Isothermal cross-sections of Merrimack River sampling stations, Hooksett Pond, July 3, 1975.

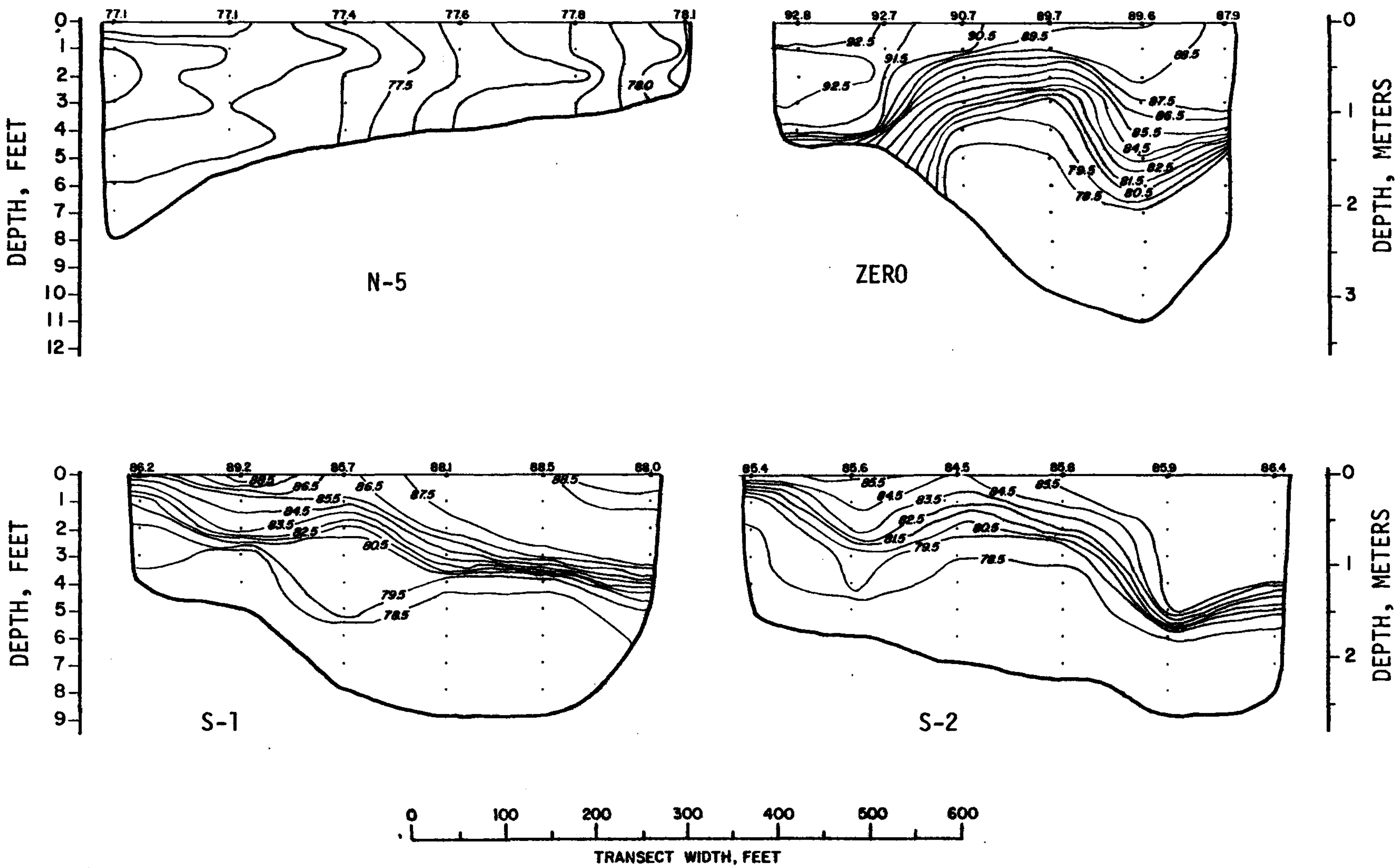

DEPTH, FEET
DEPTH, METERS
N-5
77.1
77.1
77.4
77.6
77.8
78.1
77.5
78.0
ZERO
92.8
92.7
90.7
89.7
89.6
87.9
92.5
91.5
90.5
89.5
88.5
87.5
86.5
85.5
84.5
83.5
82.5
81.5
80.5
79.5
78.5
S-1
86.2
89.2
86.7
88.1
88.5
88.0
86.5
85.5
84.5
83.5
82.5
80.5
79.5
78.5
87.5
S-2
85.4
85.6
84.5
85.8
85.9
86.4
83.5
82.5
81.5
80.5
79.5
78.5
TRANSECT WIDTH, FEET

Figure 5.

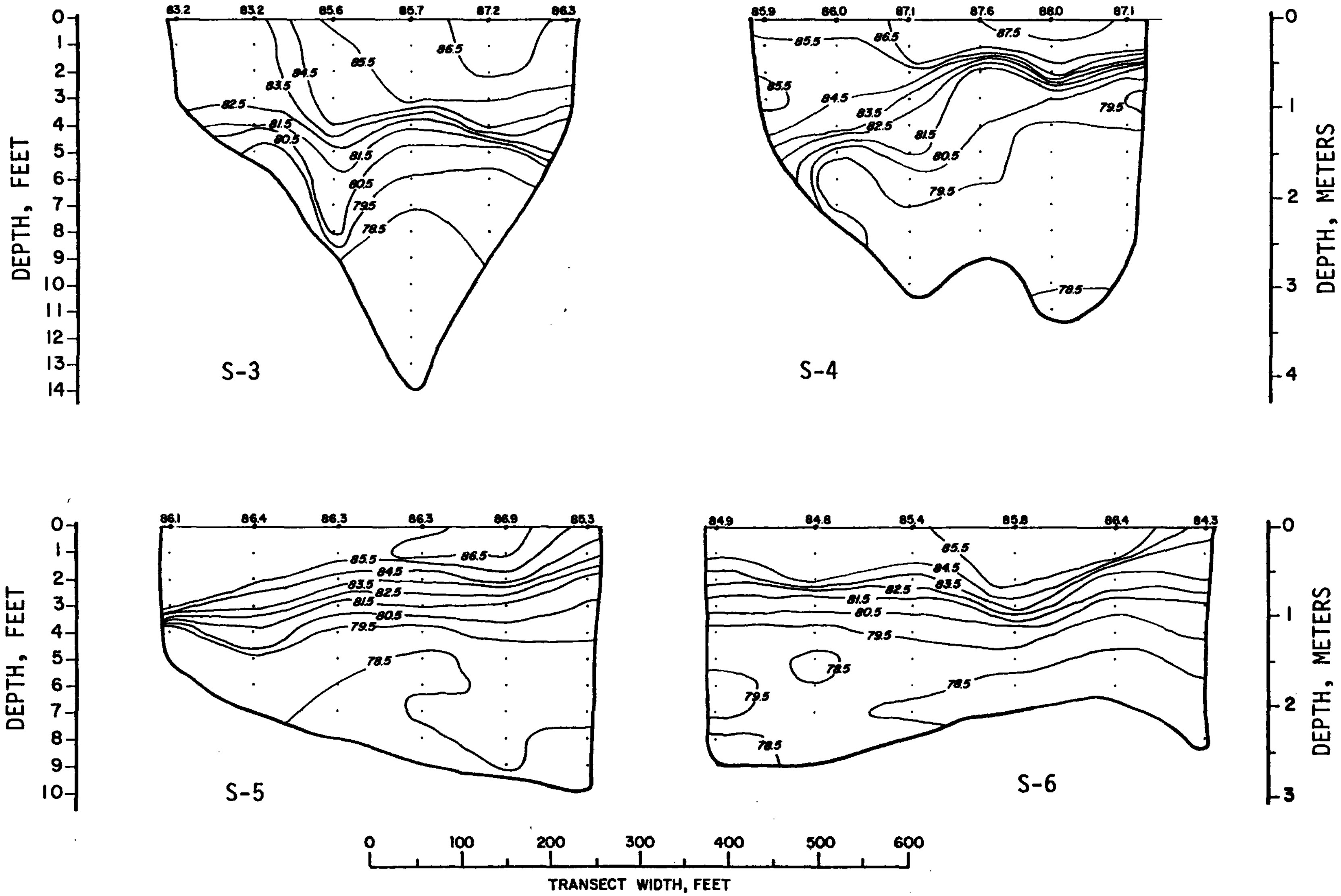

DEPTH, FEET
DEPTH, METERS
S-3
S-4
S-5
S-6
83.2
83.2
85.6
85.7
87.2
86.3
85.9
86.0
87.1
87.6
88.0
87.1
86.1
86.4
86.3
86.3
86.9
85.3
84.9
84.8
85.4
85.8
86.4
84.3
0
100
200
300
400
500
600
TRANSECT WIDTH, FEET

Figure 5.

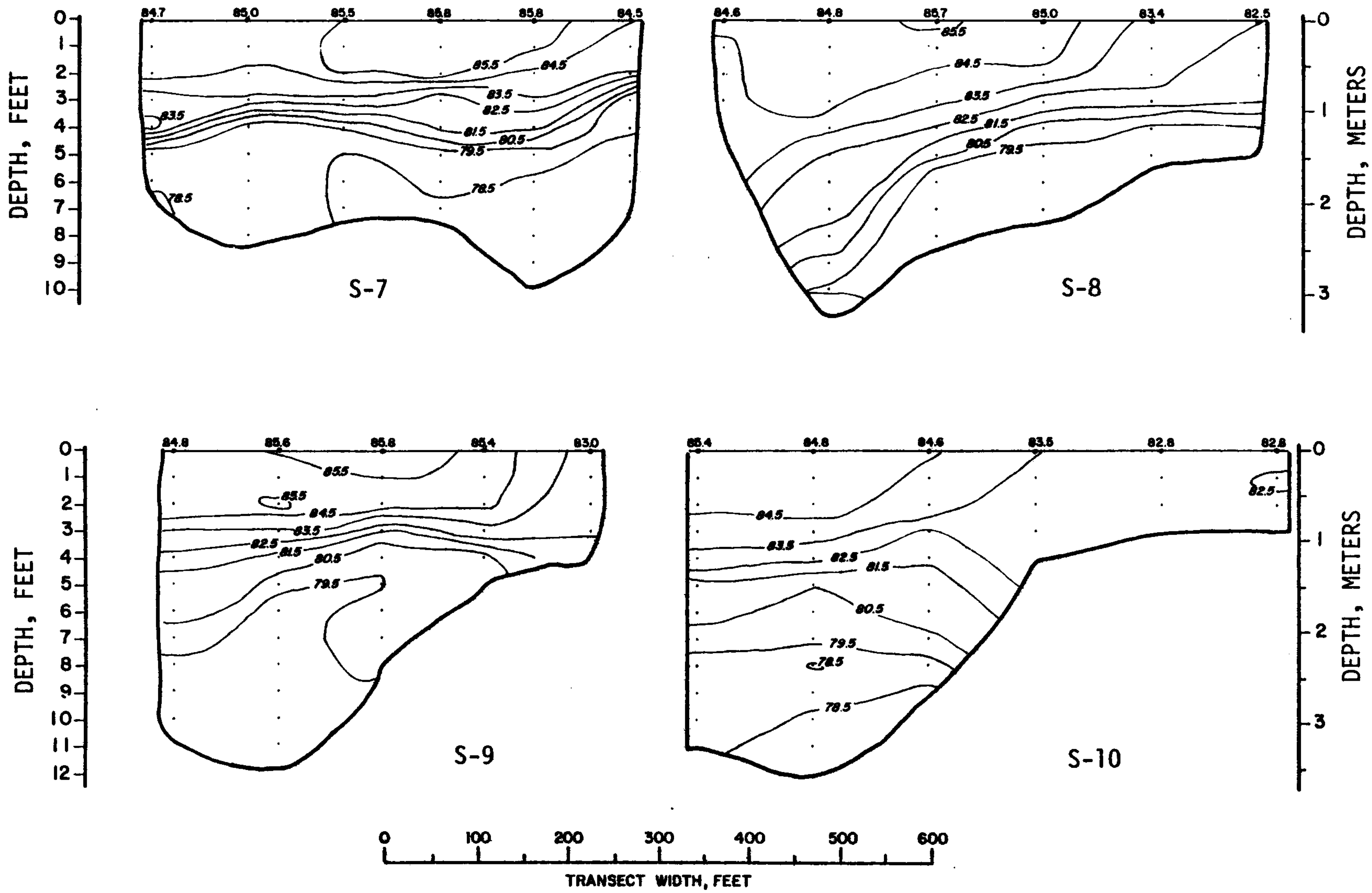

S-7
84.7 85.0 85.5 85.8 85.8 84.5
S-8
84.6 84.8 85.7 85.0 83.4 82.5
S-9
84.8 85.6 85.8 85.4 83.0
S-10
85.4 84.8 84.6 83.5 82.8 82.8
DEPTH, FEET
DEPTH, METERS
0 100 200 300 400 500 600
TRANSECT WIDTH, FEET

Figure 5.

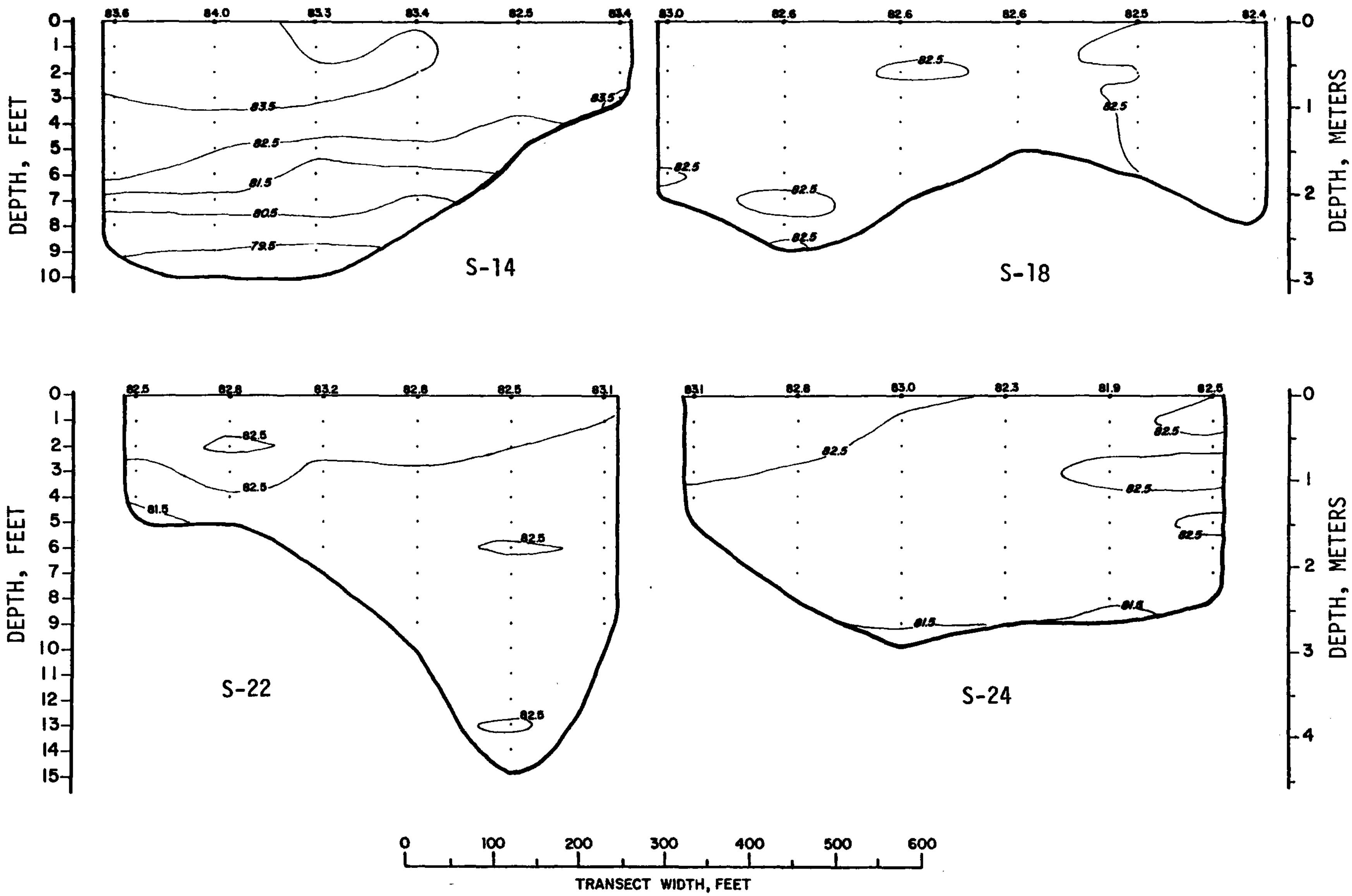
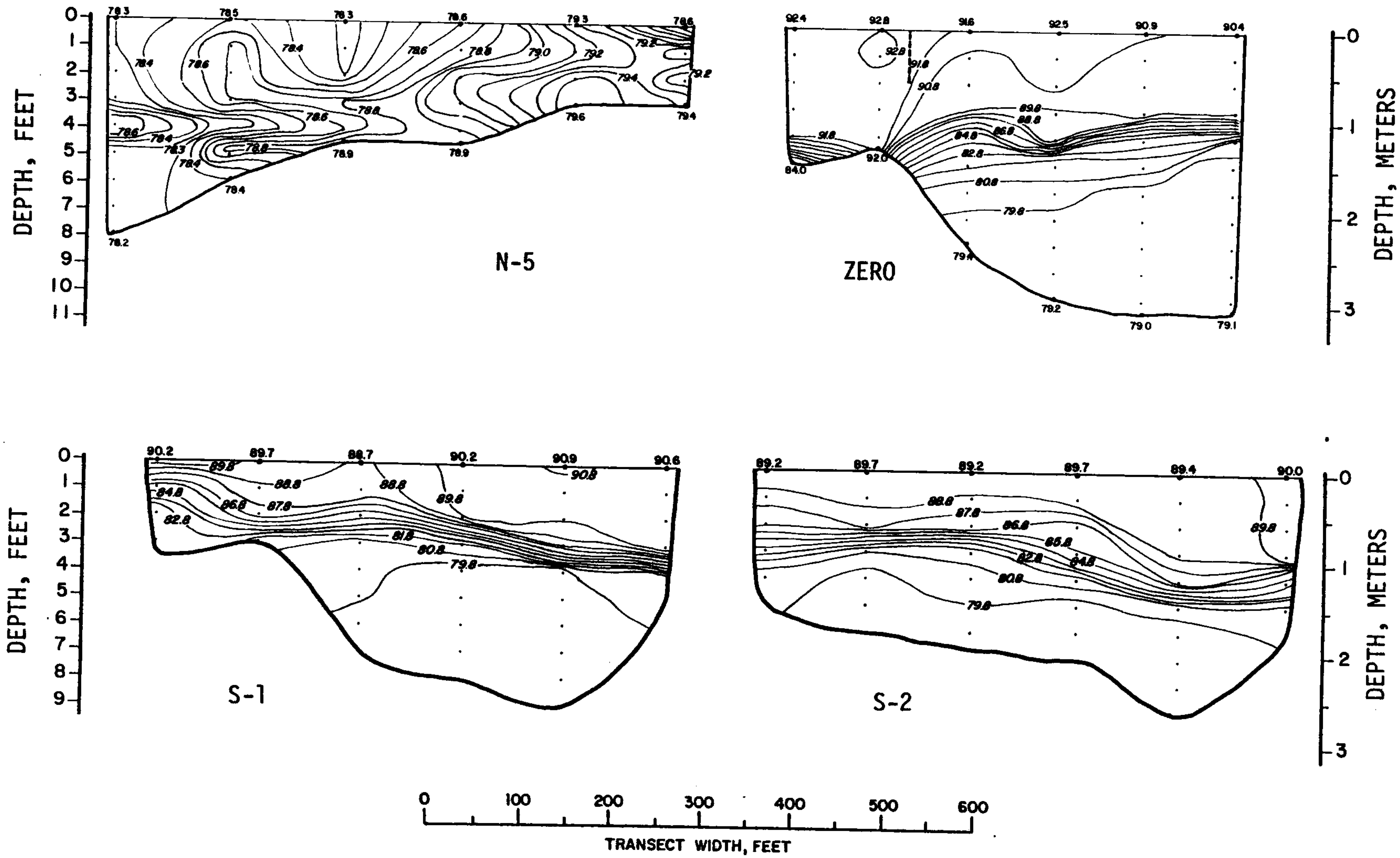

S-14
S-18
S-22
S-24
DEPTH, FEET
DEPTH, METERS
83.6
84.0
83.3
83.4
82.5
83.4
83.0
82.6
82.6
82.6
82.5
82.4
82.5
82.8
83.2
82.8
82.5
83.1
83.1
82.8
83.0
82.3
81.9
82.5
TRANSECT WIDTH, FEET

Figure 5.

Figure 6. Isothermal cross-sections of Merrimack River sampling stations, Hooksett Pond, July 7, 1975.



DEPTH, FEET
DEPTH, METERS
N-5
ZERO
S-1
S-2
0 100 200 300 400 500 600
TRANSECT WIDTH, FEET

Figure 6.

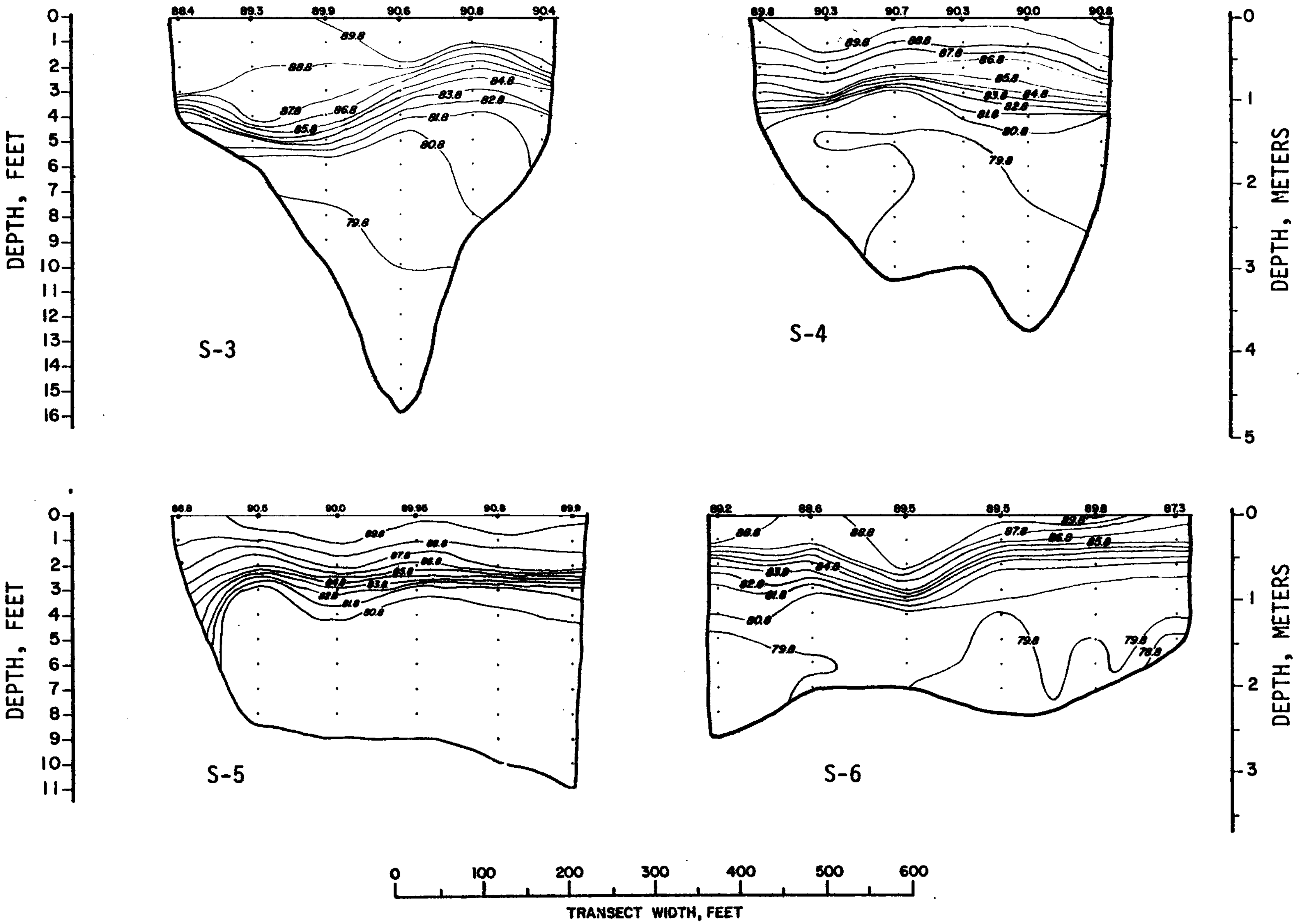

DEPTH, FEET
DEPTH, METERS
S-3
S-4
S-5
S-6
0 100 200 300 400 500 600
TRANSECT WIDTH, FEET

Figure 6.

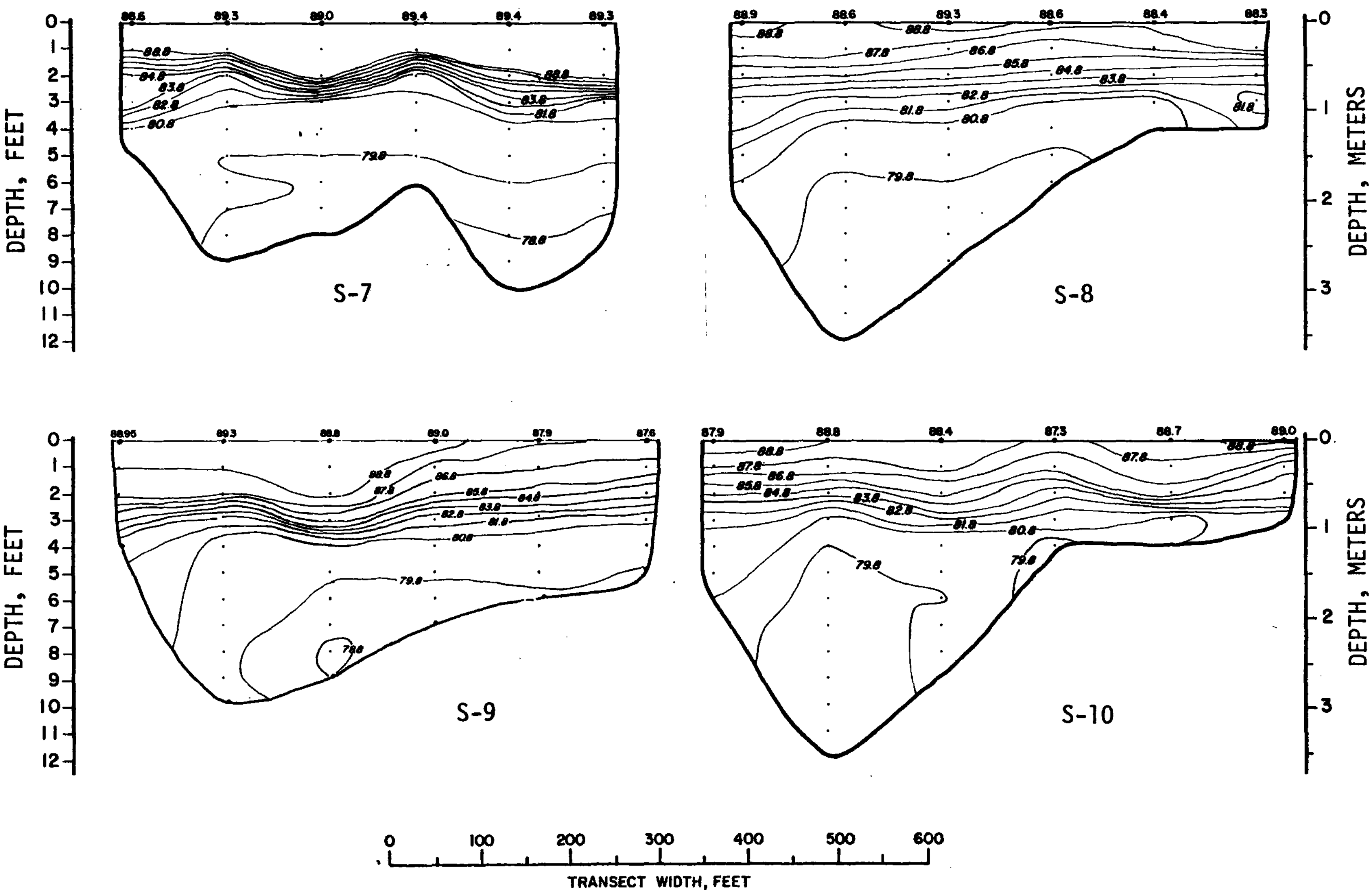

DEPTH, FEET
DEPTH, METERS
S-7
S-8
S-9
S-10
TRANSECT WIDTH, FEET
0 100 200 300 400 500 600

Figure 6.

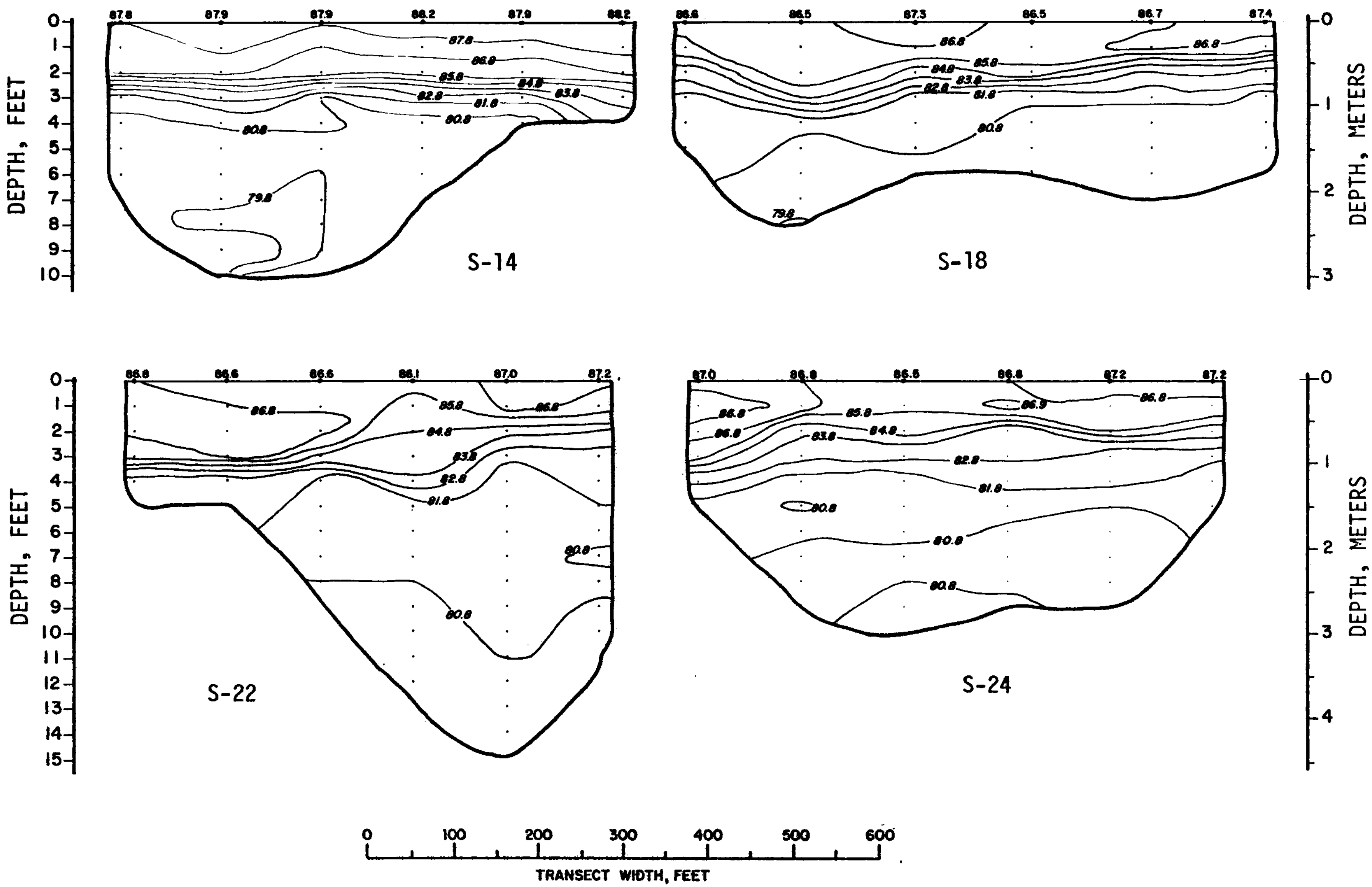

DEPTH, FEET
DEPTH, METERS
S-14
S-18
S-22
S-24
TRANSECT WIDTH, FEET
0
100
200
300
400
500
600

Figure 6.

In summary, pre-deployment surveys showed temperature distributions generally similar to past years. With the installation of the boom, water which would normally be found in surface waters only, was more thoroughly mixed with ambient water. This had the effect of lessening west-to-east temperature differentials at Stations S-1 to S-3. In general, the boom was not a successful method of containing the plume to the west bank.

C. SUMMARY AND CONCLUSIONS -- PHYSICAL

As in past years, depth of visibility readings were lowest during the spring months during seasonal high flows. Discharge during the year ranged 22,351 cfs in April to 694 cfs in August. Maximum mean ambient temperatures and Δt's (weekly sampling) occurred during August, the month of lowest flows. The plume deflector caused a greater mixing of the thermal effluent with ambient water, which tended to reduce the west-to-east temperature gradient at stations closest to the discharge canal. The deflector did not prove to be an effective method of confining the plume to the west bank of the river.

III. WATER QUALITY STUDIES

A. METHODS

1. Nutrients

Single surface water samples were taken weekly in 1-liter polypropylene bottles at Stations N-10 and S-4 and monthly at Stations Zero-West and S-17 for nutrient analyses. Analyses were done in accordance with APHA (1971) techniques, to determine concentrations (in mg/l) of nitrates (NO_3), nitrites (NO_2), total phosphates ($T-PO_4$), and orthophosphates ($O-PO_4$). Monthly means computed from weekly data for Stations N-10 (control region) and S-4 (mixing zone) are the most meaningful and are discussed in detail. Values derived from monthly sampling at Stations Zero-West and S-17 were intended only to be indicative of nutrient conditions at those stations during each month. Data collected were used as background information in biological studies and to determine if the Merrimack Generating facility was having an effect on river nutrient concentrations.

2. pH

Single samples for pH determinations were taken weekly in 12-oz. glass bottles from surface waters at Stations N-10, Zero-West, S-4 and S-17 and returned to the laboratory. An Orion Research Model 401 specific ion meter was used to measure pH. Monthly means by station were calculated from weekly data and used to determine if the discharge from the Merrimack Generating facility was affecting Merrimack River pH.

3. Dissolved Oxygen

One dissolved oxygen sample was collected weekly in a 300 ml glass stoppered bottle from surface waters at the following stations: N-10, Zero-West, S-4 and S-17. Samples were acid-fixed in the field and returned to the laboratory for titration. Precise determinations of dissolved oxygen concentrations was accomplished using the azide modification of the iodometric method (APHA, 1971).

A 24-hour dissolved oxygen and temperature survey was also conducted beginning August 14 using a Yellow Spring Instrument Company (YSI) Model 54 Oxygen Meter with probe. Regular instrument calibration checks were performed during the survey using the iodometric method described above. Stations N-10, Zero, S-4, S-17 and S-24 were sampled at mid-channel and west and east littoral zones at 4-hour intervals throughout the 24-hour period. The 24-hour survey data, as well as that collected during weekly samplings, was used to determine the degree to which dissolved oxygen concentrations were being affected by the operation of the Merrimack Station.

B. RESULTS AND DISCUSSION

1. Nutrients

Monthly means of 1975 nutrient concentrations are listed by station in Table 5.

Mean monthly nitrate concentrations were at their highest levels (0.572 mg/l) during April and declined steadily to minimum seasonal levels in September (0.162 mg/l). Throughout July and August consistent levels of nitrates, ranging from 0.180 to 0.186 mg/l, were found at both Stations N-10 and S-4. Nitrites, which are largely indicators of local sewage inputs, showed relatively consistent mean monthly concentrations (.002 - .009 mg/l) at Stations N-10 and S-4 throughout

TABLE 5. MEAN MONTHLY NUTRIENT CONCENTRATION (mg/l) BY STATION, HOOKSETT POND, MERRIMACK RIVER, 1975.

STATIONS

Month		N-10 **	Zero-West *	S-4 **	S-17 *
April	NO_2	.002	.002	.002	<.001
	NO_3	.558	.620	.572	.625
	T-PO_4	.091	.088	.087	.100
	O-PO_4	.004	.007	.003	.011
May	NO_2	.009	.005	.006	.004
	NO_3	.346	.305	.324	.291
	T-PO_4	.087	.087	.084	.081
	O-PO_4	.012	.000	.023	.000
June	NO_2	.008	.010	.008	.010
	NO_3	.239	.359	.246	.362
	T-PO_4	.083	.085	.083	.090
	O-PO_4	.036	.039	.020	.036
July	NO_2	.009	.011	.008	.009
	NO_3	.184	.180	.186	.157
	T-PO_4	.036	.055	.038	.047
	O-PO_4	.012	.016	.015	.015
August	NO_2	.007	.008	.009	.007
	NO_3	.180	.172	.181	.217
	T-PO_4	.058	.061	.059	.033
	O-PO_4	.023	.016	.030	.011
September	NO_2	.007	.009	.007	.008
	NO_3	.162	.171	.163	.175
	T-PO_4	.058	.085	.062	.079
	O-PO_4	.025	.028	.022	.021
October	NO_2	.006	.004	.005	.004
	NO_3	.284	.318	.295	.312
	T-PO_4	.071	.073	.077	.223
	O-PO_4	.016	.027	.025	.191

* One sample per month

** Monthly means of weekly samples

the study season. Mean monthly total phosphate concentrations ranged from 0.036 mg/l during July to 0.091 in April. Levels of total phosphate remained fairly consistent during August and September, ranging from 0.058 to 0.062 mg/l. Both nitrate and total phosphate concentrations declined noticeably during the periods of low flows and high temperatures when algal productivity increased to maximum summer levels (July-September). Concentrations of orthophosphates unexpectedly did not show a similar trend, as indicated by the increase in mean monthly values between July and August at both Stations N-10 and S-4. No major between station differences were noted for any of the parameters studied.

Formerly, seasonal means for each nutrient were computed using data from all four stations (N-10, Zero-West, S-4 and S-17). The 1975 seasonal means included data from Stations N-10 and S-4 only. The resultant values for nitrites (NO_2) and orthophosphates ($O-PO_4$) were quite comparable to past years. However, mean seasonal nitrates (0.280 mg/l) were lower than those of 1971 (0.393 mg/l) (NAI, 1971) and higher than those of 1972 (0.149 mg/l) (NAI, 1973), 1973 (0.174 mg.1) (NAI, 1974), and 1974 (0.261 mg/l) (NAI, 1975). Similarly, total phosphates (0.070 mg/l) were higher than those of 1971-1974 (0.004, 0.037, 0.034 and 0.042 mg/l, respectively). In general, concentrations of nutrients, particularly phosphates, in the Hooksett Pond area of the Merrimack River were high when compared to other rivers in the northeast (Environmental Protection Agency, 1974). This is very likely the result of inputs of wastewater from sources above the generating facility.

2. <u>pH</u>

Mean monthly pH values are listed by station in Table 6. The lowest (5.81 in August) and highest (7.16 in October) mean monthly pH values of the season were encountered at Station N-10. Mean monthly pH over all stations in April (5.98) were lower than those for subsequent study months. This is in contrast to the trend toward neutrality evi-

TABLE 6. MEAN MONTHLY AND SEASONAL pH VALUES BY STATION, HOOKSETT POND, MERRIMACK RIVER, 1975.

STATIONS

MONTH	N-10	ZERO-WEST	S-4	S-17
April	6.06[1]	5.86	5.94	6.06
May	6.35	6.38	6.46	6.47
June	6.18	6.25	6.33	6.21
July	6.55	6.53	6.26	6.51
August	5.81	6.14	6.24	6.22
September	6.59	6.68	6.62	6.86
October	7.16	6.81	6.94	6.88
Mean for sampling season	6.38	6.38	6.40	6.46

[1]No samples for April 21 and 29

dent during October when the monthly mean value for all stations was 6.95. As indicated above, Station N-10 had a higher mean monthly pH value in October and a lower value in August, when compared to downstream stations. No major shifts in pH were noted on any given sampling date during these months. The mean seasonal pH, computed by using all 1975 readings, was 6.40. Compared to the corresponding annual means of past years, the 1975 pH was lower than those of 1971 (7.07), 1972 (7.02), and 1974 (6.47) but higher than that of 1973 (6.20). Prior to 1971 (NAI, 1967, 1968 and 1970) sampling techniques were not consistent with later years but findings were generally comparable (range of means 6.27-6.66) to findings of later years.

3. Dissolved Oxygen

a. Weekly Surface Dissolved Oxygen

Monthly means and ranges of 1975 weekly surface dissolved oxygen (DO) levels are listed by station in Table 7. Weekly DO concentrations ranged from 14.1 mg/l at Station S-17 during April to 6.6 mg/l at Station Zero-West in July. Concentrations at S-17 were equal to or greater than those of Station N-10 during all months except May and October. This may partially be the result of the influences of the Suncook River which enters the Merrimack near Station S-6 East. When compared to ambient dissolved oxygen levels at Station N-10, Station Zero-West DO levels were consistently slightly reduced throughout the study period. As in past years, DO concentration differences between the thermally-altered stations and ambient N-10 levels were smallest during peak temperature/low flow months. In contrast, the greatest differences in mean monthly dissolved oxygen between Stations N-10 and Zero-West occurred in April (1.7 mg/l) and October (1.5 mg/l).

The 1975 mean DO concentrations at Stations N-10 (9.7 mg/l), Zero-West (8.8 mg/l), S-4 (9.5 mg/l) and S-17 (9.8 mg/l) were higher than each station's corresponding concentration from 1971 through 1974,

TABLE 7. MEAN MONTHLY SURFACE DISSOLVED OXYGEN CONCENTRATIONS (mg/L) AND MONTHLY RANGES, HOOKSETT POND, MERRIMACK RIVER, 1975.

STATION		APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	MEAN AND RANGE FOR SAMPLING SEASON
N-10	Range Mean	12.3-13.8 12.9	8.8-11.1 9.9	7.3-9.5 8.5	7.3-7.8 7.5	7.6-9.5 8.3	8.7-10.5 9.4	10.9-12.7 11.7	7.3-13.8 9.7
ZERO-WEST	Range Mean	9.8-12.4 11.2	8.1-9.5 8.7	7.0-8.6 7.8	6.6-7.0 6.8	7.2-9.0 7.9	7.7-9.8 8.8	8.8-11.7 10.2	6.6-12.4 8.8
S-4	Range Mean	12.4-13.5 12.9	9.0-11.2 9.8	7.3-8.8 8.3	7.1-7.5 7.2	7.6-8.6 8.1	8.3-10.2 9.2	10.2-12.1 11.3	7.1-13.5 9.5
S-17	Range Mean	12.3-14.1 12.9	8.7-11.1 9.8	8.0-9.6 8.9	7.3-7.9 7.6	7.6-9.5 8.4	8.5-10.3 9.7	10.5-12.0 11.3	7.3-14.1 9.8

likely as a result of higher flows noted during the late summer months. The only exceptions occurred during 1972 when the mean DO concentration at Stations N-10 (9.8 mg/l) and Zero-West (9.0 mg/l) exceeded those of 1975.

b. <u>24-Hour Dissolved Oxygen</u>

Results of the 1975 24-hour dissolved oxygen-temperature survey are listed in Table 8. Clear and warm weather conditions prevailed throughout the two day period, with air temperatures ranging from 89.0°F at noon on August 14 to 61.0°F during the early morning of August 15. Relative humidity varied from 39 to 100% during this same time period. Initially, daily flows averaged 1,687 cfs but diminished to 1,201 cfs during the second day of study. Relatively cool discharge water temperatures reflected the fact that Unit #2 was not in operation throughout the survey period.

Lowest DO levels were encountered at Station N-10 West during the 0400 sampling (5.5 mg/l), corresponding to restricted flows (H. Slattum, personal communication) and decreased photosynthetic activity. During this time, the five western littoral zone stations experienced the widest range of concentrations (5.5 to 7.6 mg/l) of all similar samplings throughout the 24-hour survey. The 1600 sampling yielded the highest dissolved oxygen reading of the survey (9.4 mg.1), recorded along the eastern littoral zone at Station S-17. Mean dissolved oxygen levels (over all Stations) over the 24-hour period at the east (7.9 mg/l) and west (7.9 mg/l) littoral zones and at midstream (8.0 mg/l) were nearly identical.

Station Zero-West showed the greatest reductions in dissolved oxygen concentrations when compared to Station N-10. In all cases these reductions were less than 1.0 ppm and reflected the effects of the inverse relationship of oxygen solubility to water temperatures. It is interesting to note that the mean concentrations of dissolved oxygen at

TABLE 8. MEANS AND RANGES OF TEMPERATURE AND DISSOLVED OXYGEN PROFILES, 24-HOUR DISSOLVED OXYGEN STUDY, AUGUST 14-15, HOOKSETT POND, MERRIMACK RIVER, 1975.

1200-14 August 1975

STATION		WEST		MID-RIVER		EAST	
		D.O. (ppm)	TEMP. (°F)	D.O. (ppm)	TEMP. (°F)	D.O. (ppm)	TEMP. (°F)
N-10	*R	8.4-8.4	74.1-78.5	8.4-8.4	78.4-78.4	8.3-8.6	78.4-79.2
	*M	8.4	77.8	8.4	78.4	8.4	78.8
Zero	R	8.0-8.5	78.6-82.6	8.4-8.5	78.1-78.8	8.5-8.7	77.7-78.3
	M	8.2	81.4	8.5	78.3	8.7	78.1
S-4	R	8.4-8.4	77.7-78.4	8.2-8.4	78.4-81.1	8.2-8.4	78.8-80.8
	M	8.4	78.0	8.3	79.7	8.3	79.8
S-17	R	7.6-8.0	78.6-80.6	8.2-8.3	79.0-80.4	8.5-8.9	79.3-82.4
	M	7.8	79.7	8.2	79.7	8.8	81.5
S-24	R	8.7-9.2	79.3-82.4	8.0-8.2	79.9-81.3	7.6-8.2	80.6-82.4
	M	9.0	80.9	8.1	80.4	8.0	81.7

1600-14 August 1975

STATION		WEST		MID-RIVER		EAST	
		D.O. (ppm)	TEMP. (°F)	D.O. (ppm)	TEMP. (°F)	D.O. (ppm)	TEMP. (°F)
N-10	R	8.8-8.9	78.6-79.7	8.6-8.7	78.8-78.8	8.7-9.2	78.8-79.2
	M	8.8	78.9	8.7	78.8	8.8	79.0
ZERO	R	8.2-8.5	79.7-82.8	8.7-8.8	78.6-78.8	9.0-9.0	78.6-78.8
	M	8.3	82.0	8.8	78.8	9.0	78.8
S-4	R	8.8-8.9	78.4-78.8	8.7-8.8	79.0-80.6	8.6-8.7	80.1-80.6
	M	8.8	78.8	8.8	79.7	8.6	80.4
S-17	R	8.2-8.4	79.0-79.5	8.5-8.5	79.5-79.7	8.2-9.4	78.8-81.0
	M	8.3	79.3	8.5	79.6	8.9	80.2
S-24	R	8.6-8.7	79.5-79.7	8.4-8.6	79.3-80.2	7.9-8.3	80.1-80.4
	M	8.7	79.6	8.5	79.6	8.1	80.2

2000-14 August 1975

STATION		WEST		MID-RIVER		EAST	
		D.O. (ppm)	TEMP. (°F)	D.O. (ppm)	TEMP. (°F)	D.O. (ppm)	TEMP. (°F)
N-10	R	8.4-8.5	78.8-78.8	8.6-8.8	79.2-79.8	8.6-8.7	79.2-79.6
	M	8.5	78.8	8.7	79.6	8.7	79.5
ZERO	R	7.8-8.0	83.8-84.1	8.0-8.8	79.7-83.3	8.2-8.8	79.9-81.5
	M	7.9	84.0	8.5	81.1	8.7	80.2
S-4	R	8.2-8.4	79.6-80.7	8.4-8.6	80.1-81.2	8.5-8.6	80.4-80.6
	M	8.3	80.3	8.5	80.8	8.5	80.5
S-17	R	8.3-8.4	78.5-80.1	8.5-8.6	79.6-80.1	8.4-8.5	79.5-80.3
	M	8.4	79.8	8.6	80.0	8.5	80.1
S-24	R	7.8-8.0	77.9-79.2	8.5-8.6	79.2-79.9	8.1-8.3	79.4-79.9
	M	7.8	78.8	8.6	79.8	8.2	79.8

2400-14 August 1975

STATION		WEST		MID-RIVER		EAST	
		D.O. (ppm)	TEMP. (°F)	D.O. (ppm)	TEMP. (°F)	D.O. (ppm)	TEMP. (°F)
N-10	R	7.2-7.4	78.8-78.8	7.6-7.7	78.8-78.8	7.0-7.5	78.1-78.8
	M	7.2	78.8	7.6	78.8	7.3	78.7
Zero	R	6.9-7.0	82.4-83.3	7.2-7.9	78.8-82.6	6.9-7.5	80.6-82.4
	M	7.0	82.9	7.6	80.7	7.2	81.8
S-4	R	7.3-7.4	79.0-80.6	6.8-7,7	79.7-80.8	7.3-7.6	78.8-79.7
	M	7.4	80.1	7.4	80.4	7.4	79.4
S-17	R	7.4-7.6	79.0-80.4	7.3-7.7	79.0-79.7	7.2-7.4	77.9-77.9
	M	7.6	80.1	7.5	79.6	7.3	77.9
S-24	R	7.2-7.3	77.0-78.6	7.4-7.8	78.8-79.7	7.1-7.6	78.8-78.8
	M	7.3	78.1	7.6	79.5	7.4	78.8

Continued

TABLE 8. (CONTINUED)

0400-15 August 1975

STATION		WEST		MID-RIVER		EAST	
		D.O.(ppm)	TEMP.(°F)	D.O.(ppm)	TEMP.(°F)	D.O.(ppm)	TEMP.(°F)
N-10	R	5.5-7.6	73.9-77.9	7.1-7.3	76.1-77.7	7.0-7.2	76.8-78.3
	M	6.6	76.9	7.2	77.2	7.1	77.8
Zero	R	6.2-6.8	78.8-89.6	6.8-7.5	78.8-89.6	6.4-7.1	78.8-87.4
	M	6.7	87.4	7.1	83.3	6.8	82.9
S-4	R	6.4-7.2	81.0-81.5	6.7-7.4	79.2-83.3	6.9-6.9	81.5-81.9
	M	7.0	81.4	7.2	80.9	6.9	81.7
S-17	R	7.0-7.3	77.5-78.8	7.2-7.4	78.8-78.8	7.1-7.2	77.9-78.4
	M	7.2	78.6	7.3	78.8	7.1	78.2
S-24	R	6.6-6.8	77.0-78.4	7.2-7.3	79.3-79.3	6.8-7.4	77.9-78.8
	M	6.8	77.9	7.3	79.3	7.2	78.6

0800-15 August 1975

STATION		WEST		MID-RIVER		EAST	
		D.O.(ppm)	TEMP.(°F)	D.O.(ppm)	TEMP.(°F)	D.O.(ppm)	TEMP.(°F)
N-10	R	7.1-7.3	76.2-77.4	7.1-7.4	76.2-77.3	7.1-7.3	76.2-77.2
	M	7.2	76.4	7.3	76.3	7.2	76.4
Zero	R	7.0-7.1	91.8-91.9	7.1-7.4	78.3-90.9	7.0-7.1	78.8-90.0
	M	7.1	91.9	7.2	84.9	7.1	88.1
S-4	R	7.2-7.4	79.3-84.9	7.2-7.5	78.3-87.1	7.1-7.4	79.2-84.7
	M	7.3	83.3	7.4	81.7	7.3	82.2
S-17	R	7.5-7.7	80.3-81.2	7.6-7.6	81.0-81.0	7.4-7.6	80.4-80.8
	M	7.6	81.0	7.6	81.0	7.5	80.6
S-24	R	7.8-7.9	79.2-79.2	7.6-7.7	79.2-79.2	7.5-7.6	78.4-78.8
	M	7.9	79.2	7.6	79.2	7.6	78.7

1200-15 August 1975

STATION		WEST		MID-RIVER		EAST	
		D.O.(ppm)	TEMP.(°F)	D.O.(ppm)	TEMP.(°F)	D.O.(ppm)	TEMP.(°F)
N-10	R	8.4-8.5	76.8-77.0	8.2-8.2	76.8-77.0	8.0-8.3	77.0-77.2
	M	8.4	77.0	8.2	77.0	8.1	77.1
Zero	R	7.6-7.9	81.5-90.5	7.8-8.2	77.0-87.8	7.6-8.4	77.4-89.1
	M	7.7	88.1	8.0	81.0	8.1	82.4
S-4	R	8.1-8.2	81.0-82.4	7.7-8.2	77.0-85.6	7.6-8.0	77.2-84.2
	M	8.2	81.9	8.0	79.6	7.9	79.8
S-17	R	7.7-8.2	81.7-82.2	8.0-8.2	81.5-81.9	8.4-8.6	80.6-80.8
	M	8.0	81.9	8.1	81.6	8.6	80.6
S-24	R	8.8-9.2	80.6-81.1	8.0-8.4	79.9-80.6	8.0-8.2	79.5-80.6
	M	8.9	80.8	8.2	80.3	8.1	80.3

Zero-West and N-10 differed less during the 2400, 0400 and 0800 samplings. This is possibly the result of the aerating effect of the spray modules on water which has had dissolved oxygen reduced by plant and animal respiration in the absence of any significant photosynthetic activity during periods of darkness.

No dissolved oxygen concentrations were noted which were less than that generally considered to be critical for the maintenance of a warm-water fishery (5.0 mg/l).

C. SUMMARY AND CONCLUSIONS -- CHEMICAL

Nitrate and total phosphate concentrations were generally higher than in past years. This is likely the result of one of two things: 1) higher inputs of wastes upstream of the Merrimack Station or 2) smaller populations of primary producers in Hooksett Pond. pH readings continued a trend toward lower values noted in past years, with between-station differences noted in October and August when N-10 had a higher and lower mean monthly pH, respectively, than did downstream stations. The lowest dissolved oxygen value recorded during weekly sampling was 6.6 mg/l, noted at Station Zero-West in July; during the 24-hour survey in August a reading of 5.5 mg/l was recorded at Station N-10 west. During the summer months, Station Zero-West weekly dissolved oxygen concentrations were approximately 1.0 ppm lower than those of Station N-10. No dissolved oxygen concentrations were recorded which were below the 5.0 mg/l, generally considered to be the minimum concentration for the maintenance of a warm water fishery (NTAC, 1968). With the exception of dissolved oxygen and pH, no between station differences were noted for the parameters studied.

IV. BIOLOGICAL STUDIES

A. METHODS

1. Chlorophyll *a*

One surface water sample was collected weekly in a one-gallon polyethylene container concurrently with plankton sampling at Station N-10, Zero-West, S-4 and S-17. Chlorophyll *a* determinations were made with a spectrophotometer using the trichromatic method (APHA, 1971). Laboratory results were reported as μg/l. Data gathered were used to assess potential among station differences in mean monthly chlorophyll *a* concentrations as a result of the operation of the Merrimack Station.

2. Plankton Monitoring Studies

Single plankton samples were collected weekly with a metered, #20-mesh (76 μ) plankton net to allow the determination of potential impacts of the Merrimack Station on phytoplankton and zooplankton populations. Horizontal tows were taken just below the surface and at an approximate depth of 6 feet at Stations N-10 and S-4, while at Zero-West and S-17, only surface tows were taken. After collection, samples were preserved with 2 ml of 10% formalin solution. In the laboratory, plankton were identified to major groups and dominant forms and enumerated. While in previous years cohesive phytoplankton cell groups (i.e., algal filaments or colonies) were enumerated as single units, in 1975 individual cells were counted to provide more consistent comparisons among years. Forty-five Whipple disc fields (3 primaries - 15 fields each) of a Sedgewick-Rafter cell at 125x were examined for phytoplankton; nine vertical strips (3 for each primary) at 50x were examined for zooplankton. Abundances were expressed as cells/100 liters.

A two-way, analysis of variance (ANOVA) was used to compare testing abundances and percent composition among the four stations and among sampling dates. A three-way fixed-effects ANOVA was used to test differences between near-surface and sub-surface tows at Stations N-10 and S-4 (Sokal and Rohlf, 1969). Abundance data were transformed by ln (n + 1) and percent composition by the arcsin $\sqrt{}$ proportion. Tukey's Method (Guenther, 1964) for Multiple Comparisons was applied to significant station effects ($\alpha \leq 0.5$) for surface ANOVA's. Multiple comparisons were not used to compare dates or to test differences where only two alpha levels of effect existed.

3. Plankton Entrainment

a. Station Location and Sampling Frequency

Sampling site locations and frequency of sampling were selected to allow a general assessment of the magnitude of potential impacts of entrainment on river plankton and immature fish populations. The four entrainment sampling sites for the Merrimack Generating Station entrainment program were located at the intake structures, at the discharge weir, at a point immediately downstream from the last row of power spray modules (PSM's) and at the mouth of the discharge canal. Two samples were taken at each of the sites during each field sampling day. Plankton samples were collected weekly at the intake structures and canal mouth from June 24 through October 14, and again on October 28. At the discharge weir, sampling occurred monthly until August 6 when weekly sampling was instituted to more accurately monitor effects of entrainment on the plankton communities. In addition, to assess effects of turbulence caused by the spray modules, samples were taken monthly (July through October) in the discharge canal just downstream of the spray module system.

b. Temperature

Surface water temperatures were taken at each station in conjunction with the above sampling using a precision grade mercury thermometer with an accuracy of ± 0.1°C. From these data, the Δt's between the intake and the three thermally influenced stations (discharge weir, below PSM's, mouth of canal) were calculated.

c. Chlorophyll *a*

One gallon of surface water was collected at each entrainment station during sampling. Chlorophyll *a* levels were determined by the trichromatic method (APHA, 1971) and were recorded in μg/l. Additionally, unsuccessful attempts were made at measurements, using Lorenzen's (1967) acidification treatment, of the relative degradation of chlorophyll to its inactive form phaeophyton "a".

d. Evans Blue and Neutral Red Stains

Laboratory tests were conducted from May through mid-July in an effort to modify both the Neutral Red (a vital stain) and Evans Blue (a mortal stain) staining procedures for freshwater plankton live-dead determinations. Crippen and Perrier (1974) had previously used these stains to determine mortality in marine phytoplankton and zooplankton which had been exposed to elevated temperatures. Objectives of these freshwater experiments included deciding which stain better suited the requirements of the study, what was the most efficient staining concentration, and what was the minimum effective incubation period. During this investigative period, two replicate samples each of phytoplankton and zooplankton were taken weekly at each station.

Filtered phytoplankton was collected in one-quart jars during a surface tow at each station, reduced to a one-half quart volume, and aerated overnight, then stained. A concentration of 1:350 for Evans Blue was found to be effective. Perrier, Shipman, and Lindsay (1976, unpublished) found that Evans Blue at concentrations as low as 1:200 were effective for use with plankton from both rivers and ponds. After July 15, 28 cc's of Evans Blue (at 1:350) were added to each phytoplankton sample immediately upon collection. After a three-hour incubation period (Crippen and Perrier, 1974), samples were washed and resuspended using water collected from each respective station and filtered through a #20 mesh (76 μ) net. Phytoplankton were then identified and enumerated as either alive or dead and notes were taken on the microscopic appearance of each major group. Observations of the zooplankton exposed to the Evans Blue Stain were also recorded for comparison with the Neutral Red staining technique.

Each zooplankton sample was filtered into a quart jar attached to the trailing end of a #20 mesh (76 μ) net during a surface tow at each station. The sample was later diluted to one gallon, using filtered water from the respective station, and inoculated one hour after collection with an experimentally-determined volume of 40 cc's of Neutral Red stain. After a six hour incubation period (Crippen and Perrier, 1974), samples were filtered through a #20 mesh (76 μ) net and washed thoroughly with deionized water. Samples were placed in eight-dram (33 mls) vials, preserved with one ml of 37%, unbuffered formalin and two mls of a solution containing one molar each of acetic acid and sodium acetate, and stored at 3°C. During analysis notes were taken to describe the condition of both zooplankton and phytoplankton and to compare the effectiveness of the Neutral Red staining technique to that of Evans Blue.

From these experiments, both stains were found to be useful agents for use in freshwater plankton live-dead determinations. However, due to the excessive time required by the Neutral Red technique for sample preparation and processing, the Evans Blue staining method was chosen for the Merrimack River entrainment study for both phytoplankton and zooplankton.

e. Phytoplankton

Qualitative microscopic analysis was made at 125x on all phytoplankton samples, with approximately 1000 cells counted per sample. Cells exhibiting no blue color in the chloroplast were regarded as living, while those having blue coloration were counted as dead. Gaff and Okong'O-Ogola (1970) distinguished living plant cells from dead ones by using Evans Blue and found that living cells excluded the dye, but dead cells were stained. Crippen and Perrier (1974) referred to Evans Blue as a mortal stain, because the semipermeable membranes of living plant cells excluded this stain, while the membranes of dead cells fail to stop dye penetration. Percent mortality determinations were calculated for each sample by dividing the number of stained cells by the total cell count. Phytoplankton mortality due to entrainment was then expressed as the percent mortality observed at the discharge locations minus that found at the intake. Samples were then preserved with 10 percent buffered formalin and stored.

f. Zooplankton

Evans Blue was used after July 22 for zooplankton mortality determinations. Two half-quart samples were collected in the same manner as with phytoplankton and immediately stained with 28 cc's of Evans Blue. After a two hour incubation period (Crippen and Perrier, 1974), the zooplankton were filtered from the solution using a #20 mesh nylon net, washed free of excess dye, and resuspended in filtered water from their respective stations. The number of zooplankters examined was determined by limiting individual sample analysis time to approximately one hour to insure same-day processing of all samples. From July 22 to September 3, approximately 300 individuals were counted per sample in the one hour period. However, due to the sparseness of the zooplankton community after September 9, organism counts were reduced to 50 per sample. Organisms exhibiting no motility and having a bright blue color were counted as dead. Organisms were regarded as living when they emerged unstained, exhibited the blue color only in the gut area due to phytoplankton ingestion, or were motile (Crippen and Perrier, 1974; Perrier *et al.*, 1976, unpublished). Determinations using this semi-quantitative procedure were converted to percent mortality by dividing the number of dead organisms by the total count for each taxon. Zooplankton mortality as a result of entrainment was expressed as the difference between the percent mortalities observed at the intake and at the discharge stations.

g. Immature Fish

Duplicate tows were taken along the bottom at each of the four entrainment stations using an NAI - modified, 1/2 meter by 1 meter Tucker trawl (Tucker, 1951) equipped with a 505 μ mesh nylon net. A one-quart jar was affixed to the end of the net to collect the filtered sample. As soon as possible after collections, any fish larvae present were counted and designated as alive or dead, based on motility. No stains were used during this portion of the entrainment sampling. Both live and dead larvae were preserved with 10 percent formalin in separate vials for subsequent species identification.

h. Statistical Analyses

The Wilcoxon Matched-Pairs Signed-Rank Test (Siegel, 1956) was used to test the change in percent mortality between the intake and the discharge weir over the sampling season. For diatoms, green algae, and total zooplankton, a series of non-orthogonal Multiple Linear Regressions (Snedecor and Cochran, 1967) was employed to determine if there was any relationship between the change in percent mortality induced by entrainment and ambient river temperature or Δt. The following models were tested:

Model 1: Δ Mortality = $a+b_1$ (ambient °F) + b_2 (Δt°F)

Model 2: Δ Mortality = $a+b_1$ (ambient °F)

Model 1 effects were also adjusted for Model 2 effects to determine relationships between mortality and Δt, assuming ambient effects are held constant.

4. Periphyton

Periphyton accumulators (25mm x 75mm glass slides) were installed at Stations N-10, Zero-West, S-4, and S-17, where they were suspended at a depth of approximately two feet. Additional accumulators were also installed at Stations N-10 and S-4 at a depth of approximately 6 feet. Single samples were collected weekly (short-term) and monthly (long-term) to determine the effects of the heated discharge upon periphyton communities. Major groups of algae greens (Chlorophyceae), blue-greens (Cyanophyceae), and diatoms (Bacillariophyceae), colonizing the slides were identified and enumerated microscopically. The cells or organisms within 25 random fields per slide were examined at a magnification of 250x. Populations were estimated by extrapolating these counts to represent the total number of organisms within all possible fields per slide surface area. These data were reduced to average cell numbers per square millimeter of slide surface. Percent composition of each algal group for each slide was also calculated.

Weekly and monthly 2-foot depth abundance data were analyzed over the 26-week sampling period using a two-way analysis of variance (ANOVA), after transformation of data to the log scale $X_i = \ln (X_i + 1)$ (Kirk, 1968). Where significance was indicated ($p < .05$), Tukey's Method for Multiple Comparisons (Guenther, 1964) was employed for station comparisons. Abundance data for the 6-foot depth (Stations N-10 and S-4 only) were compared to surface data using a three-way ANOVA with depths, stations and weeks or months as treatments.

Analysis of weekly and monthly two-foot depth percentage composition data was conducted using a two-way ANOVA after arcsin transformation (ARCSIN $\sqrt{p}$ where p = proportion) (Sokal and Rohlf, 1969) with the same design described above for abundance data. A three-way ANOVA was used for analysis of depth related differences in station percent composition.

5. Benthic Invertebrates

Stations N-10, Zero-West, S-4 and S-17 were sampled with a 556 cm^2 Ponar grab on June 27, August 12 and October 8, 1975. Duplicate samples were taken at mid-river and near the east and west banks at each station in order to determine impacts of the thermal plume on macrobenthic invertebrates. Samples were sieved through a #30 mesh (0.595mm) screen and preserved with a 10% formaldehyde solution to which rose bengal stain was added to facilitate sorting. Upon return to the laboratory, benthic samples were sorted, represerved in ethanol, and the organisms were identified and enumerated. All organisms were identified to the lowest practicable taxa.

6. Fish Surveys

a. Electrofishing

Fish were collected by shocking 1000-foot sections along both the east and west banks of the river at the following stations: N-9 and N-10; N-6 and N-7; Zero and S-1; S-4 and S-5; S-17 and S-18. A 220 V pulsating DC generator mounted in a 17 ft. boat was used for shocking. Fish collected during three separate surveys (July, August and September) were identified, weighed, measured, and released.

b. Immature Fish Seining

Seining activities were conducted when flows permitted at East and West banks of Stations N-10, N-7, Zero, S-2 and S-17 from early June through September. Numbers, species, and size ranges of immature fish collected in each haul of a 15-foot long, 1/4-inch stretch mesh minnow seine at each station were recorded.

Since the number of hauls varied with area sampled, abundance of each fish species was converted to catch per haul. Typically, three hauls were taken at N-10 West; two were taken at N-10 East; and one was taken along the east and west littoral zones of Stations N-7, Zero, S-2, and S-17.

c. Fyke Netting

Four fyke netting stations (N-10 East, N-10 West, S-3 East, and S-2 West) were sampled monthly from May through October to monitor populations of resident fish, especially smallmouth bass (*Micropterus dolomieui*), yellow perch (*Perca flavescens*) and pumpkinseed sunfish (*Lepomis gibbosus*). Nets were set twice per week for two-day periods for a total of 16 net-days each month ~~at each station~~. Captured fish were identified, weighed, measured, and released. Where possible, scale samples from ten fish per "inch-class" of each species were taken for subsequent age determinations. Analysis of age and growth using the back-calculation method (Lagler, 1956) was employed to define the growth histories of smallmouth bass, pumpkinseed, and yellow perch. Data from the 1972, 1973, 1974, and 1975 seasons were used in this method, and results were compared to those of Wightman (1971) for 1967-1969 populations to document whether or not any long-term growth rate changes had occurred since that time. Length-at-capture data were analyzed using a one-way analysis of variance.

The distribution of the major species revealed by monthly fyke netting was analyzed statistically using parametric 2-way analysis of variance in a randomized block design (Sokal and Rohlf, 1969) after the catch data was transformed to X_i = Log (X_i + 1.0). This transformation was necessary to remove the effect of heterogeneous variance usually associated with this type of data (Kempthorne, 1952).

Length-weight equations of the form Log Wt (grams) = Log a + c Log total length (millimeters), which describe the general pattern of weight accretion as length increases and thus provide an index of robustness, were computed for pumpkinseed, yellow perch, and smallmouth bass captured by fyke netting. This technique was described in detail by Lagler (1956).

7. Preliminary Fish Toxicity Study

This preliminary study was intended to provide general data as to whether the Merrimack Station effluent was acutely toxic to indigenous fish species. The species of fish used in the test were smallmouth bass, yellow perch, and pumpkinseed. Originally, largemouth bass (*Micropterus salmoides*) were to be used, but due to insufficient sample sizes, smallmouth bass (*M. dolomieui*), which are caught in greater numbers), were substituted. Experiments were conducted during late August, early September and late September 1975.

Holding nets used were of a type similar to those reported by Dickson *et al.* (1974) and Basch and Truchan (1974) and consisted of a 4-foot by 4-foot by 8-foot, 1/2-inch square mesh, knotless nylon net supported by a wooden framework. Two nylon netting partitions of 3/8-inch mesh were sewn in to divide the 8-foot long net into three equally-sized compartments, one for each species. A styrofoam float was affixed to the ends of each frame to help maintain position in the water. Each net was anchored with a triangular harness and cement blocks. The nets were moored to remain perpendicular to the river current during the tests. An adjustable anchor was attached to the downstream side of the frames to compensate for the capsizing effect caused by the current. Two holding nets were maintained at both the control and experimental stations. The location of the "control" holding nets was slightly upstream of the intake for Unit #1 (at Station N-5) and about 100 feet from the western shoreline. The two discharge canal holding nets were moored within the mouth of the discharge canal to insure full exposure to the plant effluent just before it entered the river. During the tests, continuous temperature data were provided by the Public Service Company of New Hampshire temperature monitoring station in the discharge canal.

All fish used in these experiments were obtained by fyke netting at Stations N-10 East, N-10 West, S-2 West and S-3 East. An attempt was made to obtain at least 15 representatives of each species to be tested. Smallmouth bass, yellow perch and pumpkinseed sunfish were segregated and stocked in each of four holding-nets. Following a three day acclimation period, any dead fish were removed and subtracted from the initial total. Those remaining were observed daily for the next ten days, and numbers of dead or obviously affected fish were recorded and removed. At the end of the 10-day period, the holding nets were brought to shore and a final tally of live, dead, and/or missing fish was performed. A mortality index was calculated for each species to compare viability of the fish at the intake and discharge sites. This was calculated by dividing the total number of fish that died by the total number fish tested, minus those that died during acclimation or were unaccounted for at the end of the test.

B. RESULTS AND DISCUSSION

1. Chlorophyll *a*

Monthly means of chlorophyll *a* concentrations are listed by station in Table 9. The lowest mean monthly chlorophyll *a* level (1.72 μg/l) was found during October at Station Zero-West. Greatest amounts

TABLE 9. MEAN MONTHLY CONCENTRATIONS (μg/l) OF CHLOROPHYLL *a* BY STATION, HOOKSETT POND, MERRIMACK RIVER, 1975.

	STATIONS			
MONTH	N-10	ZERO-WEST	S-4	S-17
April	1.82	1.81	1.97	1.85
May	2.13	2.33	2.06	2.07
June	4.69	3.65	4.05	4.67
July	5.20	3.35	3.73	5.14
August	5.49	3.28	3.74	6.66
September	2.42	2.01	2.36	2.16
October	1.78	1.72	1.78	2.00

were present at Station S-17 during August, when a maximum mean monthly concentration of 6.66 µg/l was noted. All stations experienced their greatest seasonal increase in concentrations between May and June as standing crop of phytoplankton increased, and their greatest decrease between August and September as water temperature dropped and phytoplankton abundance lessened.

Mean monthly chlorophyll *a* concentrations were lower at Stations Zero-West and S-4 than at N-10 from June through September. Maximum reductions between these stations occurred in August when flows were low and ambient water temperatures were high. Mean monthly concentrations at Station S-17 approached the levels observed at N-10, indicating recovery in the far-field regions. Similar power plant influences on chlorophyll *a* concentrations have been observed in Lake Norman, North Carolina (Smith *et al.*, 1973).

During past study years mean vernal (April and May) chlorophyll *a* concentrations were low and quite comparable (1.62 µg/l in 1972, 2.34 µg/l in 1973, and 2.05 µg/l in 1974). Corresponding autumnal (September and October) levels, however, have tended to decline from a high of 8.41 µg/l in 1973 to a low of 2.03 µg/l in 1975. Mean chlorophyll *a* levels over all stations were computed for the months of peak standing crop (July for 1971, September for 1972 and 1973, and August for 1974 and 1975). Results revealed that the August 1975 peak concentrations (4.79 µg/l) were the lowest of the four years, and those of August 1974 (20.92 µg/l) were the highest.

2. Plankton

Mean monthly near-surface plankton abundance by major groups and percent composition by station are presented in Tables 10-13 and Figure 7. Sub-surface abundance is illustrated in Figure 8. Appendix II contains the results of all statistical analyses discussed in the text.

a. Near-Surface Plankton

Diatoms, principally *Asterionella* spp., *Melosira* spp., *Fragiliaria* spp., and *Tabellaria* spp., dominated the early spring near-surface samples (Figure 7; Table 10). On April 14, 85% of the total plankton collected at Station N-10 were diatoms. In contrast, only 1.8% of the August 4 near-surface plankton were diatoms. This shift was the result of rising water temperatures becoming less favorable for diatoms, but more favorable to green algae (Hawkes, 1969).

Mean monthly diatom abundance was less at Station Zero-West than at N-10 from April through October, with the greatest difference (58.8%) occurring in July. Mean monthly chlorophyll *a* concentrations in July were 5.20 and 3.35 μg/l at Stations N-10 and Zero-West, respectively. Downstream from the discharge canal, mean monthly diatom abundance at Station S-4 was similar to that observed at N-10, but was lower at S-17 than at N-10.

A two-way analysis of variance (ANOVA) showed significant among-station differences ($p < .05$) in diatom abundance, but not percent composition, when tested over the season. Tukey's method revealed significantly lower diatom abundance at Station Zero-West than at N-10 ($\alpha = .05$). No other between-station comparisons were significant.

As mentioned previously, seasonal growth trends exhibited by diatoms and green algae varied inversely (Figure 7, Table 11). During April and May, when diatoms were abundant, green algae comprised a low percentage. For example, on May 6, green algae comprised only 2.1% of the total plankton collected at Station S-17. In the spring, the green algae community appeared to respond positively to the artificially-heated environment at Station Zero-West where the green algal cell counts were more than three times greater than those at the other main-stream stations. These large springtime increases at Zero-West were attributed to the genera *Palmodictyon* sp., *Stigeoclonium* sp., and *Cladophora* sp. which proliferated in the favorable thermal conditions of the

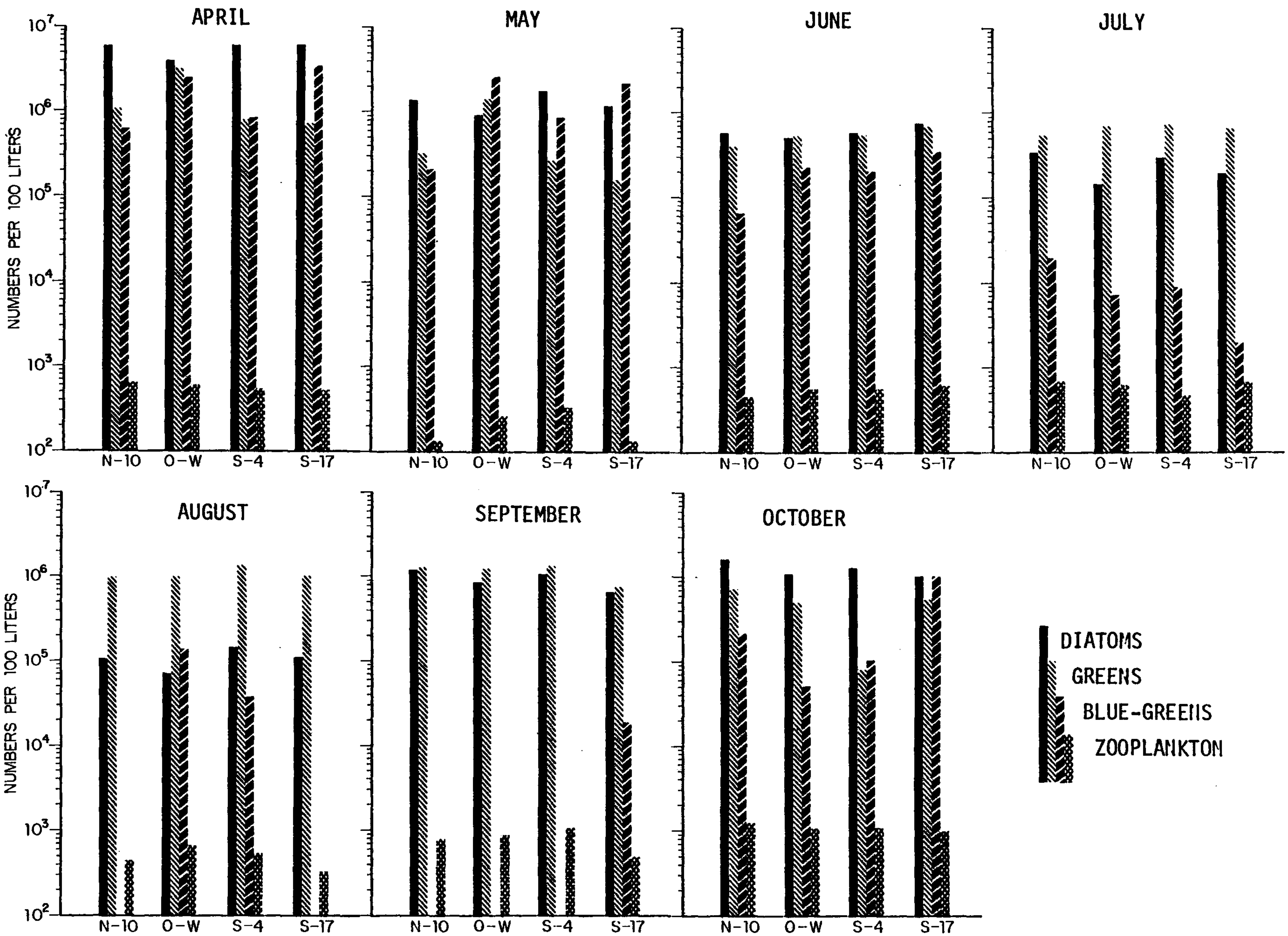


Figure 7. Mean monthly plankton abundance in near surface samples, Hooksett Pond, Merrimack River, 1975.

TABLE 10. MEAN MONTHLY DIATOM ABUNDANCE AND PERCENT COMPOSITION IN NEAR-SURFACE PLANKTON SAMPLES. HOOKSETT POND, MERRIMACK RIVER, 1975.

MEAN MONTHLY ABUNDANCE
(THOUSANDS OF INDIVIDUALS PER 100 LITERS)

MONTH	STATIONS N-10	O-W	S-4	S-17	$\bar{x}$
April	6545.4	4281.3	6635.7	5690.9	5788.3
May	1514.9	9769.7	1939.3	1388.1	3653.0
June	614.1	533.6	600.2	793.6	635.4
July	368.7	152.0	314.0	219.1	263.5
August	101.3	711.9	159.9	119.4	273.1
September	1306.8	861.0	1103.4	669.9	985.3
October	1850.1	1195.8	1439.7	1018.1	1375.9
$\bar{x}$	1757.3	2500.8	1741.7	1414.2	1853.5

MEAN MONTHLY PERCENT COMPOSITION

MONTH	STATIONS N-10	O-W	S-4	S-17	$\bar{x}$
April	78.94	40.71	78.91	63.53	65.53
May	69.98	17.38	59.49	33.49	45.09
June	44.21	36.74	37.55	33.94	38.11
July	35.54	16.61	27.48	22.44	25.52
August	7.85	5.50	9.04	9.49	7.97
September	46.10	37.62	41.35	43.88	42.23
October	59.51	63.68	56.71	53.01	58.23
$\bar{x}$	48.88	31.18	44.37	37.11	40.39

TABLE 11. MEAN MONTHLY GREEN ALGAE ABUNDANCE AND PERCENT COMPOSITION AT NEAR-SURFACE PLANKTON SAMPLES. HOOKSETT POND, MERRIMACK RIVER, 1975.

MEAN MONTHLY ABUNDANCE
(THOUSANDS OF INDIVIDUALS PER 100 LITERS)

	STATIONS				
MONTH	N-10	O-W	S-4	S-17	$\bar{x}$
April	1093.6	3571.3	853.7	670.1	1533.8
May	349.1	1607.0	283.2	178.8	604.5
June	418.8	561.6	584.9	743.4	577.2
July	595.1	741.1	791.9	730.1	714.5
August	1176.4	1048.0	1557.5	1132.9	1228.7
September	1453.2	1369.1	1423.0	793.3	1259.6
October	730.1	512.4	807.7	564.6	653.7
$\bar{x}$	830.9	1336.5	900.2	687.6	938.8

MEAN MONTHLY PERCENT COMPOSITION

	STATIONS				
MONTH	N-10	O-W	S-4	S-17	$\bar{x}$
April	13.19	33.44	10.15	7.48	16.07
May	16.13	28.59	8.69	4.31	14.43
June	30.15	38.67	36.59	31.8	34.31
July	57.36	80.95	69.28	74.75	70.59
August	91.16	80.95	88.00	90.01	87.53
September	51.26	59.83	53.33	51.92	54.09
October	23.49	27.29	31.82	29.40	28.00
$\bar{x}$	40.40	49.96	42.56	41.39	43.58

discharge canal (Cairns, 1956). Unexpectedly, however, chlorophyll *a* concentrations at Zero-West remained similar to those observed at the other stations throughout this period.

From July through September, the period of highest algal standing crop, green algae, comprised primarily of *Eudorina* spp., *Sphaerocystis* spp. and *Pediastrum* spp., made up as much as 98.2% of the total algal population. During this period mean monthly chlorophyll *a* concentrations reached a maximum, while nitrate and total phosphate declined to their lowest concentrations, likely as a result of algal uptake.

A two-way analysis of variance showed that neither abundance nor percent composition of green algae differed significantly ($p > .05$) among stations when the entire season was considered.

Bluegreen algae (Figure 7, Table 12) generally occurred in lower numbers than diatoms and green algae through most of the study season. Peak abundance was reached in April and May, but declined during the summer months. Percent composition of bluegreens ranged from 68.2% at Station Zero-West on May 6, to 0% at Stations N-10 and S-17 during August, and at N-10, Zero-West and S-4 during September. These apparent disappearances of bluegreen algae cannot be explained.

A two-way ANOVA and multiple comparison showed that among-station differences in percent composition were significant ($p < .01$), with higher percentages of bluegreen algae occurring at Station Zero-West than at N-10 over the study season. No significant abundance differences among stations were found for bluegreen algae ($p < .05$).

The zooplankton community (Figure 7, Table 13) was sparse, as in past years. Zooplankton were least abundant at all stations (minimum = 138 individuals/100 liters) during May, when rotifers and copepod nauplii were predominant. During the late summer and fall months, zooplankton abundance gradually increased as ambient water temperatures

TABLE 12. MEAN MONTHLY BLUEGREEN ALGAE ABUNDANCE AND PERCENT COMPOSITION IN NEAR-SURFACE PLANKTON SAMPLES. HOOKSETT POND, MERRIMACK RIVER, 1975.

MEAN MONTHLY ABUNDANCE
(THOUSANDS OF INDIVIDUALS PER 100 LITERS)

STATIONS

MONTH	N-10	O-W	S-4	S-17	$\bar{x}$
April	620.6	2661.4	878.8	2565.8	1681.7
May	228.1	2976.9	904.4	2445.2	1638.7
June	78.6	243.0	213.0	350.3	221.2
July	20.0	28.7	9.0	2.2	14.9
August	.0	169.4	339.4	.0	52.2
September	.0	.0	.0	19.7	4.9
October	231.1	49.8	100.8	199.7	145.3
$\bar{x}$	168.4	875.6	306.5	797.6	537.0

MEAN MONTHLY PERCENT COMPOSITION

STATIONS

MONTH	N-10	O-W	S-4	S-17	$\bar{x}$
April	7.49	25.31	10.45	28.64	17.98
May	10.54	52.97	27.75	58.99	37.57
June	5.67	16.73	13.33	14.99	12.68
July	1.93	.78	.79	.23	.94
August	.00	13.09	2.33	.00	3.83
September	.00	.00	.00	1.29	.33
October	7.44	2.66	708.30	10.40	182.20
$\bar{x}$	4.73	15.94	108.98	16.18	36.51

TABLE 13. MEAN MONTHLY ZOOPLANKTON ABUNDANCE IN NEAR-SURFACE PLANKTON SAMPLES. HOOKSETT POND, MERRIMACK RIVER, 1975.

MEAN MONTHLY ABUNDANCE
(INDIVIDUALS PER 100 LITERS)

	STATIONS				
MONTH	N-10	O-W	S-4	S-17	$\bar{x}$
April	611.0	567.8	504.8	467.0	537.7
May	141.3	258.3	353.0	137.8	222.6
June	431.6	584.0	529.4	589.2	533.6
July	673.8	602.5	467.5	652.0	599.0
August	439.3	637.5	429.8	320.3	456.7
September	757.3	838.0	1024.0	454.3	768.4
October	1135.2	1014.0	1019.6	962.0	1032.7
$\bar{x}$	598.5	643.1	618.3	511.8	592.9

cooled. In October the numbers of rotifers, cladocerans and copepod nauplii combined yielded the most substantial mean monthly zooplankton community at each station during the 1975 season.

Results of a 2-way ANOVA ($p < .05$) and Tukey's method for multiple comparisons, showed zooplankton to be more abundant over the season at Station Zero-West than at N-10. Similarly, Brauer, Neill, and Magnuson (1975) found that Lake Monona, Wisconsin, zooplankton were more abundant in waters near a thermal outfall than in control regions.

b. Sub-surface Plankton

Trends noted during the sub-surface plankton surveys generally resembled those of the near-surface surveys (Figure 8); three-way ANOVA yielded no significant depth differences for any of the taxa studied. These deeper (6 ft) tows were taken below the depth of maximum thermal influence at Station S-4.

The diatoms, *Asterionella* spp., *Tabellaria* spp., and *Fragilaria* spp. dominated samples taken during the spring and early summer; *Melosira* spp. prevailed in late summer samples collected when ambient temperatures were high and flows were minimal. Results of a three-way fixed-effects ANOVA (Sokal and Rohlf, 1969) showed no significant among-station differences in diatom abundance or percent composition ($p > .05$) over the season.

Green algal abundance reached its peak at Stations N-10 and S-4 during September. Estimates of abundance and generic composition paralleled those of the near-surface samples, again producing no statistically significant differences between these sites.

As with the near-surface samples, bluegreen algae nearly disappeared during the summer months, and became re-established in October. During each month when bluegreens were present, numbers of cells at

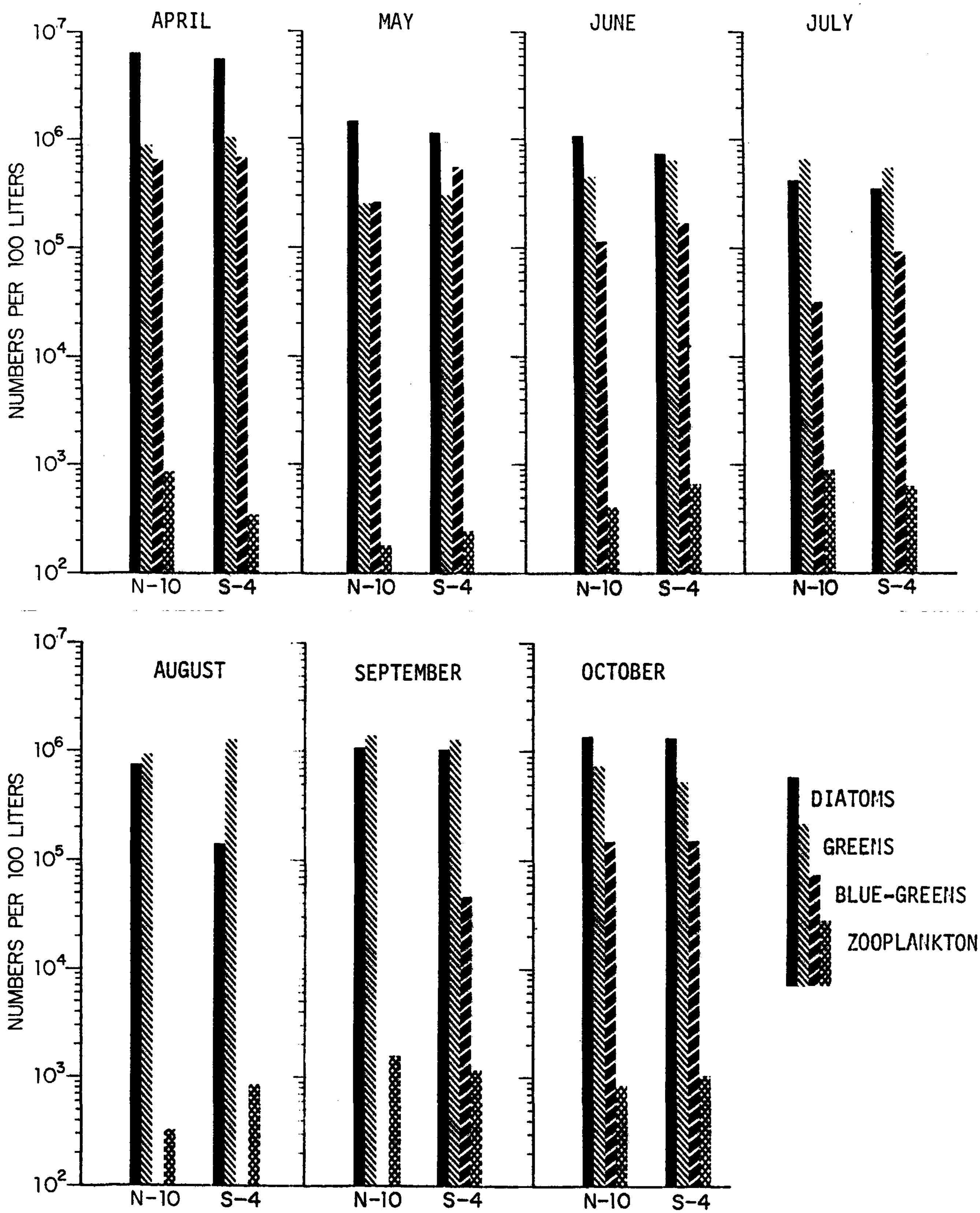


Figure 8. Mean monthly plankton abundance in sub-surface (6ft.) samples. Hooksett Pond, Merrimack River, 1975.

Station S-4 exceeded those at N-10. Results of statistical tests (3-way fixed-effects ANOVA, Tukey's Test) indicated that these observed differences were significant ($p < .05$).

Unlike the near-surface samples where the greatest zooplankton abundance occurred in October, the largest mean monthly sub-surface zooplankton community (principally rotifers and copepod nauplii), occurred at both stations during September. No statistically significant among-station differences in abundance or percent composition were noted.

c. Summary and Conclusions

Dominant phytoplankton genera encountered during the 1975 season included *Asterionella* spp., *Fragilaria* spp., *Tabellaria* spp., *Melosira* spp., *Eudorina* spp., *Sphaerocystis* spp., *Pediastrum* spp., and *Oscillatoria* spp. Rotifers, copepods, and cladocerans constituted the bulk of the primary consumers feeding upon the phytoplankton.

In general, as in past study years, the most pronounced changes in the indigenous plankton community of Hooksett Pond occurred at Station Zero-West. Diatoms, which dominated the spring and early summer phytoplankton community, constituted a higher monthly percentage of the community at N-10 than at Zero-West from April through October. Previous years' data show similar decreases at the discharge canal mouth. Although green algae showed large springtime increases at Zero-West, among-station differences over the season were not significant. Monitoring studies from 1971 through 1973 showed a decreased green algal abundance at Zero-West, but no station differences were seen in 1974 (NAI, 1972; 1973; 1974). Bluegreen algae occurred in higher percentages at Station Zero-West than at N-10 throughout the 1975 season. This dominance at the discharge canal mouth also appeared in 1973, but not in 1972 or 1974. Zooplankton, sparse as in past years, was more abundant at Station Zero-West than at N-10. Previous years' monitoring since

1972 failed to show any station differences in zooplankton occurrence.

3. Entrainment

The entrainment portion of the Merrimack River Monitoring Program was designed to generally assess the magnitude of potential impacts of entrainment on river plankton populations. Tables 14-17 present mortality data for diatoms, green algae, bluegreen algae and total zooplankton populations at the four sampling stations (intake, discharge weir, below power spray modules, discharge canal mouth). Water temperatures and chlorophyll *a* concentrations are also presented in these tables. Results of statistical analyses discussed in this section are contained in Appendix III.

a. Phytoplankton

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Dominant diatom genera during the 1975 study period were *Melosira, Asterionella* and *Tabellaria*. Ambient river temperatures ranged from 51.8° to 81.8° during the season, while Δt's between the intake and the discharge weir varied between 0.0° and 23.4°F (Table 14). Diatom percent mortality at the intake ranged from 0% to 5.9% and from 0% to 16.6% at the discharge weir.

Results of the Wilcoxin Matched-Pairs Signed-Rank Test (Siegel, 1956), used to test the change in percent mortality of diatoms between the intake and the discharge weir over the sampling season, indicated a significant ($p < .05$) increase in mortality. Two linear regression models were then employed to determine if the mortality as a result of entrainment was related to ambient river temperature, the

TABLE 14. WEEKLY WATER TEMPERATURES, CHLOROPHYLL a CONCENTRATION AND PERCENT MORTALITY OF DIATOMS AT FOUR ENTRAINMENT SAMPLING STATIONS. HOOKSETT POND, MERRIMACK RIVER, 1975.

SAMPLING DATE	AMBIENT TEMP (°F)	DISCHARGE WEIR TEMP (°F)	ΔT (°F)	INTAKE % MORTALITY REPLICATE 1 N	%MORT.	REPLICATE 2 N	%MORT.	MEAN %MORT.	INTAKE CHL a (µg/l)	DISCHARGE REPLICATE 1 N	%MORT.	REPLICATE 2 N	%MORT.	MEAN %MORT.	DISCHARGE WEIR CHL a (µg/l)	Δ% MORTALITY FROM INTAKE TO WEIR (D%-I%)
6/24	76.0			1593	1.1	---	---	1.1								
7/2	76.0			68	4.5	---	---	4.5	11.07							
7/9	79.4	102.7	23.3	593	2.7	170	10.6	4.5	10.76	269	16.4	299	16.8	16.6	8.82	+12.1
7/15	73.8			403	1.0	367	5.5	4.4	2.27							
7/22	81.8			227	0.0	585	0.2	0.1	1.57							
8/1	80.6			139	0.0	163	9.9	5.2	---							
8/6	80.6	86.0	5.4	61	0.0	90	6.7	3.9	5.42	*12	100.0	*12	100.0	100.0	2.40	NA
8/12	77.0	96.8	19.8	64	0.0	16	0.0	0.0	4.44	---	---	89	0.0	0.0	3.57	0.0
8/19	75.2	98.6	23.4	158	0.0	107	0.0	0.0	6.12	134	7.5	94	0.0	4.4	4.93	+4.3
9/3	68.0	89.6	21.6	71	0.0	57	0.0	0.0	3.06	8	0.0	26	0.0	0.0	2.74	0.0
9/9	68.0	91.4	23.4	131	8.2	52	0.0	5.9	3.57	65	0.0	100	0.0	0.0	2.21	-6.5
9/16	62.6	77.0	14.4	376	0.0	329	0.0	0.0	2.23	300	10.7	148	9.5	10.3	1.96	+10.2
9/23	64.4	86.9	22.5	205	0.0	239	0.0	0.0	2.94	220	15.5	287	0.0	6.7	2.88	+6.7
9/30	59.9	79.7	19.8	95	0.0	167	0.0	0.0	1.95	103	2.0	46	0.0	1.4	1.86	+1.3
10/7	57.2	57.2	0.0	451	0.0	553	0.0	0.0	1.37	640	0.0	466	0.0	0.0	1.56	0.0
10/14	56.3	75.2	18.9	672	0.9	596	2.4	1.6	3.08	941	3.2	753	5.4	4.2	2.22	+2.6
10/28	51.8	51.8	0.0	736	0.0	612	0.0	0.0	1.97	684	0.0	792	0.0	0.0	1.02	0.0

SAMPLING DATE	BELOW MODULES REPLICATE 1 #'s	%MORT.	REPLICATE 2 N	%MORT.	µg/l CHL a	MEAN %MORT.	CANAL MOUTH REPLICATE 1 N	%MORT.	REPLICATE 2 N	%MORT.	µg/l CHL. a	MEAN %MORT.
6/24							862	21.0	---	---	---	21.0
7/2							47	21.3	---	---	5.33	21.3
7/9	113	10.6	376	6.4	7.20	8.5	105	7.6	209	0.0	6.72	3.8
7/15							369	4.1	329	6.1	1.45	5.1
7/22							25	20.0	107	15.9	1.09	18.0
8/1							34	0.0	---	---	---	0.0
8/6							40	15.0	33	6.1	2.60	10.6
8/12	0		0		1.49	---	58	0.0	12	0.0	2.33	0.0
8/19							57	0.0	28	0.0	6.07	0.0
9/3							32	12.5	38	0.0	2.99	6.2
9/9	166	18.1	73	0.0	2.76	9.0	87	0.0	85	27.1	3.48	13.6
9/16							236	0.0	215	0.0	2.44	0.0
9/23							107	1.9	128	0.0	3.14	1.0
9/30							130	0.0	128	0.0	1.87	0.0
10/7							392	0.0	378	0.0	1.53	0.0
10/14	639	1.1	666	1.5	2.65	1.3	724	0.0	740	0.0	2.82	0.0
10/28							628	0.0	571	0.0	0.96	0.0

TABLE 15. WEEKLY WATER TEMPERATURES, CHLOROPHYLL a CONCENTRATION AND PERCENT MORTALITY OF GREEN ALGAE AT FOUR ENTRAINMENT SAMPLING STATIONS. HOOKSETT POND, MERRIMACK RIVER, 1975.

SAMPLING DATE	AMBIENT TEMP (°F)	DISCHARGE WEIR TEMP (°F)	ΔT (°F)	INTAKE % MORTALITY					INTAKE CHL a (μg/l)	DISCHARGE					DISCHARGE WEIR CHL a (μ g/l)	Δ% MORTALITY FROM INTAKE TO WEIR (D%-I%)
				REPLICATE 1		REPLICATE 2		MEAN		REPLICATE 1		REPLICATE 2		MEAN		
				N	%MORT.	N	%MORT.	%MORT.		N	%MORT.	N	%MORT.	%MORT.		
6/24	76.0			1281	0.5	---	---	0.5								
7/2	76.0			899	0.3	---	---	0.3	11.07							
7/9	79.4	102.7	23.3	1067	1.4	814	0.0	0.8	10.76	1194	12.2	1228	2.7	7.4	8.82	+6.7
7/15	73.8			675	14.9	691	7.3	11.0	2.27							
7/22	81.8			966	1.9	722	0.9	1.5	1.57							
8/1	80.6			917	8.2	1129	4.7	6.3	---							
8/6	80.6	86.0	5.4	974	5.0	966	0.0	2.5	5.42	1096	32.6	1021	13.3	23.2	2.40	+20.7
8/12	77.0	96.8	19.8	933	3.3	1001	2.8	3.0	4.44	1016	67.4	924	76.2	71.6	3.57	+68.5
8/19	75.2	98.6	23.4	944	2.4	901	2.4	2.4	6.12	923	11.9	910	13.1	12.5	4.93	+10.0
9/3	68.0	89.6	21.6	938	1.9	912	2.9	2.4	3.06	1002	14.4	1001	11.5	12.9	2.74	+10.6
9/9	68.0	91.4	23.4	879	11.2	978	8.1	9.6	3.57	1078	12.9	925	6.9	10.1	2.21	+0.5
9/16	62.6	77.0	14.4	721	18.6	744	20.2	19.4	2.23	718	6.2	930	16.9	12.2	1.96	-7.2
9/23	64.4	86.9	22.5	760	22.7	809	20.7	21.7	2.94	889	27.4	848	26.2	26.8	2.88	+5.1
9/30	59.9	79.7	19.8	31	0.0	75	0.0	0.0	1.95	63	4.8	56	1.8	3.4	1.86	+3.3
10/7	57.2	57.2	0.0	200	0.0	167	5.1	2.3	1.37	83	15.7	246	0.0	3.9	1.56	-0.5
10/14	56.3	75.2	18.9	112	0.0	24	33.4	5.9	3.08	111	0.0	113	0.0	0.0	2.22	-5.9
10/28	51.8	51.8	0.0	144	0.0	161	0.0	0.0	1.97	232	0.0	208	0.0	0.0	1.02	0.0

SAMPLING DATE	BELOW MODULES						CANAL MOUTH					
	REPLICATE 1		REPLICATE 2		μg/l CHL a	MEAN %MORT.	REPLICATE 1		REPLICATE 2		μg/l CHL. a	MEAN %MORT.
	N	%MORT.	N	%MORT.			N	%MORT.	N	%MORT.		
6/24							2399	43.9	---	---	---	43.9
7/2							878	3.0	---	---	5.33	3.0
7/9	1347	14.9	994	4.7	7.20	10.6	972	0.0	1272	6.8	6.72	3.4
7/15							1229	16.5	793	16.6	1.45	16.5
7/22							1000	17.4	772	25.1	1.09	21.2
8/1							995	28.4	1025	22.9	---	25.6
8/6							999	16.6	974	16.4	2.60	16.5
8/12	1087	5.4	1029	6.5	1.49	6.0	997	9.8	1166	8.3	2.33	9.0
8/19							978	11.9	973	13.7	6.07	12.8
9/3							1086	3.4	996	5.9	2.99	4.6
9/9	843	11.1	973	11.7	2.76	11.5	928	5.8	906	3.8	3.48	4.8
9/16							837	7.9	847	7.7	2.44	7.8
9/23							935	1.8	902	5.5	3.14	3.6
9/30							209	1.9	267	0.0	1.87	1.0
10/7							140	0.0	215	0.0	1.53	0.0
10/14	220	18.6	259	19.3	2.65	19.0	145	16.6	69	11.6	2.82	14.1
10/28							327	0.0	218	3.7	0.96	1.8

TABLE 16. WEEKLY WATER TEMPERATURES, CHLOROPHYLL a CONCENTRATION AND PERCENT MORTALITY OF BLUEGREEN ALGAE AT FOUR ENTRAINMENT SAMPLING STATIONS. HOOKSETT POND, MERRIMACK RIVER, 1975.

SAMPLING DATE	AMBIENT TEMP (°F)	DISCHARGE WEIR TEMP (°F)	ΔT (°F)	INTAKE REPLICATE 1 N	INTAKE REPLICATE 1 %MORT.	INTAKE REPLICATE 2 N	INTAKE REPLICATE 2 %MORT.	INTAKE MEAN %MORT.	INTAKE CHL a (µg/l)	DISCHARGE REPLICATE 1 N	DISCHARGE REPLICATE 1 %MORT	DISCHARGE REPLICATE 2 N	DISCHARGE REPLICATE 2 %MORT.	DISCHARGE MEAN %MORT.	DISCHARGE WEIR CHL a (µ g/l)	Δ% MORTALITY FROM INTAKE TO WEIR (D%-I%)
6/24	76.0															
7/2	76.0								11.07							
7/9	79.4	102.7	23.3						10.76						8.82	
7/15	73.8								2.27							
7/22	81.8			40	0.0	---	---	0.0	1.57							
8/1	80.6								---							
8/6	80.6	86.0	5.4						5.42						2.40	
8/12	77.0	96.8	19.8						4.44						3.57	
8/19	75.2	98.6	23.4						6.12						4.93	
9/3	68.0	89.6	21.6						3.06						2.74	
9/9	68.0	91.4	23.4						3.57						2.21	
9/16	62.6	77.0	14.4						2.23						1.96	
9/23	64.4	86.9	22.5						2.94						2.88	
9/30	59.9	79.7	19.8	860	60.5	770	50.7	55.9	1.95	960	64.6	598	31.5	51.9	1.86	-4.0
10/7	57.2	57.2	0.0	295	13.6	310	6.5	9.9	1.37	320	12.5	190	52.6	27.4	1.56	+15.5
10/14	56.3	75.2	18.9	190	0.0	370	13.5	8.9	3.08	---	---	130	77.0	77.0	2.22	+68.1
10/28	51.8	51.8	0.0	60	0.0	165	0.0	0.0	1.97	100	25.0	---	---	25.0	1.02	+25.0

SAMPLING DATE	BELOW MODULES REPLICATE 1 N	BELOW MODULES REPLICATE 1 %MORT.	BELOW MODULES REPLICATE 2 N	BELOW MODULES REPLICATE 2 %MORT.	BELOW MODULES µg/l CHL a	BELOW MODULES MEAN %MORT.	CANAL MOUTH REPLICATE 1 N	CANAL MOUTH REPLICATE 1 %MORT.	CANAL MOUTH REPLICATE 2 N	CANAL MOUTH REPLICATE 2 %MORT.	CANAL MOUTH µg/l CHL. a	CANAL MOUTH MEAN %MORT.
6/24											---	
7/2											5.33	
7/9					7.20						6.72	
7/15											1.45	
7/22							220	0.0	100	0.0	1.09	0.0
8/1											---	
8/6					1.49						2.60	
8/12											2.33	
8/19											6.07	
9/3											2.99	
9/9					2.76						3.48	
9/16											2.44	
9/23											3.14	
9/30							610	63.9	660	50.0	1.87	57.0
10/7							182	54.9	220	45.4	1.53	50.2
10/14	300	33.3	103	61.2	2.65		50	0.0	200	0.0	2.82	0.0
10/28							---	---	8	100.0	0.96	100.0

TABLE 17. WEEKLY WATER TEMPERATURES AND PERCENT MORTALITY OF TOTAL ZOOPLANKTON AT FOUR ENTRAINMENT SAMPLING STATIONS. HOOKSETT POND, MERRIMACK RIVER, 1975.

SAMPLING DATE	AMBIENT TEMP (°F)	DISCHARGE WEIR TEMP (°F)	ΔT (°F)	INTAKE % MORTALITY REPLICATE 1 N		INTAKE % MORTALITY REPLICATE 2 N		INTAKE % MORTALITY MEAN %MORT	DISCHARGE REPLICATE 1 N		DISCHARGE REPLICATE 2 N		DISCHARGE MEAN %MORT.	Δ% MORTALITY FROM INTAKE TO WEIR (D%-I%)
				N	%MORT.	N	%MORT.	%MORT	N	%MORT.	N	%MORT.	%MORT.	
6/24	76.0			127	9.4	---	---	---						
7/2	76.0			137	16.1	131	12.9	14.5						
7/9	79.4	102.7	23.3	112	22.3	107	28.9	25.5	100	55.0	107	49.5	52.2	+23.2
7/15	73.8			104	24.0	71	25.3	24.5						
7/22	81.8			100	42.0	105	20.0	30.7						
8/1	80.6			310	28.1	318	33.3	30.7						
8/6	80.6	86.0	5.4	308	29.2	340	40.6	35.2	330	29.4	327	32.4	30.9	-4.3
8/12	77.0	96.8	19.8	309	23.0	337	27.9	25.6	346	78.9	304	84.9	81.7	+56.1
8/19	75.2	98.6	23.4	345	57.2	342	43.6	50.4	327	41.0	330	41.9	41.5	-8.9
9/3	68.0	89.6	21.6	94	47.9	52	48.1	47.9	51	31.4	50	32.0	31.7	-16.3
9/9	68.0	91.4	23.4	71	8.1	69	10.0	9.0	68	7.3	64	14.0	10.6	-2.1
9/16	62.6	77.0	14.4	77	15.6	81	16.0	15.8	57	24.6	72	19.4	21.7	+5.9
9/23	64.4	86.9	22.5	139	15.2	172	11.7	13.2	71	45.1	95	33.7	38.6	+2.54
9/30	59.9	79.7	19.8	49	8.2	72	2.8	4.9	61	14.8	57	17.6	16.2	+11.2
10/7	57.2	57.2	0.0	50	14.0	54	31.5	23.1	48	16.7	51	19.7	18.2	-7.8
10/14	56.3	75.2	18.9	54	7.5	50	14.0	10.6	50	38.0	49	20.5	29.3	+12.9
10/28	51.8	51.8	0.0											

SAMPLING DATE	BELOW MODULES REPLICATE 1 N		BELOW MODULES REPLICATE 2 N		BELOW MODULES MEAN %MORT.	CANAL MOUTH REPLICATE 1 N		CANAL MOUTH REPLICATE 2 N		CANAL MOUTH MEAN %MORT.
	N	%MORT.	N	%MORT.	%MORT.	N	%MORT.	N	%MORT.	%MORT.
6/24						137	43.1	110	31.8	37.4
7/2										
7/9										
7/15										
7/22										
8/1						311	29.3	325	30.5	29.9
8/6						447	10.5	353	8.5	9.5
8/12	306	21.2	393	22.4	21.8	367	22.3	338	26.3	24.3
8/19						311	31.8	326	34.4	33.1
9/3						300	51.3	50	56.0	53.6
9/9	100	8.0	76	13.2	10.6	53	30.2	72	8.3	19.2
9/16						81	24.7	72	30.6	27.6
9/23						101	15.8	196	18.4	17.1
9/30						69	4.3	93	4.3	4.3
10/7						69	23.2	55	25.4	24.3
10/14	53	15.1	52	30.8	23.0	51	9.8	61	6.6	8.2
10/28						---	---	---	---	---

magnitude of the temperature change (Δt) between the intake and the discharge, or a combination of the two factors. This analysis revealed that diatom mortality was significantly ($p < .05$) related to ambient river temperature and Δt acting in conjunction, and with Δt when adjusted for ambient effects. There was no significant relationship with ambient temperature only. These results suggest that the magnitude of the increased temperature experienced by diatoms between the intake and the discharge does influence the resultant mortality. Ambient river temperature appears to further influence mortality by acting synergistically with the Δt factor. Hatfield, Pfeiffer and Wurtz (1966) found that Susquehanna River diatoms passed through condensers with temperature increases of 11°C in 10 seconds, were not killed so long as the maximum temperature was below 33.5°C (92.3°F). However, since only three of our sampling dates showed discharge weir temperatures greater than 92.3°F, this observed mortality difference may reflect varying thermal histories between the two study areas.

In general, percent mortality for diatoms on a given sampling date increased from the intake to the discharge, and subsequently decreased below the spray modules and at the canal mouth. This is to be expected since the diatom population should commence proliferation in the discharge canal (Hatfield, Pfeiffer and Wurtz, 1966). One exception to the trend occurred on 9 September when the observed mortality at the four sampling stations was lowest at the discharge weir. Since this was a date with a high Δt, sampling error appears to be the most plausible explanation for this non-characteristic data.

CHLOROPHYTA

Dominant green algae genera during the 1975 season were *Eudorina, Spirogyra, Pediastrum, Sphaerocystis* and *Dictyosphaerium*. Green algae mortality at the intake varied between 0% and 21.7%, and between 0% and 71.5% at the discharge weir. As shown for diatoms, the increase in green algae mortality from the intake to the discharge weir throughout the season was significant ($p < .05$). However, linear regression analysis revealed that the increased mortality was not significantly correlated with Δt or with ambient river temperature, but the presence of a significant increase in mortality suggests that some other factor such as mechanical or chemical stress was the primary reason for entrainment-induced mortality. This is further supported by considering that the more fragile physical structure of the green algae, principally the filamentous forms is more susceptible to mechanical damage than forms such as the diatoms which have silicified cell walls.

Although there is some variability in the data, particularly in September and October when the amount of green algae sampled was low, general trends across the four sampling locations showed increased mortality from the intake to the discharge with subsequent recovery at the spray modules and the canal mouth (Table 15).

CYANOPHYTA

Bluegreen algae, primarily *Oscillatoria*, were first collected in the September 30 samples. Analysis of the intake samples revealed that 55.8% of the indigenous bluegreen community was dead before entrainment. This could have been caused by surface runoff introducing bluegreens of terrestrial origin (temporary pools and puddles) into the river (Smith, 1950). After September 30, bluegreen algae mortality ranged from 0% to 9.9% at the intake and from 25% to 77% at the discharge weir. It was assumed that the predominance of bluegreen algae in the discharge samples resulted from turbulent scouring of the resident discharge canal population by the effluent.

Statistical analyses were not performed on the bluegreen algal mortality since they were present on only four sampling dates. Trends in the data (Table 16) do indicate a higher mortality at the discharge weir than at the intake. There is no conclusive trend apparent between the discharge weir and the canal mouth.

TOTAL PHYTOPLANKTON

Chlorophyll *a* concentrations are included in Tables 14-16. However, since the acidification technique of Lorenzen (1967) which corrects chlorophyll *a* estimates for phaeophyton "a" was not used, these data cannot reflect the magnitude of entrainment mortality. Instead, these values are presented as an indicator of phytoplankton standing crop.

In general, there is a trend of decreasing chlorophyll *a* concentrations over all stations from July to October. This corresponds with the trends noted in the river plankton monitoring program, and is probably related to decreasing water temperatures. The highest concentrations (10-11 μg/l) occurred at the intake in early July, but the magnitude of these values suggests possible sampling or analytical errors. After elimination of the questionable samples, results of a Wilcoxon Matched-Pairs Ranked-Sum Analysis (Siegel, 1956) showed that chlorophyll *a* concentrations at the discharge canal mouth were significantly ($p < .05$) lower than those at the intake over the sampling season. Chlorophyll *a* values observed during the river monitoring survey also reflected this trend from June through September.

The impacts of entrainment on phytoplankton as reported in the literature are varied. Storr (1974) found that the change in phytoplankton and zooplankton mortality from intake to discharge was not significant at two nuclear generating stations on Lake Ontario although operational temperature rises often varied by 7°C between the stations. He concluded that phytoplankton show very low mortality at temperatures under 35°C, and that mechanical stress plays an important role in total mortality.

On the other hand, Verduin (1973) found that declines in phytoplankton metabolism in the presence of thermal additions was related to lethal temperatures rather than mechanical damage in the condensers since decreases in metabolic rate were most severe when ambient temperatures exceeded 27°C (80.6°F).

Gurtz and Weiss (1974) found a relationship between intake temperature, Δt and primary productivity of phytoplankton populations entrained at the Wylie coal-fired plant on Lake Wylie, North Carolina. Relatively constant inhibitions of productivity occurred for a 10° to 20°F increase, regardless of initial temperature, although there was a trend toward greater inhibition when ambient temperatures were greater than 83°F. A Δt of 30°F produced successively greater productivity inhibition with increasing ambient temperatures. Smith, Brooks and Jensen (1974), however, reported little evidence for any loss of primary productive capacity for entrained freshwater phytoplankton populations due to passage through the condenser systems at the Marshall Steam Station, North Carolina.

Patrick (1974) reviewed literature relevant to entrainment studies, and concluded that temperature increases toward the optimum range for growth of a particular species increase algal diversity and biomass if the change is not too large. However, temperature shifts at the upper limit of the tolerance range are deleterious. The effects of thermal increases can be harmful if the Δt is large, if exposure is continued for several hours, or if the water temperature approaches the upper tolerance limit.

In general, algal populations entrained through the Merrimack Station cooling system during the 1975 season were temporarily affected by factors such as temperature, mechanical abrasion, and turbulence, but the extent of damage varied with time of year and composition of the community.

b. Total Zooplankton

Zooplankton populations sampled in 1975 were dominated by copepod adults and nauplii, cladocerans and rotifers. Percent mortality at the intake ranged from 4.9% to 50.4% and from 10.6% to 81.7% at the discharge weir. Results of statistical analyses indicated that there was no significant increase in zooplankton mortality between the intake and the discharge weir. As shown in Table 17, on five sampling dates, the percent mortality in the discharge weir was less than that observed at the intake. This could be the result either of sampling error or of sampling resident discharge canal plankton populations in addition to those emerging from the Merrimack plant. The mortalities observed at the discharge canal mouth were similar to those observed at the intake. In general the zooplankton community appeared to be more resilient than the phytoplankton in surviving environmental variation induced by the Merrimack Station cooling system discharge.

c. Immature Fish

Numbers of immature fish collected during two weekly Tucker trawl tows at each station are shown in Table 18. As the data illustrate, fish were found in tow samples on June 24, July 9, 15, 22 and 31, 1975 and only at the intake and canal mouth stations. Fish collected during the survey period were all *Lepomis* spp. (sunfish).

Twenty-one dead *Lepomis* spp. were collected on July 9 at the intake area where the ambient temperature was 79.3°F. Thirteen living and eight dead sunfish were collected on the same date at the discharge canal mouth, where water temperature was 93.9°F. On July 31, all fish caught at the canal mouth were dead and in a state of decomposition at the time of collection. No fish were collected in the discharge canal itself on any of the sampling dates.

TABLE 18. RESULTS OF IMMATURE FISH ENTRAINMENT SURVEYS, HOOKSETT POND, MERRIMACK RIVER, 1975.

	INTAKE		DISCHARGE CANAL	
	LIVE	DEAD	LIVE	DEAD
24 June		6[1] 6.95 mm[2]		
9 July		21 8.45 mm	13 17.85 mm	8 9.33 mm
22 July		1 (uniden.) 8.0 mm		
31 July				13 5.46 mm

[1] *Lepomis* spp. unless otherwise noted

[2] Mean length of all captured fish

The small numbers of fish caught during the immature fish sampling program precludes an evaluation of the potential impact of the Merrimack Station. The absence of appreciable numbers of fish in samples taken at the intake structure may be related to behavioral traits. For instance, Richardson (1913), found that larval forms of largemouth bass, suckers and certain minnows remain in the littoral zone where they maintain tight aggregations. Faber (1967) was unsuccessful in his attempts to capture larval largemouth and smallmouth bass in open water areas and therefore assumed that their larvae were littoral in habit. The relatively infrequent collection of a few individuals from one genus (*Lepomis* spp.) in Merrimack River entrainment sampling may have been an indication of successful entrainment avoidance by fish inhabiting Hooksett Pond. The total absence of fish in samples taken in the discharge canal and of live fish near the intake structure would tend to be supportive of this. Further studies in 1976, which will be conducted during months of higher larval fish abundance will provide additional data from which, hopefully, more meaningful conclusions can be drawn.

d. Summary and Conclusions

Entrainment of diatoms caused significant mortality between the intake and the discharge weir. However, the data reflect a recovery of the diatom population with a resultant decrease in percent mortality from the discharge weir to the discharge canal mouth. Diatom mortalities at the canal mouth approached the values observed at the intake. The river plankton monitoring program found that although mean monthly diatom counts were reduced between Stations N-10 and Zero-West, among-station differences over the season were not significant. Diatom counts at S-4 were similar to those at N-10 for the months surveyed.

As with the diatoms, green algae experienced increased mortality from the intake to the discharge, with subsequent recovery at the spray modules and canal mouth. Results of river plankton sampling showed that green algae responded positively to the artificially-heated environment, particularly in April and May. During these months green algal cells at Zero-West were present in much higher numbers than at the other mainstream stations.

Entrainment data for bluegreen algae is inconclusive since bluegreens appeared in only four samples. However, the river monitoring program showed that bluegreen algae occurred in significantly higher percentages at Station Zero-West than at N-10 throughout the study season. Among-station differences in abundance, however, were not significant for bluegreens.

The zooplankton community, as in previous years, was sparse. Entrainment results indicated no significant increase in zooplankton mortality between the intake and the discharge weir. Trends within the data suggest no other mortality within the discharge canal. Zooplankton were found to be more abundant at Station Zero-West than at N-10 throughout the season in the river plankton monitoring program.

Chlorophyll *a* concentrations, used only as an indicator of phytoplankton standing crop, decreased from the intake to the discharge canal mouth when viewed over the sampling season. The river plankton monitoring program showed similar chlorophyll *a* changes from June through September, although all monthly mean concentrations at the S-4 and S-17 stations approached the control (N-10) values.

Thus, an overview of the four plankton taxa studied, it appears that entrainment caused increased mortality in diatoms and green algae, and that in all cases, the plankton populations exhibited some amount of recovery within the discharge canal. This generally resulted in plankton abundances below the canal mouth nearly equivalent to that at the intake.

The immature fish sampling program yielded only a few fish per sample which was insufficient to evaluate the potential impact of the Merrimack Station. However, the total absence of fish in discharge canal samples, and the presence of live fish near the intake suggested successful avoidance of entrainment by the resident fish species.

4. Periphyton

a. Weekly Sampling

Weekly periphyton slides were analyzed to determine potential impacts of the thermal plume on initial periphyton accumulation. A two-way ANOVA was used to determine among-station differences at the 2-foot depth for diatoms, green algae, and bluegreen algae collected after one week of immersion (Appendix IV). Results of this analysis and Tukey's Method for Multiple Comparisons (Guenther, 1964) showed that over the 26-week sampling period Station Zero-West had significantly fewer diatoms than Station S-17 ($\alpha = .05$). No other abundance differences were found.

Periphyton abundance at the 2-foot and 6-foot depths of Stations N-10 and S-4 were compared using a 3-way ANOVA (Appendix IV) and Tukey's Method for Multiple Comparisons. Abundance of bluegreen algae and total organisms, when compared over depths and weeks, were significantly greater at S-4 than at N-10. When analyzed within depths the abundance of bluegreens but not total organisms was greater at Station S-4 than N-10. This increased abundance of bluegreens is probably related to their ability to flourish in areas of high water temperatures (Cairns, 1956; Patrick, 1969). Significant ($p < .05$) differences across depths occurred for total organisms and diatom abundance. In each case, more organisms were found at the 2-foot depth ($p < .05$), probably as a result of higher light intensity and/or increased growth related to the higher surface temperatures.

An ANOVA comparing percent composition data among-stations (2-ft depths) showed significant differences for diatoms and green algae

($p < .01$). Tukey's Method for Pairwise Comparisons revealed that diatom percent composition was greater at both stations N-10 and S-17 than at Zero-West ($\alpha = .05$) (Figure 9), while green algae percent composition was higher at Zero-West than at N-10 and S-17 ($\alpha = .05$). These results were similar to those of Cairns (1956) who ranked diatoms as a group having a low thermal tolerance, followed in order of increasing tolerance by the green and bluegreen algae. Analyses of depth-related differences in station percent composition data using the 3-way ANOVA showed no significant among-station differences ($p > .05$).

b. Monthly Sampling

Results of monthly periphyton studies are shown in Figures 10 to 12. Supplementary data on statistical analyses are presented in Appendix IV. Of particular interest in 1975 was the low abundance of diatoms and nearly complete absence of bluegreen algae in samples collected during July, August and September, when compared to past years. A corresponding shift to green algae dominance was noted. In general, productivity, in terms of numbers of cells, were low during these months when compared to 1974 (NAI, 1975), 1973 (NAI, 1974) and 1972 (NAI, 1973).

Station, depth, and monthly differences for both abundance and percent composition of periphyton organisms were analyzed statistically for the 1975 season using ANOVA techniques. Only organisms that were present in sufficient quantities (diatoms, green algae and total organisms) were considered in this analysis. As would be expected, the time factor was highly significant, indicating the high degree of seasonal change noted in Figures 10 to 12. The depth effect was significant in only one instance: the abundance of green algae was greater at the 2-foot depth than at the 6-foot ($p < .05$). No other statistically significant differences were noted.

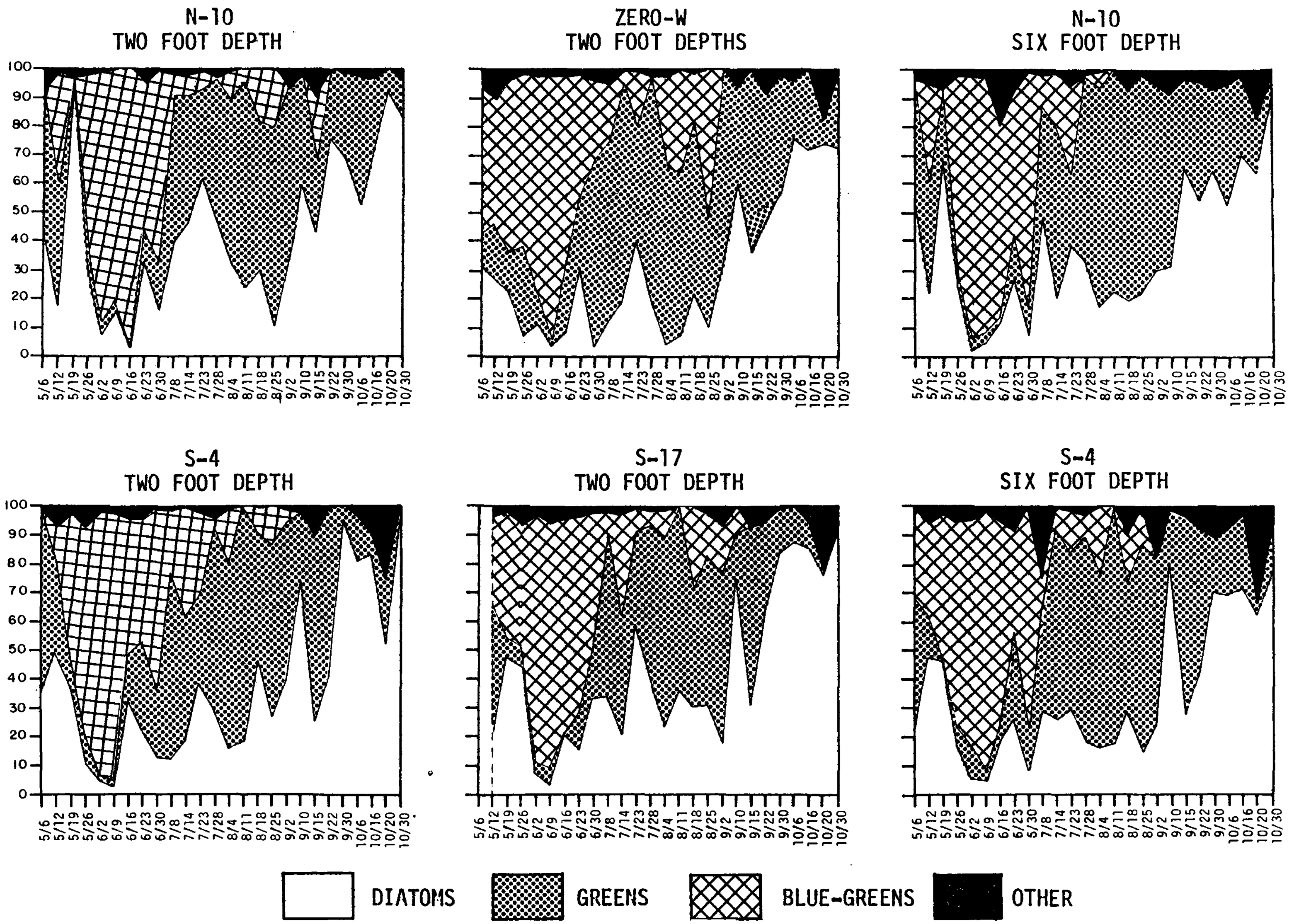

Figure 9. Percent composition of diatoms, green, and bluegreen algae on weekly periphyton slides at Stations N-10, Zero-W, S-4 and S-17 at the two foot depth and at N-10 and S-4 at 6 foot depths, Hooksett Pond, Merrimack River, 1975.

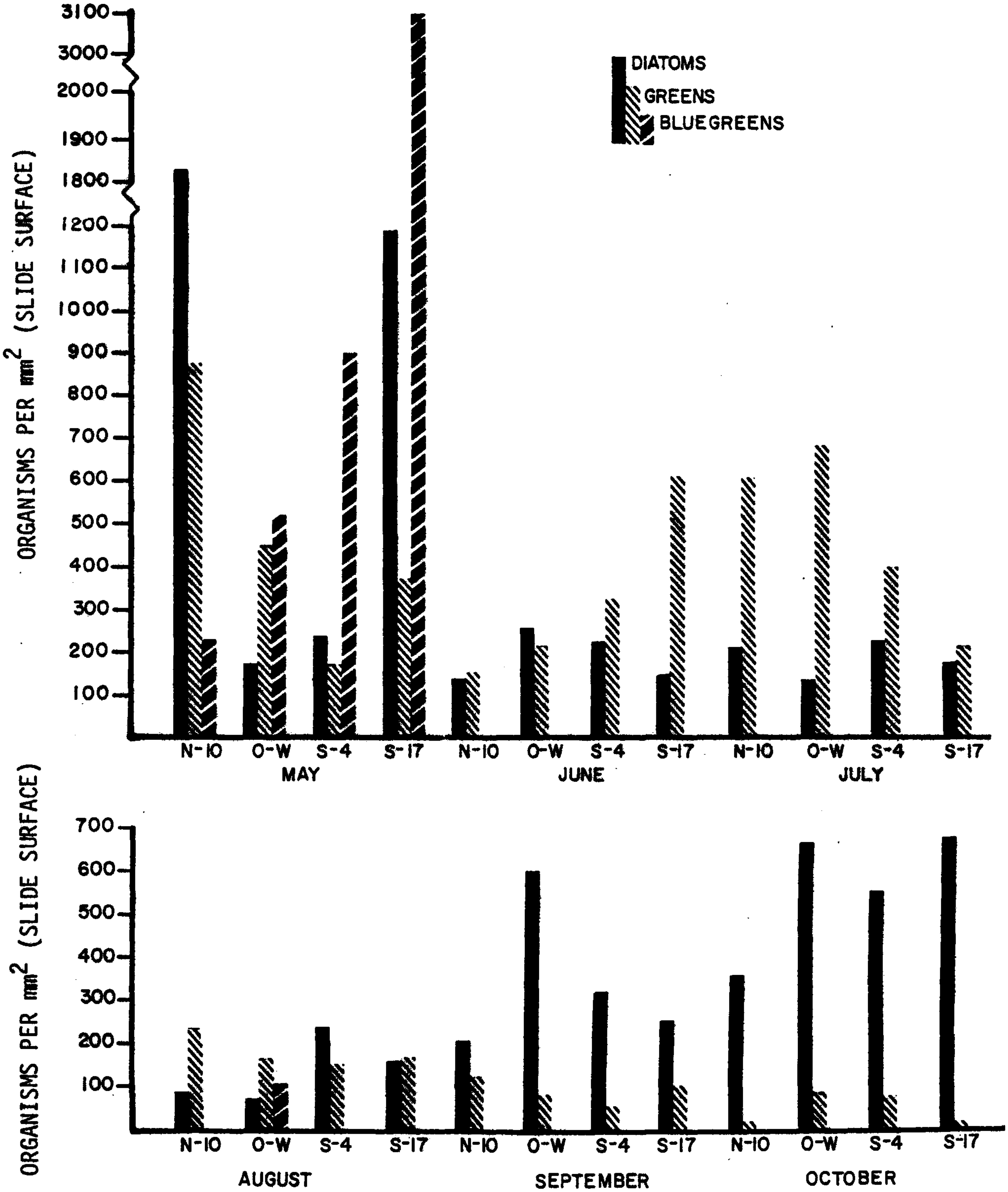

Figure 10. Abundance of periphyton organisms collected monthly at 2 foot depth, Hooksett Pond, Merrimack River, 1975.

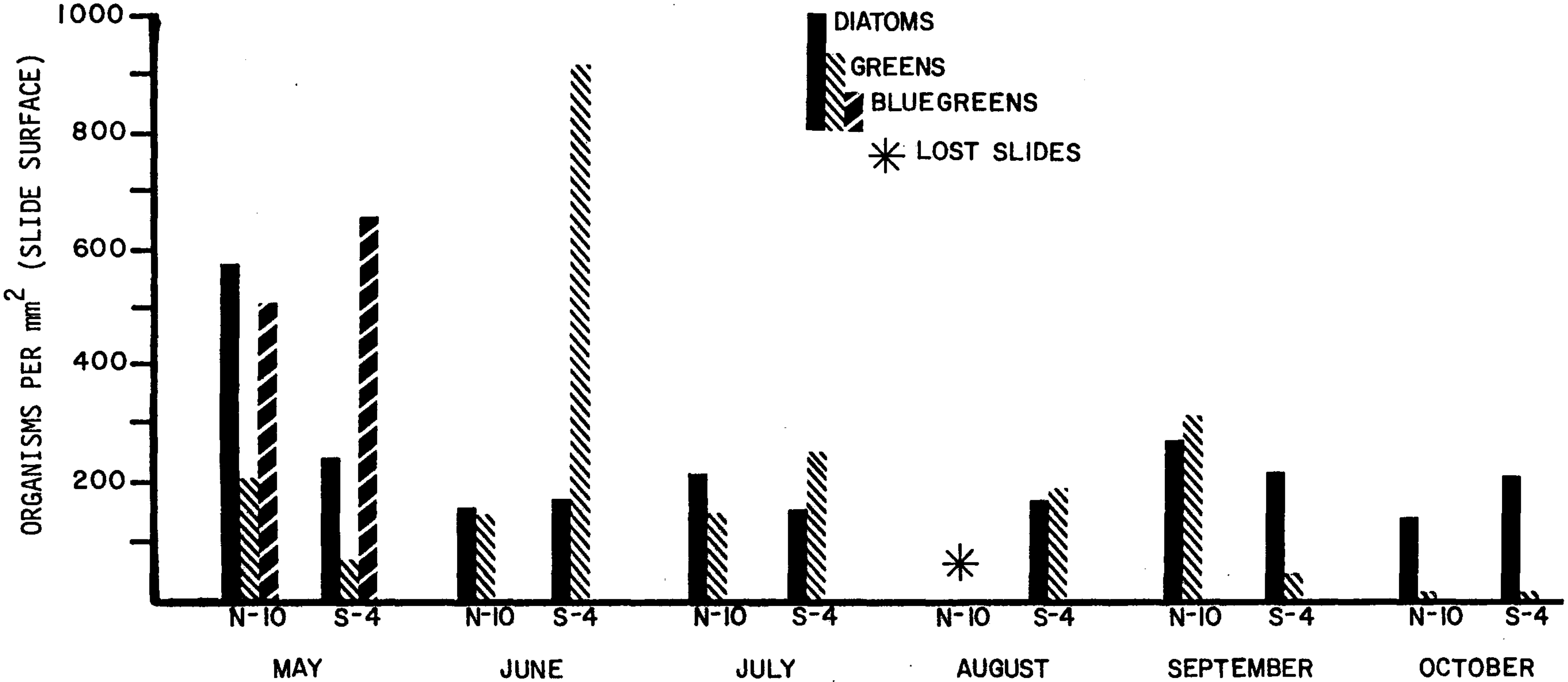

Figure 11. Abundance of periphyton organisms collected monthly at 6 foot depth, Hooksett Pond, Merrimack River, 1975.

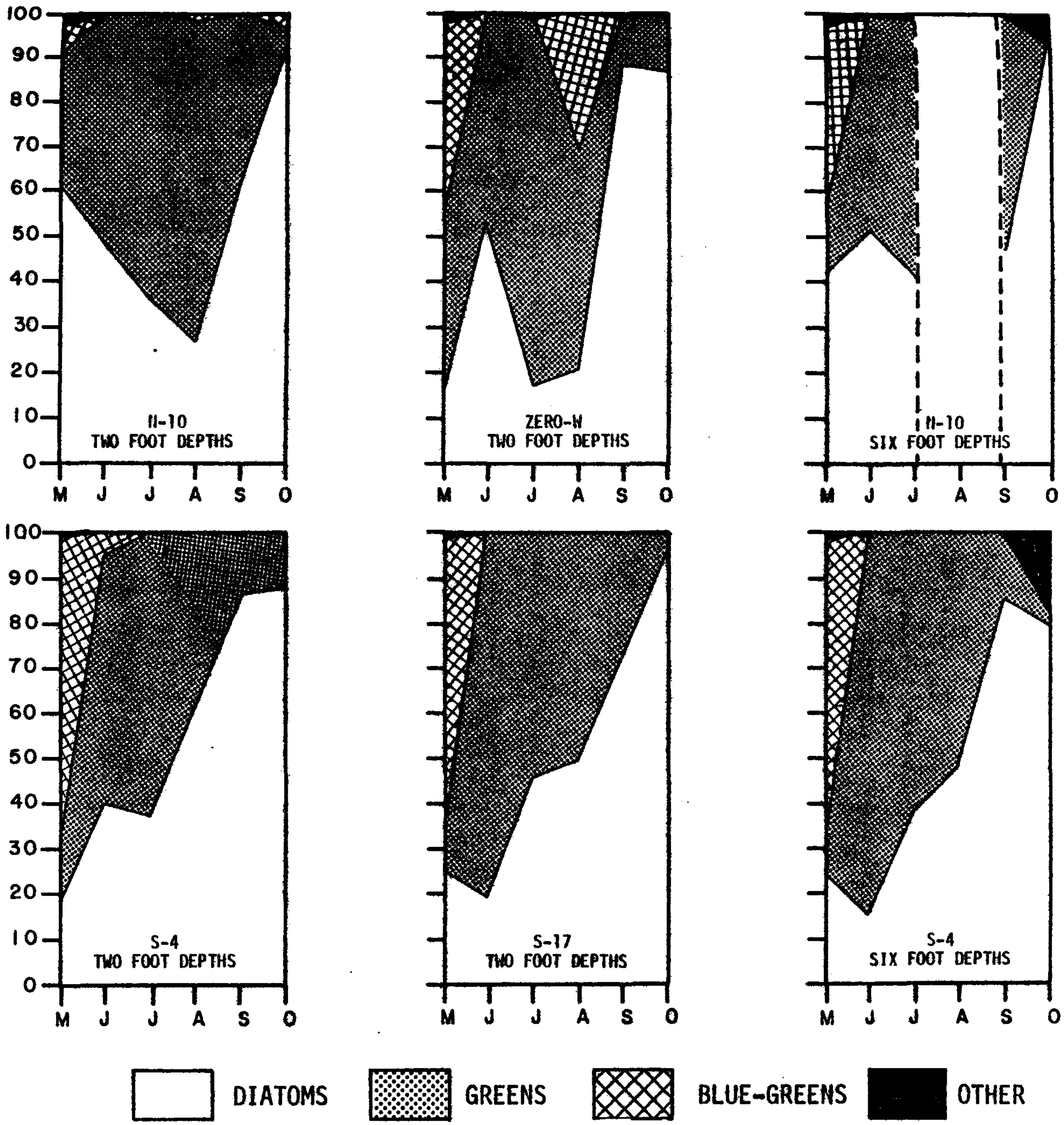

Figure 12. Percent composition of diatoms, green and bluegreen algae on monthly periphyton slides at Stations N-10, Zero-W, S-4, S-17 at two foot depths and N-10 and S-4 at six foot depths, Hooksett Pond, Merrimack River, 1976.

c. Summary and Conclusions

In summary, 1975 weekly periphyton abundance data showed little evidence of significant thermal impacts at either the 2- or 6-foot depth. Higher total numbers of organisms (including bluegreen algae) at Station S-4 were potentially related to the thermal discharge as were the lower percentage of diatoms and higher percentage of green algae at Station Zero-West. Analysis of monthly data showed no statistically significant differences among stations over the study season. During 1974 statistically significant reductions in diatom abundance were found in both weekly and monthly slides at Station Zero-West (2-foot) and S-4 (6-foot depth) and were generally consistent with past years. Higher flows during 1975 could have served to mitigate impacts noted in past years.

5. Benthic Macroinvertebrates

Results of the 1975 benthic invertebrate surveys (June 27, August 12, October 8) are presented in Tables 19-21. As in the years 1970-1974, dipterans, especially chironomids, and oligochaetes were the dominant groups found during 1975. The percentage composition of these organisms ranged from 79.3% to 96.5% at Station N-10 in October and June, respectively. The relative abundance of these organisms generally declined from June to October, in part because of a relative increase in the numbers of molluscs, both clams (Pelecypoda) and snails (Gastropoda). Dominance of the benthic macroinvertebrate fauna by oligochaetes and dipterans is expected in situations like Hooksett Pond, which is characterized by low flow velocities and relatively high levels of productivity (Reid, 1961).

Lowest total number of organisms for all samples combined was collected during August ($\Sigma = 8458$); highest occurred in June ($\Sigma = 12,543$); and an intermediate number was obtained during October ($\Sigma = 9005$). In contrast with 1973 and similar to 1974, total numbers of organisms were

TABLE 19. RESULTS OF BENTHIC INVERTEBRATE SURVEY, HOOKSETT POND, MERRIMACK RIVER, JUNE 27, 1975.

STATION 6/27/75	TEMP °F	TURBELLARIA	CURTISIA FOREMANI	NEMERTEA	NEMATODA	BRYOZOAN STATOBLAST	OLIGOCHAETA	OLIGOCHAETA FRAGMENTS	STYLARIA SP.	NAIS SP.	SLAVINA SP.	HIRUDINEA	HELOBDELLA SP.	HELOBDELLA STAGNALIS	HELOBDELLA ELONGATA	DINA SP.	PLACOBDELLA SP.	ISOPODA ASELLIDAE	ASELLIDAE ASELLUS SP.	HYDRACARINA	EPHEMEROPTERA	EPHEMERIDAE HEXAGENIA SP.	EPHEMERIDAE EPHORON SP.	BAETIDAE EPHEMERELLA SP. N.	ODONATA	COENAGRIONIDAE CHROMAGRION SP.	GOMPHIDAE GOMPHUS SP. N.	MEGALOPTERA SIALIS SP. L.	TRICHOPTERA	PSYCHOMYIIDAE L.	PSYCHOMYIIDAE PSYCHOMYIA SP. L.	DYTISCIDAE HYDROPORINAE L.
N-10 E	S-77.8																															
A	M-77.8				2	1	1271	337						1	1																	
B	B-77.8				3	1	762	364	111	11				5		2			1					1			1					1
N-10 M	S-76.5																															
A	M-76.5						6	1	1	1												1										
B	B-76.5	1			1		12			4						1																
N-10 W	S-76.5																															
A	M-76.5				3	1	284	89	6	3																1				2		
B	B-76.5						698	235	56	10																	2				6	
Zero E	S-87.6																															
A	M-76.2				1	4	245	40	6	4				1																		
B	B-76.2				1		204	56	3	4																1					1	
Zero M	S-88.0																															
A	M-76.2				1		4	5	1	6										4			2	1								
B	B-76.2		1				9	3	4	10													4				1					
Zero W	S-90.7																															
A	M-90.7				2		183	22	4	5	1													1								
B	B-90.2		1	1	2	3	342	51	13	11	12			1			1											1				
S-4 E	S-86.2																															
A	M-77.8					3	680	147	69	9		3		8	1	2			2													
B	B-78.3					1	559	155	73	16		1		2		3							1				3		1			
S-4 M	S-85.2																															
A	M-76.9						2	4		5			1										1									
B	B-76.8						9	6	8	15													1					1				
S-4 W	S-86.3																															
A	M-86.0					2	661	50	2	1																						
B	B-85.0						285	19																								
S-17 E	S-82.2																															
A	M-80.1		2		11	2	690	138	12	26			5	16		3											2					
B	B-80.1				6		403	114	13	12		17		3		4		1					1									
S-17 M	S-81.0																															
A	M-78.1			1	2		52	7	5	16													40								1	
B	B-78.0						4			1													34									
S-17 W	S-81.0																															
A	M-81.0		1			2	583	193	2	3		1		1													2				3	
B	B-78.5					3	650	90	5	2		1																			1	

Continued

TABLE 19. (Continued)

STATION 6/27/75	TEMP °F	ELMIDAE L.	ELMIDAE DUBIRAPHIA SP. L.	DIPTERA	CHIRONOMIDAE L.	CHIRONOMIDAE P.	POLYPEDILUM SP. L.	TRIBELOS SP. L.	CRYPTOCHIRONOMUS SP. L.	CHIRONOMIDAE P.	DICROTENDIPES SP. L.	ENDOCHIRONOMOUS SP.	GLYPTOTENDIPES SP. L.	PROCLADIUS SP. L.	CHIRONOMINAE L.	TANYPODINAE L.	TRIBE CHIRONOMINI L.	TRIBE TANYTARSINI L.	TRIBE PENTANEURINIA L.	ORTHOCLADINAE L.	CERATOPOGONIDAE PROBEZZIA SP. L.	CERATOPOGONIDAE ALLUANDOMYIA SP. L.	GASTROPODA	AMNICOLIDAE	AMNICOLA SP.	LYROGYRUS SP.	CAMPELOMA DECISUM	PHYSIDAE PHYSA SP.	PLANORBIDAE HELISOMA SP.	UNIONIDAE	ELLIPTIO COMPLANATUS	SPHAERIDAE SPHAERIUM SP.	SPHAERIDAE PISIDIUM SP.	SPHAERIDAE
N-10 E	S-77.8																																	
A	M-77.8						9	2	2		1										3				3			1				1		
B	B-77.8				1		7	5				1	3	1			1	3	1		8				12	1	23	1	1	6			1	2
N-10 M	S-76.5																																	
A	M-76.5					3	2	3										5			1	5	1		3		3			1		23	1	
B	B-76.5				4	1	47	4	8	1						1	2	1	1			1			5	2	2			1		13		
N-10 W	S-76.5																																	
A	M-76.5						7	1	2						1						3		2		6						1			
B	B-76.5				3		42	4	2								1				14						3					2		
Zero E	S-87.6																																	
A	M-76.2						2						1								6						6			1				
B	B-76.2						7	1													4					2	3			1				
Zero M	S-88.0																																	
A	M-76.2				1		1															5					2					2		5
B	B-76.2	1				2	1			1			1				1	1	1					5			2			1				4
Zero W	S-90.7																																	
A	M-90.7							1	2					1				5		1							1					4		
B	B-90.2		1		4		24	8	7				9	3													1			1				
S-4 E	S-86.2																																	
A	M-77.8				2	1	12											3			7			4		5	20			1		6		2
B	B-78.3						14											1			19			1		4	8					11		
S-4 M	S-85.2																																	
A	M-76.9					1		8		1								3									2							11
B	B-76.8					1		2	2							2	1				1						7							12
S-4 W	S-86.3																																	
A	M-86.0				6	2	78	8	8	20			1								1						4							
B	B-85.0						10	1	2												1													
S-17 E	S-82.2																																	
A	M-80.1				1								1								14				11	10	2						1	
B	B-80.1												1								5				6	1							4	
S-17 M	S-81.0																																	
A	M-78.1				1		1		1															19			3					11	1	
B	B-78.0				1	5			3									1												1				
S-17 W	S-81.0																																	
A	M-81.0				1								1								4					3	1							
B	B-78.5						1						1								3						1							1

TABLE 20 RESULTS OF BENTHIC INVERTEBRATE SURVEY, HOOKSETT POND, MERRIMACK RIVER, AUGUST 12, 1975.

STATION 8/12/75	TEMP. °F	COELENTERATA HYDRA SP.	TURBELLARIA	CURTISIA FOREMANI	NEMERTEA	NEMATODA	BRYOZOAN STATOBLAST	OLIGOCHAETA	OLIGOCHAETA FRAGMENTS	STYLARIA SP.	NAIS SP.	SLAVINA SP.	HIRUDINEA	HELOBDELLA SP.	HELOBDELLA STAGNALIS	DINA SP.	FAMILY GLOSSIPHONIIDAE	CLADOCERA	COPEPODA	AMPHIPODA HYALELLA AZTECA	HYDRACARINA	EPHEMEROPTERA N.	BAETIDAE N.	BAETIDAE EPHEMERELLA SP. N.	EPHEMERIDAE EPHORON SP. N.	ODONATA GOMPHIDAE GOMPHUS SP. N.	LIBELLULIDAE MACROMIA SP. N.	TRICHOPTERA L.	TRICHOPTERA P.	PSYCHOMYIIDAE L.	PSYCHOMYIIDAE PSYCHOMYIA SP. L.	HYDROPTILIDAE L.	HYDROPSYCHIDAE L.	HYDROPSYCHIDAE CHEUMATOPSYCHE L.	LEPTOCERIDAE L.
N-10E	S-78.3																																		
A	M-78.5						1	149	27	34	1			2	2	11				1											4				
B	B-78.4							214	26	26	1		21	1	1	5							1					1		3	4	1			
N-10M	S-78.9																																		
A	M-77.8		1		1					1											1		1		3	1									
B	B-77.9				1	2	1											1			1				1										
N-10W	S-78.0																																		
A	M-77.7			1	1	1	1	110	12	11	8	1											1							2	6				
B	B-77.5						1	121	5	4	1					2															2				
Zero-E	S-80.4																																		
A	M-80.4						1	795	54															1											
B	B-80.8					2		242	18																				1						
Zero-M	S-89.8																																		
A	M-79.3							6		1			1								1	1			3										
B	B-78.2							3		1	1											1	1		3										
Zero-W	S-92.1																																		
A	M-83.8					2		36	1	4				3							1		1	1									1		
B	B-78.9			1				17	1														1	2											2
S-4E	S-84.0																																		
*A	M-84.0																																		
B	B-80.1						1	125	29	2				5		11	1						1												
S-4M	S-88.8																																		
A	M-78.2				3			4	1										1		1				6									1	
B	B-78.0							3			1													1	9										1
S-4W	S-87.0																																		
A	M-86.4		1	18	1		6	1399	136	5						2						1				1	1								1
B	B-84.2						2	844	34	1		1			1											1									
S-17E	S-81.4																																		
A	M-81.8			1			3	306	30	7	1			6		2			1	1								2			4				2
B	B-81.2			1		1	1	495	83	9	2			1		1				3								1			1				
S-17M	S-83.1																																		
A	M-78.8				2			9	2		3								4						7										1
B	B-78.1						1	8	1										1				1		4										
S-17W	S-81.0																																		
A	M-80.0	1					1	743	56	8				1		1													1		1				
B	B-79.0			30		1		669	56	9			2	1		1										1		1		1					1

*was not preserved when sampled

Continued

TABLE 20. (Continued)

STATION 8/12/75	TEMP. °F	COLEOPTERA ELMIDAE L.	ELMIDAE *DUBIRAPHIA* SP. L	DYTISCIDAE HYDROPORINAE L.	DIPTERA L.	CHIRONOMIDAE L.	CHIRONOMIDAE P.	*POLYPEDILUM* SP. L	*CRYPTOCHIRONOMUS* SP. L.	*TRIBELOS* SP. L.	*GLYPTOTENDIPES* SP. L.	*KIEFFERULUS* SP. L.	*PROCLADIUS* SP. L.	*DICROTENDIPES* SP. L.	*PSEUDOCHIRONOMUS* SP. L.	*CHIRONOMUS* SP. L.	TRIBE TANYTARSINI L.	TRIBE PENTANEURINI L.	TRIBE CHIRONOMINI L.	SUBFAMILY TANYPODINAE L.	TABANIDAE *CHRYSOPS* SP. L.	PSYCHODIDAE *PSYCHODA* SP. L.	CERATOPOGONIDAE *PROBEZZIA* SP. L.	CERATOPOGONIDAE *ALLURUDOMYIA* SP. L.	GASTROPODA	AMNICOLIDAE	AMNICOLIDAE *AMNICOLA* SP.	AMNICOLIDAE *LYROGYRUS* SP.	*CAMPELOMA DECISUM*	PLANORBIDAE *HELISOMA* SP.	PELECYPODA UNIONIDAE	SPHAERIIDAE	SPHAERIIDAE *SPHAERIUM* SP.	*PISIDIUM* SP.
N-10E	S-78.3																																	
A	M-78.5					2		9	1	1	3	1	3				1				1			1	1		20		3	4	2			
B	B-78.4		1			3		10			11		1				1										7	3	3		1		1	
N-10M	S-78.9																																	
A	M-77.8								2		5		1	1				1				1	2	9			1	1	1				12	2
B	B-77.9						1		2					1									1	6			2		1		2		23	3
N-10W	S-78.0																																	
A	M-77.7					2		7	1		1														1		2		2		3			
B	B-77.5					3		9		1	1		2														9	7	6	1	1		1	1
Zero-E	S-80.4																																	
A	M-80.4					13									2					9					1		5							
B	B-80.8			1		4		6					2		3			1					1				9	1	2					
Zero-M	S-89.8																																	
A	M-79.3					4																	2			3							21	2
B	B-78.2					4	2	1	1															11		2		2				1	27	1
Zero-W	S-92.1																																	
A	M-83.8					12	3	3	9		38							1	2												1		11	
B	B-78.9					6	4		6		9				27					2			1						1	1			7	5
S-4E	S-84.0																																	
*A	M-84.0																									1	11	4	3	2	3			7
B	B-80.1					1		4			1											1				30			9	6	1		7	
S-4M	S-88.8																																	
A	M-78.2			1			1		1		1												1	2			5		3				32	
B	B-78.0						1				1							5						2					1				29	
S-4W	S-87.0																																	
A	M-86.4		3	2	4	8		11	1	1	4		9														18	3	20		5		5	1
B	B-84.2		1			2		13	2				4				2					1	1				4		1		1			
S-17E	S-81.4																																	
A	M-81.8					1		2			2															12	20		3				1	
B	B-81.2	1				5		9	1		1		1			1		2									26	6		4				
S-17M	S-83.1																																	
A	M-78.8								1								1						1			14	18				1		21	
B	B-78.1																								1	3	22	4					20	7
S-17W	S-81.0																																	
A	M-80.0		1	1				6					6		1												11							1
B	B-79.0					5		19		3			1										1				5				1			

*was not preserved when sampled

TABLE 21. RESULTS OF BENTHIC INVERTEBRATE SURVEY, HOOKSETT POND, MERRIMACK RIVER, OCTOBER 8, 1975.

STATION 10/8/75	TEMP °F	TURBELLARIA *CURTISIA FOREMANI*	NEMERTEA	NEMATODA	BRYOZOAN STATOBLAST	OLIGOCHAETA	OLIGOCHAETA FRAGMENTS	*STYLARIA SP.*	*NAIS SP.*	*SLAVINA SP.*	HIRUDINEA	*HELOBDELLA SP.*	*HELOBDELLA STAGNALIS*	*PLACOBDELLA ORNATA*	*DINA SP.*	COPEPODA	OSTRACODA	ISOPODA *ASELLUS SP.*	AMPHIPODA *HYALELLA AZTECA*	HYDRACARINA	EPHEMEROPTERA BAETIDAE N.	BAETIDAE *BAETISCA* N.	HEPTAGENIIDAE *STENONEMA SP.*	ODONATA COENAGRIONIDAE N.	COENGRIONIDAE N. *DIDYMOPS SP.*	GOMPHIDAE *GOMPHUS SP.* N.	TRICHOPTERA L.	PSYCHOMYIIDAE L.	PSYCHOMYIIDAE *PSYCHOMYIA SP.*	LEPTOCERIDAE L.	LEPIDOPTERA *PARARGYRACTIS SP.*	COLEOPTERA ELMIDAE *DUBIRAPHIA SP.* L.
N-10 E	S-56.9																															
A	M-56.3			3		321	68	40	5	2		1	2		2	2		1	2					1								1
B	B-56.3	2		22		341	73	40	6	3		6			1	26	1	4	4			1					2		3	1		
N-10 M	S-56.0																															
A	M-55.9		7			3														1												
B	B-55.9		12	1		1	1													2												
N-10 W	S-56.3																															
A	M-55.8			11		91	5	6	3							1												1	3			
B	B-55.8	1	1	4	2	162	11	16	2	7			1	1														1	4			
Zero E	S-56.7																															
A	M-56.5		1			152	5	1								2										1			2			
B	B-56.7		1	1		3																										
Zero M	S-56.1																															
A	M-56.0		3			1																										
B	B-56.0																															
Zero W	S-57.6																															
A	M-57.5			6		3	13	1				1				1																
B	B-57.4			11		98	12			2																1		1				
S-4 E	S-57.0																															
A	M-56.9					255	78	12	1	3	1				1								1						2		1	
B	B-56.8	4				139	29	3	2			1	5		7	6			1				2							4	1	
S-4 M	S-56.1																															
A	M-56.3		23	3		13	5						1							7												
B	B-56.2		25	3		4	1	1												5												
S-4 W	S-56.3																															
A	M-56.3			2		1018	69	46	14	318						2					2				1				1			
B	B-56.3		1	3		640	35	54	11	145						1			1		1											1
S-17 E	S-56.8																															
A	M-56.8			7	1	136	20	10	42	1		1			2																	2
B	B-56.8			6		241	34	25	43			2			2											1						1
S-17 M	S-56.1																															
A	M-56.1		13	3		18	7	1		2										1												
B	B-56.1		15			6	2			9										1												
S-17 W	S-56.1																															
A	M-56.1			1		657	126	13		9					2	1																6
B	B-56.1			1		517	89	24	1	11						1													6			

Continued

TABLE 21. (Continued)

STATION 10/8/75	TEMP °F	ELMIDAE *ANCYRONYX SP. L.*	PYTISCIDAE *HYDROPORINAE SP. L.*	HYDROPHILIDAE *BEROSUS SP. L.*	DIPTERA A.	CHIRONOMIDAE L.	CHIRONOMIDAE P.	*GLYPTOTENDIPES SP. L.*	*CRYPTOCHIRONOMUS SP. L.*	*POLYPEDILUM SP. L.*	*PROCLADIUS SP. L.*	*CRICOTOPUS SP. L*	*PSECTROCLADIUS SP. L.*	*CHIRONOMUS SP. L.*	*TRIBELOS SP. L.*	TRIBE TANYTARSINI	TRIBE PENTANEURINI	SUBFAMILY TANYPODINAE	CERATOPOGONIDAE *PROBEZZIA SP. L.*	CERATOPOGONIDAE *ALLUAUDOMYIA SP. L.*	RHAGIONIDAE *ATHERIX SP. L.*	TABANIDAE *CHYRSOPS SP. L.*	GASTROPODA	AMNICOLIDAE *AMNICOLA SP.*	AMNICOLIDAE *LYROGYRUS SP.*	AMNICOLIDAE	*CAMPELOMA DECISUM*	ANCYLIDAE *FERRISSIA SP.*	PHYSICAE *PHYSA SP.*	PLANORBIDAE *HELISOMA SP.*	PELECYPODA UNIONIDAE	SPHAERIDAE *SPHAERIUM SP.*	SPHAERIDAE *PISIDIUM SP.*
N-10 E	S-56.9																																
A	M-56.3		1			10	1	6	1	1						1					1			7	11		3	3				4	1
B	B-56.3			1		25		4	2	5	1	2							2					11	5		5	2	1	2	1	1	1
N-10 M	S-56.0																																
A	M-55.9					4														1				1	2	7						45	10
B	B-55.9					4			2										3	5				5	5						1	30	1
N-10 W	S-56.3																																
A	M-55.8					21			3	25													3	4	7	3	1			1		2	2
B	B-55.8					18			1	11									1			1	1	1	8	8				1		5	
Zero E	S-56.7																																
A	M-56.5					5		1	11	26									3				1	6	4		8	1			3	1	
B	B-56.7																							3								8	2
Zero M	S-56.1																																
A	M-56.0								1															1								7	
B	B-56.0																																
Zero W	S-57.6																																
A	M-57.5					15		33	15					3			1									2						5	
B	B-57.4					8		22	6		1													2	3	1					2	2	
S-4 E	S-57.0																																
A	M-56.9					5		2		5	2		1											13	22		4		1	2		2	
B	B-56.8		1			6		1			2	1			1								2	16	36	1	19		10	2		6	5
S-4 M	S-56.1																																
A	M-56.3				1					1															2	5					2	246	14
B	B-56.2					1		2		2													1		1	4					2	121	42
S-4 W	S-56.3																																
A	M-56.3					170	1	1	9	2	13	2	11			3			3					3			12						
B	B-56.3					60		5	2	10	6		14	1				2						2			1				2		
S-17 E	S-56.8																																
A	M-56.8					116		12	4		3					2			1					6	2		2				1		
B	B-56.8					18		4	2										2					3	6		2				1	3	1
S-17 M	S-56.1																																
A	M-56.1					2			2															27	29	14					1	48	21
B	B-56.1					3																		46	12	5					2	38	17
S-17 W	S-56.1																																
A	M-56.1					62		7	2	44	2		2						2					6	2	1	7			1		1	1
B	B-56.1	1				22		1	1	1	4													5	7	3	11		1	1	1	1	3

relatively constant throughout the three sampling periods. In 1973, total numbers ranged from 5064 during June to 21,654 during October. In 1974, total numbers collected during each of the three surveys were 9146, 8536, and 10,791 in June, August and October, respectively.

The data in Tables 19 to 21 indicate that, as in past years, total numbers of organisms collected at mid-channel were lower than numbers on the east and west sides of the river. This is expected as the more rapidly flowing water at mid-channel results in a less suitable substrate for oligochaetes, dipterans, clams and detritus feeding snails, than in the littoral zones where currents are of a lesser magnitude. Previous sediment studies (NAI, 1970) indicated that the mid-channel portion of the river has a coarser, less organically-enriched substrate than does the shore. Such substrate usually results in a less suitable habitat for benthic macroinvertebrates (Gaufin, 1973). However, of the few mayflies (Ephemeroptera) collected in June and August, the numbers of *Epheron* spp. and *Ephemerella* spp., were generally higher in the mid-channel areas. These organisms are bottom clinging forms, as contrasted to burrowing forms (Needham *et al.*, 1935).

During the June 27 macrobenthic invertebrate sampling, Station N-10 produced the highest number of organisms collected during 1975 (Σ = 4642). Station Zero (Σ = 1428), S-4 (Σ = 3129) and S-17 (Σ = 3309) all produced fewer organisms than did the control station. Diversity of macrobenthos (number of taxa) was also less at southern stations. Station S-17 was the least diverse followed by S-4, Zero and N-10. The confluence of the discharge canal and river (Zero-West) contained a slightly greater number of taxa (23) than the western side of Station N-10 (20). For the most part, many of the same taxa were represented at both stations. Numbers of taxa collected which were common to only one of these stations (i.e., Psychomysidae at N-10) were too low to allow meaningful comparisons.

In August, the month highest ambient temperatures were recorded during benthic sampling, the number of organisms collected at

Station N-10 (Σ = 1080) was less than collected at Zero (Σ = 1504), S-4 (Σ = 2967) and (Σ = 2869). The number of taxa at Station Zero-West (24) was again similar to Station N-10 West (25). As in June, numbers of organisms in taxa unique to either location were low. A slightly lower number or taxa did occur at Station Zero as a whole (east, mid and west) and at S-4 and S-17.

During October, Station Zero produced the lowest number of organisms (Σ = 536). Both Stations S-4 (Σ = 3966) and S-17 (Σ = 2785) had higher numbers of benthos than did Station N-10 (Σ = 1724). Numbers of taxa were less at Station Zero (26) than at N-10 (45) but were comparable to N-10 at the remaining downstream stations.

In summary, with the exception of October, Station Zero produced the lowest numbers of benthic macroinvertebrates of all stations sampled. This is generally consistent with the findings of 1972 (NAI, 1973), 1973 (NAI, 1974) and 1974 (NAI, 1975). During the August and October surveys, Stations S-4 and S-17 had greater numbers of benthos than did Station N-10. Numbers of taxa collected at Station Zero were lower than at other stations during August and October and in June, lower at S-17 than at other stations. In general, the results of the 1975 benthic surveys reflected in part natural fluctuations in the macroinvertebrate community, combined with between station habitat differences, and possible thermal effects. The majority of macrobenthos at all stations in Hooksett Pond (dipterans and oligochaetes) are relatively resistant to elevated temperatures (Markowski, 1959; Trembley, 1961; Mann, 1965; Proffitt, 1969) which would make it less likely that a readily discernible impact would occur among these organisms. Bottom substrate at Station Zero (particularly the west bank) consists of a coarse sand which is a result of past discharge canal dredging activity and the high rate of flow from the Canal itself. Sand is a poor habitat which generally will support only a few representatives of a few species (Hynes, 1970). Because of this it is difficult to separate thermal/chemical effects from those caused by substrate, particularly at Station Zero.

6. Fisheries Surveys

The following section discusses results of the electrofishing, immature fish seining, and fyke netting programs for the 1975 sampling period. A finfish species list compiled from all sampling techniques appears in Appendix V.

a. Electrofishing

Sixteen fish species (1,975 individuals) were captured during the July, August and October electrofishing periods. Tables 22 to 24. contain the number of each species sampled at the six stations as well as the surface, mid-depth, and bottom water temperatures for each sampling period and are used to illustrate the relationship between the Merrimack Station discharge and the distribution of fishes in the Hooksett Pond littoral zones.

Pumpkinseed (*Lepomis gibbosus*), redbreasted sunfish (*L. auritus*), yellow perch (*Perca flavescens*), white sucker (*Catostomus commersoni*), and largemouth bass (*Micropterus salmoides*) were the most abundant species captured during the sampling period. Pumpkinseed were consistently the most abundant, while the rank of each other species within the top five varied. The relative abundance of white suckers decreased throughout the season, while that of largemouth bass increased.

The mean number of individuals per station for the five predominant fish species is presented in Table 25. These stations have been grouped according to their relation to the thermal discharge: i.e., control, mixing zone and far-field regions.

TABLE 22. CATCH PER ELECTROFISHING STATION, JULY 29 - AUGUST 1, HOOKSETT POND, MERRIMACK RIVER, 1975.

					PK	RBS	YP	BG	SM	LM	BB	YB	CP	Golden	Fallfish/northern creek chub	Shiner	white sucker	eel	Johnny darter	Margined mad tom		
STATION		TEMPERATURE (°F) SURF.	MID.	BOT.	*Lepomis gibbosus*	*Lepomis auritus*	*Perca flavescens*	*Lepomis macrochirus*	*Micropterus dolomieui*	*Micropterus salmoides*	*Ictalurus nebulosus*	*Ictalurus natalis*	*Esox niger*	*Notemigonus crysoleucas*	*Semotilus spp.*	*Notropis spp.*	*Catostomis commersoni*	*Anguilla rostrata*	*Etheostoma nigram*	*Noturus insignis*	Number of Species	TOTAL
N-9/N-10	East	80.2	80.3	81.0	8	12	13		1	3						6	1	2			8	46
	West	79.0	79.0	79.1	3		3			2	1		1			14	24	4	1	1	10	54
N-6/N-7	East	78.2	77.7	77.7	2	1	3			6					2	1	26	7			8	48
	West	77.3	77.5	77.8	3	8	1		1	1	1				8	8	6	3			10	40
Zero/S-1	East	86.0	77.0	77.7	28	31	1		1	9	1	2			1						8	74
	West	85.0	77.8	77.1	18	19			2		1				3		1				6	44
Old Canal	----	87.5	87.4	87.3	26	3	1	1	2	12											6	45
S-4/S-5	East	83.2	76.0	76.0	36	23	22		2	10	1	3					2	1			9	100
	West	86.0	76.2	76.0	16	4	1		1	1											5	23
S-17/S-18	East	81.5	77.5	77.5	7	4	2			1	2				1	1		2			8	20
	West	80.0	77.8	77.5	2	13			2												3	17
TOTAL					149	118	47	1	12	45	7	5	1	0	15	30	60	19	1	1	N/A	511

TABLE 23. CATCH PER ELECTROFISHING STATION, AUGUST 26 - 27, HOOKSETT POND, MERRIMACK RIVER, 1975.

STATION		TEMPERATURE (°F) SURF.	MID.	BOT.	*Lepomis gibbosus*	*Lepomis auritus*	*Perca favescens*	*Lepomis macrochirus*	*Micropterus dolomieui*	*Micropterus salmoides*	*Ictalurus nebulosus*	*Ictalurus natalis*	*Esox niger*	*Notemigonus crysoleucas*	*Semotilus* spp.	*Notropis* spp.	*Catostomus commersoni*	*Anguilla rostrata*	*Etheostoma nigram*	*Noturus insignis*	Number of Species	TOTAL
N-9/N-10	East	73.0	72.5	72.5	13	3	3		1	1							2				6	23
	West	72.1	72.1	72.1	5	2	2			4			1		6	5	17	8			9	50
N-6/N-7	East	73.4	72.0	72.0	9	3	7			5	4		2		2		33	5			9	70
	West	73.0	72.0	72.0	9	6	10		3	10					18		13	7			8	76
Zero/S-1	East	81.0	71.5	71.5	38	22	2		2	6	9							1			7	80
	West	79.5	77.5	77.5	89		6			19	14			16	3		1	3			8	151
Old Canal	----	82.5	82.2	82.2	77	15	2		1	8	1										6	104
S-4/S-5	East	77.0	75.0	71.2	21	6	8		1	11	2	1			3	14	2	3			11	72
	West	77.5	77.0	74.0	34	12	4		1	2											5	53
S-17/S-18	East	77.5	75.5	73.0	37	5	4			9							1	5			6	61
	West	78.0	76.0	72.5	14	28				1								2			4	45
TOTAL					346	102	48	0	9	76	30	1	3	16	32	19	69	34	0	0	N/A	785

TABLE 24. CATCH PER ELECTROFISHING STATION, OCTOBER 9, 10, AND 13, HOOKSETT POND, MERRIMACK RIVER, 1975.

STATION		TEMPERATURE (°F) SURF.	MID.	BOT.	*Lepomis gibbosus*	*Lepomis auritus*	*Perca flavescens*	*Lepomis macrochirus*	*Micropterus dolomieui*	*Micropterus salmoides*	*Ictalurus nebulosus*	*Ictalurus natalis*	*Esox niger*	*Notemigonus crysoleucas*	*Semotilus spp.*	*Notropis spp.*	*Catostomus commersoni*	*Anguilla rostrata*	*Etheostoma nigram*	*Noturus insignis*	Number of Species	TOTAL
N-9/N-10	East	55.5	54.8	54.8	11		2			10						1	6				5	30
	West	54.0	54.0	54.0	14	5	9		5	1	7	3					6				8	50
N-6/N-7	East	54.5	54.5	54.5	38	6	8		1	16	3	2	1	2	8	13	13		1		13	112
	West	52.8	52.8	52.8	1		2		1	2							3				5	9
Zero/S-1	East	62.5	54.7	54.2	39	7			3	12	4	1			1			3		1	9	71
	West	59.5	59.0	56.1	86	12	1		1	13	1									1	7	115
Old Canal	----	65.0	65.1	65.1	42	4	4		1	31	2							1			7	85
S-4/S-5	East	54.2	53.5	53.3	36	12			3	6	1		1					2			7	61
	West	61.0	56.8	56.1	38	1	16		3	9	1	1					7				8	76
S-17/S-18	East	54.3	54.3	54.2	24	2			1		8									1	5	36
	West	57.0	56.9	56.9	20	4	3		3			2						2			6	34
TOTAL					349	53	45	0	22	100	27	9	2	2	9	14	35	8	1	3	N/A	679

TABLE 25. MEAN # INDIVIDUALS PER ELECTROFISHING STATION FOR PREDOMINANT FISH SPECIES, HOOKSETT POND, MERRIMACK RIVER, 1975.

SAMPLING PERIOD	SAMPLE GROUP*	PUMPKINSEED	REDBREAST SUNFISH	YELLOW PERCH	LARGEMOUTH BASS	WHITE SUCKER
July - August	Control	4.00	5.25	4.25	3.00	14.25
	Mixing	24.80	16.00	5.00	6.40	0.60
	Far-Field	4.50	8.50	1.00	0.50	0.00
August	Control	9.00	3.50	5.50	5.00	16.25
	Mixing	51.80	11.00	4.40	9.20	0.60
	Far-Field	25.50	16.50	2.00	5.00	0.50
October	Control	16.00	2.75	5.25	7.25	7.00
	Mixing	48.20	7.20	4.20	14.20	1.80
	Far-Field	22.00	3.00	1.50	0.00	0.00

* Control = N9/N10 and N6/N7 (4 stations)
Mixing = O/S1, Old Canal and S4/S5 (5 stations)
Far-Field = S17/S18 (2 stations)

The two sunfish species and largemouth bass were predominant in the mixing zone and far-field regions. Yellow perch were found infrequently downstream of the mixing zone, while white suckers predominated in the regions north of the discharge canal.

The greatest number of species was collected at Stations N-9/N-10 and N-6/N-7 during July (10 species), at S-4/S-5 in August (11 species), and at N-6/N-7 during October (13 species). Fewer species were always encountered at other stations and dates.

Catch per electrofishing station within the temperature ranges experienced during 1975 is plotted in Figure 13. Catch per station was computed by dividing the total number of individuals captured within a

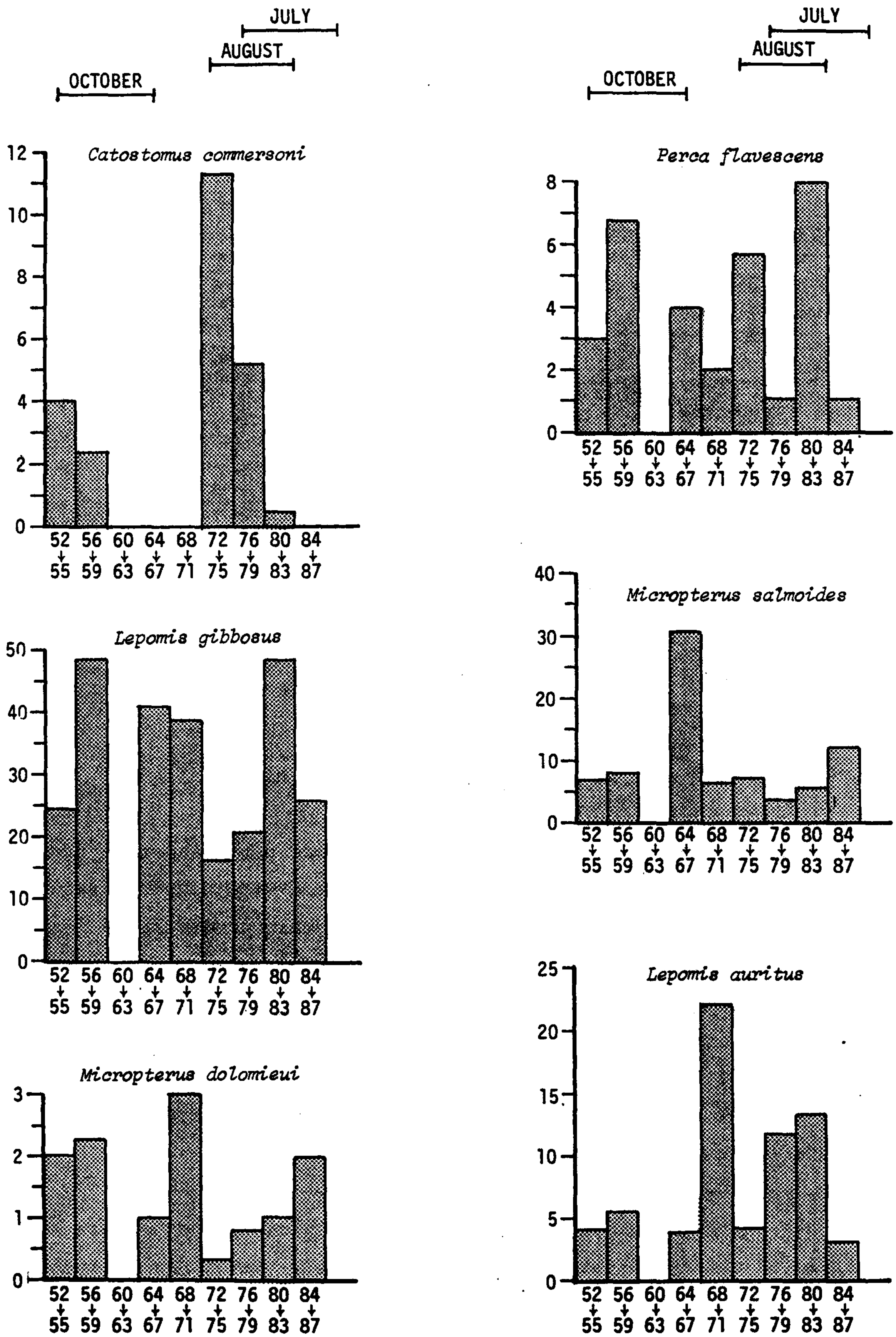

Figure 13. Catch per unit electrofishing effort per 4°F interval, Hooksett Pond, Merrimack River, 1975.

4°F temperature class (measured at mid-depth) by the number of stations sampled within that class throughout the season. This removed the bias exerted by unequal electrofishing effort among the temperature classes. Unlike the bimodal distributions exhibited by the 1974 data (NAI, 1975), there was no observable relationship between water temperature and distribution of the six major fish species in Hooksett Pond. The wide temperature range (52.8 - 87.4°F) throughout the 1975 field season is one reason a distinct distribution pattern was not observed. In addition, temperature ranges during the October and the July and August electrofishing periods did not overlap.

Distinct relationships between fish distribution and water temperature are sometimes used as indicators of thermal preference for each species; however, as pointed out by Stauffer *et al.* (1975), Ferguson (1958), and Barans and Tubb (1973), other factors such as thermal history, light, feeding activity, social behavior, age and sex of the fish, and dissolved oxygen concentrations can also influence temperature preferenda and fish distribution. The difficulty of randomly sampling complex environments also makes the field observation of thermal preferences very difficult (Stauffer *et al.*, 1975). On the other hand, the absence of a distinct distributional pattern related to thermal intervals may suggest that indeed the effect of temperature plays a lesser role in fish distribution compared to other factors such as habitat availability. Data from previous years' research on Hooksett Pond reinforce this conclusion (NAI, 1973; 1974; 1975).

b. Immature Fish Seining

Seine hauls were employed to illustrate the distribution of young fishes in relation to the Merrimack Station discharge. Seining yielded a total of 9,609 specimens representing 14 species. Total catch was distributed as shown in Table 26. These data are expressed as catch-per-unit-effort by species in Table 27. White suckers (*Catostomus commersoni)* and shiners (*Notropis* spp.) were the two predominant

TABLE 26. NUMBERS OF INDIVIDUALS CAPTURED BY SEINING, HOOKSETT POND, MERRIMACK RIVER, 1975.

	NORTH			SOUTH		
	N-10	N-7	ZERO	S-2	S-17	TOTAL
East	862	2,534	52	250	148	3,846
West	1,839	142	2,084	1,492	206	5,763
Total	2,701	2,676	2,136	1,742	354	
	5,377			2,096		9,609

TABLE 27. CATCH PER MINNOW SEINE EFFORT, 1975. BASED ON WEEKLY HAULS AT 5 STATIONS. NUMBERS IN PARENTHESES REPRESENT NUMBER OF HAULS IN MEAN, HOOKSETT POND, MERRIMACK RIVER, 1975.

	NORTH			SOUTH		MEANS		
MONTH/SPECIES	N-10	N-7	ZERO	S-2	S-17	$\bar{X}$ NORTH	$\bar{X}$ SOUTH	$\bar{X}$
May								
Lepomis gibbosus	1.70(10)	0.00(4)	0.00(4)	0.00(4)	0.25(4)	1.21(14)	0.12(8)	0.69(26)
L. auritus	0.70	0.00	0.00	0.00	0.25	0.50	0.12	0.31
Etheostoma nigrum	0.30	0.00	0.00	0.00	0.00	0.21	0.00	0.12
Notropis spp.	34.59	1.50	0.00	0.00	0.00	25.14	0.00	13.54
Ictalurus natalis	0.00	0.25	0.00	0.00	0.00	0.07	0.00	0.04
Larvae	present	absent	absent	absent	absent			
June								
Lepomis gibbosus	0.05(20)	0.00(8)	0.88(8)	0.00(8)	0.00(8)	0.04(28)	0.00(16)	0.15(52)
Perca flavescens	8.85	0.88	0.88	1.62	2.00	6.57	1.81	4.23
Micropterus salmoides	1.45	1.38	2.75	0.88	0.00	1.43	0.44	1.33
Etheostoma nigrum	1.35	0.00	10.50	2.50	0.75	0.96	1.62	2.63
Catostomus commersoni	18.75	167.50	87.50	43.25	0.38	61.25	21.82	53.15
Notropis spp.	52.45	28.38	59.88	86.25	24.25	45.57	55.25	50.75
Lepomis auritus	0.00	0.00	0.50	4.88	0.00	0.00	2.44	0.83
Notemigonus crysoleucas	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.02
Ictalurus natalis	0.00	0.00	0.00	0.12	0.00	0.00	0.06	0.02
Esox niger	0.00	0.00	0.00	0.25	0.50	0.00	0.38	0.12
Semotilus sp.	0.00	0.00	0.00	0.12	0.00	0.00	0.06	0.02
Larvae	present*	present*	present*	absent*	present*			
July								
Micropterus salmoides	0.67(15)	0.33(6)	0.50(6)	1.00(6)	0.67(6)	0.57(21)	0.83(12)	0.64(39)
Micropterus dolomieui	0.40	0.00	1.67	0.33	0.00	0.28	0.17	0.46
Esox niger	0.07	0.00	0.00	0.00	0.00	0.05	0.00	0.02
Etheostoma nigrum	6.73	0.50	3.50	3.17	0.17	4.95	1.67	3.72
Catostomus commersoni	0.67	2.17	0.00	0.17	0.00	1.10	0.08	0.62
Ictalurus nebulosus	0.07	0.00	0.00	0.00	0.00	0.05	0.00	0.02
Notropis spp.	43.73	163.83	0.33	92.67	25.83	78.05	59.25	60.31
Lepomis auritus	0.00	0.17	0.33	0.00	0.67	0.05	0.33	0.18
Lepomis gibbosus	0.00	0.00	0.33	0.50	0.67	0.00	0.58	0.23
Semotilus spp.	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.10
Larvae	absent	absent	absent	absent	absent			

*Larvae becoming large enough to be identified.

Continued

TABLE 27. (Continued)

MONTH/SPECIES	NORTH			SOUTH		MEANS		
August	N-10	N-7	ZERO	S-2	S-17	$\bar{X}$ NORTH	$\bar{X}$ SOUTH	$\bar{\bar{X}}$
Lepomis gibbosus	0.12(25)	0.70(10)	0.10(10)	0.40(10)	0.90(10)	0.28(35)	0.65(20)	0.37(65)
Lepomis auritus	0.12	0.00	0.70	0.80	2.00	0.08	1.40	0.58
Micropterus salmoides	0.12	0.10	0.00	0.90	0.10	0.11	0.50	0.22
Micropterus dolomieui	0.40	0.00	0.10	0.50	0.10	0.28	0.30	0.26
Etheostoma nigrum	0.56	0.30	0.00	0.00	0.00	0.48	0.00	0.26
Ictalurus nebulosus	0.28	0.00	0.00	0.00	0.10	0.20	0.05	0.12
Catostomus commersoni	0.04	0.00	0.00	0.00	0.00	0.03	0.00	0.02
Notropis spp.	0.68	0.40	0.30	0.30	0.10	0.60	0.20	0.43
Ictalurus natalis	0.00	0.00	0.00	0.20	0.30	0.00	0.25	0.08
Noturus insignis	0.00	0.00	0.00	0.00	0.10	0.00	0.05	0.02
Larvae	absent	absent	absent	absent	absent			
September								
Micropterus salmoides	0.05(20)	0.00(8)	0.12(8)	0.00(8)	0.00(8)	0.04(28)	0.00(16)	0.04(52)
Micropterus dolomieui	0.05	0.00	0.25	0.00	0.00	0.04	0.00	0.06
Etheostoma nigrum	0.10	0.00	0.00	0.00	0.00	0.07	0.00	0.04
Notropis sp.	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.02
Catostomus commersoni	0.00	0.00	0.00	0.12	0.00	0.00	0.06	0.02
Lepomis gibbosus	0.00	0.00	0.00	0.50	0.00	0.00	0.25	0.08
Larvae	absent	absent	absent	absent	absent			
SEASON MEANS								
Catostomus commersoni	4.29(90)	37.58(36)	19.44(36)	0.17(36)	0.08(36)	13.80(126)	4.88(72)	11.92(234)
Esox niger	0.01	0.00	0.00	0.06	0.11	<0.01	0.08	0.03
Etheostoma nigrum	1.63	0.17	2.92	1.08	0.19	1.21	0.64	1.30
Ictalurus nebulosus	0.09	0.00	0.00	0.00	0.03	0.06	0.01	0.04
Lepomis auritus	0.11	0.03	0.36	1.31	0.69	0.09	1.00	0.38
L. gibbosus	0.23	0.19	0.28	0.31	0.39	0.22	0.35	0.27
Micropterus dolomieui	0.09	0.00	0.36	0.19	0.03	0.13	0.11	0.16
M. salmoides	0.48	0.39	0.72	0.61	0.14	0.45	0.38	0.47
Notemigonus crysoleucas	0.00	0.00	0.03	0.00	0.00	0.00	0.00	<0.01
Notropis spp.	22.98	33.89	13.47	34.69	9.72	26.10	22.21	22.96
Perca flavescens	1.97	0.19	0.19	0.36	0.44	1.46	0.40	0.94
Semotilus spp.	0.00	0.00	0.11	0.03	0.00	0.00	0.01	0.02
Noturus insignis	0.00	0.00	0.00	0.00	0.03	0.00	0.01	<0.01
Ictalurus natalis	0.00	0.03	0.00	0.08	0.08	0.00	0.07	0.03

species caught during the 1975 season. *Notropis* spp. dominated the monthly catches from May through July, but were found principally at the north stations during May. After June, their distribution among the north and south stations was rather homogeneous, although during July fewer were caught at Station Zero than at either the north or south stations. Overall, more white suckers were captured at north stations than at south stations, although this was primarily due to their predominance at N-7 during June and July. This contrasts with the 1974 season when suckers were more prevalent at the southern stations during June and July. No white suckers were caught while seining in May; their distribution throughout Hooksett Pond was homogeneous during August and September.

Pumpkinseed, which were second in total abundance during 1974, and juveniles of other important species such as smallmouth bass, largemouth bass, and yellow perch were found less frequently in 1975 than young *Notropis* spp. and white suckers. Pumpkinseed were the most abundant species at the southern stations and at Station Zero except during the month of May. Smallmouth bass were first taken by seining during July, and were evenly distributed throughout Hooksett Pond for the remainder of the season. Largemouth bass were found primarily at northern stations and Station Zero in June, but were present in slightly greater numbers at the southern stations during July and August. Yellow perch were seined only in June, when they were most abundant at Station N-10.

Larval and post-larval fishes were observed at most stations during June. The larvae were large enough to be captured by seine and included in the catch-per-effort statistics beginning in July. No larvae were observed after June at any station (Table 27). This was expected since all major species in Hooksett Pond spawn during the spring and early summer.

In years prior to 1974, the area under the direct influence of the discharge (Station Zero to S-2) became devoid of juvenile fishes when water temperatures reached their annual maximum (85-90°F) during July (NAI, 1974). Juvenile abundance in 1975 followed this trend; the relatively high numbers of juveniles seined in June fell off sharply during July and August when the water temperatures in the vicinity of the discharge rose to 87-95°F. Centrarchid abundance, which rose in July and August of 1974 (NAI, 1975) did not exhibit a similar increase in 1975. This may be indicative of poor 1975 nesting success caused by abnormally high, cold waters during the June nesting period (Figure 2).

As with the electrofishing data, catch-per-unit of seine effort within various temperature ranges was computed for the five most abundant species and is presented in Figure 14. As in 1974, fallfish (*S. corporalis*) were not included because of their infrequent occurrences in the seine hauls. Modal temperatures based on seine data for these five species during 1974 (NAI, 1975) and 1975 are listed below:

	MODE °F	
SPECIES	1975	1974
Lepomis gibbosus	86.0-89.9	89.0-92.9
Perca flavescens	74.0-77.9	69.0-72.9
Micropterus dolomieui	86.0-89.9	89.0-92.9
Catostomus commersoni	70.0-73.9	77.0-80.9
Notropis hudsonius	82.0-85.9	77.0-80.9

In general, there was good correlation between the modal temperatures observed during 1974 and 1975 for pumpkinseed and smallmouth bass; apparent preferred temperatures do not coincide as well for the other three species. There was also a correlation between the modal seining temperature and the 1974 electrofishing modal temperature of 69-71°F (NAI, 1975) for white suckers. However, since catch data for a species is influenced by its relative susceptibility to the sampling gear as well as its actual distribution throughout the physical environment, the correlation of temperature modes between electrofishing and seining samples may be an artifact of sampling bias. In 1975 as in 1974, the two centrarchid species, *Micropterus dolomieui* and *Lepomis gibbosus*, were seined at the highest temperatures.

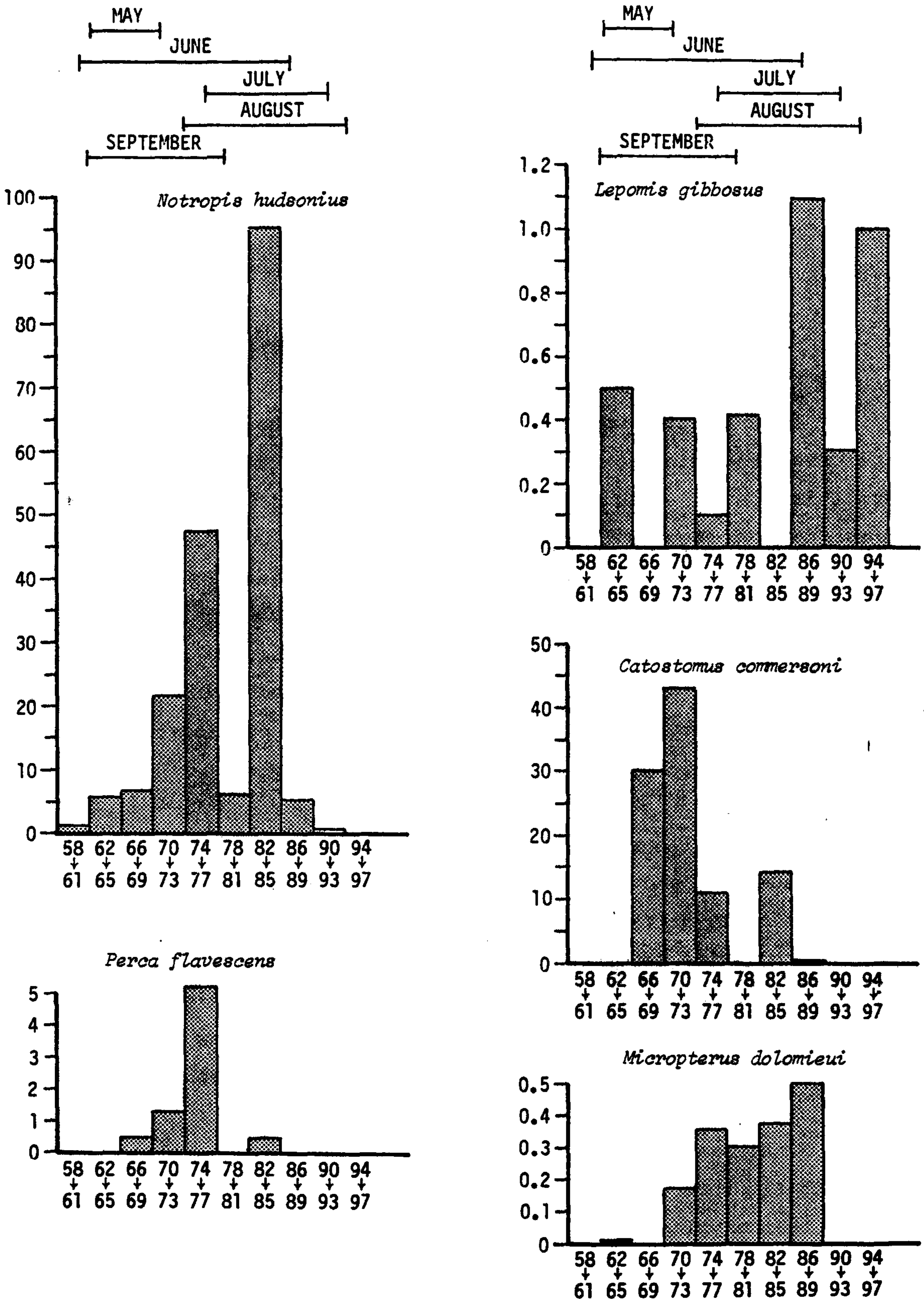

Figure 14. Catch per unit seining effort per 4°F interval, Hooksett Pond, Merrimack River, 1975.

As reported for 1974 (NAI, 1975), it is difficult to compare the results of electrofishing with those of seining because of the different sizes of the individuals captured by each method. In addition, the 1975 samples cannot be compared because there was no definite thermal distribution in the electrofishing samples to correlate with modes in the seining samples.

c. Fyke Netting

Fyke netting was employed to illustrate the distribution of larger fishes within Hooksett Pond in relation to the Merrimack Station thermal discharge. This method during 1975 yielded 2855 specimens representing 18 species (Table 28). One rainbow trout (*Salmo gairdneri*), a species not previously captured from Hooksett Pond by fyke netting, and a brook trout (*Salvelinus fontinalis*), which has not been collected in this river section since 1968 (Wightman, 1971) were both taken during 1975. In addition, walleye pike (*Stizostedion vitreum*) and tadpole madtom (*Noturus gyrinus*), species captured previously but absent from the 1974 samples, were also taken during 1975.

Brown bullheads, pumpkinseed, white suckers, yellow perch, redbreast sunfish, and smallmouth bass were the most frequently captured species during 1975 (Table 28). White perch were also abundant. Brown bullheads and white suckers predominated at the north stations, while pumpkinseed and suckers were predominant at the southern stations. In 1973 and 1974, pumpkinseed were the most abundant species south of the discharge; brown bullheads predominated both north and south in 1972.

Analysis of variance (ANOVA) (Kirk, 1968) was employed to test the hypothesis that fish distribution in Hooksett Pond was not homogeneous and that any lack of homogeneity may have been related to the thermal discharge. Results of ANOVA tests comparing catch-per-unit-effort among various locations are presented in Tables 28-32. In general, a significant north/south difference in these tables indicates

TABLE 28. MONTHLY MERRIMACK RIVER FYKE NET CATCH TOTALS, BY STATIONS. HOOKSETT POND, MERRIMACK RIVER, 1975.

	May 29 - June 6				June 25 - 27				July 23 - 25				Aug. 20 - 22				Sept. 17 - 19				Oct. 31-Nov. 5				TOTALS		
	1*	2*	3*	4*	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	North	South	Grand
Anguilla rostrata	1	0	0	2	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	4	3	7
Catostomus commersoni	13	17	38	6	60	2	58	4	27	6	24	6	13	11	11	1	125	18	31	17	4	18	0	0	314	196	510
Esox niger	0	0	0	0	1	0	1	0	2	1	0	0	2	0	0	2	1	3	0	1	0	3	0	0	13	4	17
Ictalurus natalis	2	0	0	1	3	0	0	0	3	3	0	0	4	5	0	0	6	9	0	0	2	1	0	0	38	1	39
I. nebulosus	4	1	5	4	24	4	87	15	32	20	8	5	204	34	0	47	366	94	1	12	11	38	0	0	832	184	1016
Lepomis auritus	0	1	0	5	3	0	1	0	2	2	0	7	7	17	2	5	7	40	1	8	0	0	0	21	79	50	129
L. gibbosus	2	2	41	52	10	7	86	13	10	7	8	13	12	28	61	23	39	37	25	25	7	10	2	49	171	398	569
Micropterus dolomieui	1	4	3	10	1	2	2	11	0	16	2	19	7	17	2	10	1	15	0	4	0	1	0	0	65	63	128
M. salmoides	0	0	0	0	0	0	0	0	0	0	0	1	5	2	0	0	4	2	1	0	1	0	0	0	14	2	16
Morone americana	1	0	7	10	7	1	12	0	10	1	4	0	6	1	2	0	4	4	16	0	1	0	0	0	36	51	87
Notemigonus crysoleucas	0	0	1	0	0	0	18	3	0	0	0	1	0	0	0	0	6	0	0	0	1	2	1	0	9	24	33
Noturus gyrinus	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Noturus insignis	0	1	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	0	7
Perca flavescens	26	19	0	34	32	7	7	12	9	10	0	4	7	11	2	5	30	36	1	5	9	13	0	3	209	73	282
Salmo gairdneri	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Salvelinus fontinalis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Semotilus corporalis	0	0	0	0	0	0	0	0	1	4	0	0	0	1	0	0	0	0	0	1	0	2	0	2	8	3	11
Stizostedion vitreum	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
TOTAL																									1801	1054	2855

* STATION CODE

1 = N-10W
2 = N-10E
3 = S- 2W
4 = S- 3E

TABLE 29. ANALYSIS OF VARIANCE FOR MERRIMACK RIVER FYKE NET CATCHES OF *PERCA FLAVESCENS* (AFTER LOG TRANSFORMATION). HOOKSETT POND, MERRIMACK RIVER, 1975.

SOURCE OF VARIATION	DEGREES OF FREEDOM	MEAN SQUARE	F
Month (M)	4	1843.1616	4.542**
Station (S)	3	4174.8448	10.289**
N/S	1	11422.8778	28.151**
E/W	1	26.9363	0.066NS
N/S x E/W	1	1074.7200	2.649NS
M x S	12	1296.1478	3.194*
Error	18	405.7770	

TABLE OF MEANS

	LOCATION				
MONTH	NE	NW	SE	SW	$\bar{X}$
May	.703270	1.113943	sw .000000	.867200	.709147
June	.326606	.953571	.598640	.422549	.575341
July	.544068	.477121	.301030	.000000	.330555
August	.565166	.437530	.349485	.176091	.382068
September	.981893	.900530	.349485	.088046	.599988
$\bar{X}$	.624200	.739049	.355253	.310777	$\bar{\bar{X}}$ =.505223

$\bar{X}_N$ = .678602 $\bar{X}_E$ = .496804

$\bar{X}_S$ = .331845 $\bar{X}_W$ = .513643

TABLE 30. ANALYSIS OF VARIANCE FOR MERRIMACK RIVER FYKE NET CATCHES OF *ICTALURUS NEBULOSUS* (AFTER LOG TRANSFORMATION). HOOKSETT POND, MERRIMACK RIVER, 1975.

SOURCE OF VARIATION	DEGREES OF FREEDOM	MEAN SQUARE	F
Month (M)	4	4519.2288	10.422**
Station (S)	3	11045.7344	25.523**
N/S	1	16192.310	37.415**
E/W	1	3529.156	8.155*
N/S x E/W	1	13415.737	30.999**
M x S	12	4431.6816	10.240**
Error	18	432.7779	
Total	37		

TABLE OF MEANS

	LOCATION				
MONTH	NE	NW	SE	SW	$\bar{X}$
May	.088046	.477121	.397940	.301030	.275535
June	.301030	.909771	.661109	1.355692	.806901
July	.736743	.928666	.326606	.471004	.615755
August	.946047	1.712032	1.085863	.0000	.935985
September	1.189425	1.962139	.602060	.088046	.960416
$\bar{X}$	.652258	1.278037	.638802	.443154	$\bar{\bar{X}}$ =.742254
N	10	9	9	10	38

$\bar{X}_N$ = .948680 $\bar{X}_E$ = .645884

$\bar{X}_S$ = .535829 $\bar{X}_W$ = .838625

TABLE 31. ANALYSIS OF VARIANCE FOR MERRIMACK RIVER FYKE NET CATCHES OF *MICROPTERUS DOLOMIEUI* (AFTER LOG TRANSFORMATION). HOOKSETT POND, MERRIMACK RIVER, 1975.

SOURCE OF VARIATION	DEGREES OF FREEDOM	MEAN SQUARE	F
Month (M)	4	382.7729	0.971^{NS}
Station (S)	3	3336.6016	8.466^{**}
N/S	1	2.1400	0.005^{NS}
E/W	1	9846.4800	24.985^{**}
N/S x E/W	1	161.1848	0.409^{NS}
M x S	12	942.1132	2.391^{*}
Error	18	394.0960	

TABLE OF MEANS

	LOCATION				
MONTH	NE	NW	SE	SW	$\bar{X}$
May	.238560	.176091	.397940	.544068	.356548
June	.238561	.088046	.565166	.150515	.260572
July	.678490	.000000	.759257	.150515	.397066
August	.715682	.389075	.349485	.150515	.401189
September	.676091	.088046	.287016	.000000	.262788
$\bar{X}$	.509477	.145158	.479976	.199122	$\bar{\bar{X}}$ =.334532

$\bar{X}_N$ = .336905 $\bar{X}_E$ = .495503

$\bar{X}_S$ = .332158 $\bar{X}_W$ = .173560

TABLE 32. ANALYSIS OF VARIANCE FOR MERRIMACK RIVER FYKE NET CATCHES OF *LEPOMIS GIBBOSUS* (AFTER LOG TRANSFORMATION). HOOKSETT POND, MERRIMACK RIVER, 1975.

SOURCE OF VARIATION	DEGREES OF FREEDOM	MEAN SQUARE	F
Month (M)	4	1822.6864	2.718^{NS}
Station (S)	3	3329.8432	4.965^{*}
N/S	1	8475.7559	12.638^{**}
E/W	1	1173.8960	1.750^{NS}
N/S x E/W	1	339.8777	0.507^{NS}
M x S	12	1954.0896	2.914^{*}
Error	18	670.6346	
Total	37		

TABLE OF MEANS

	LOCATION				
MONTH	NE	NW	SE	SW	$\bar{X}$
May	.176091	.000	1.217483	1.132113	.638982
June	.422549	.458227	.621519	1.348287	.712645
July	.422549	.539590	.608741	.451545	.505606
August	.764136	.598640	.826606	1.162655	.838009
September	1.007470	1.016711	.838346	.645017	.876886
$\bar{X}$	.558559	.580704	.778656	.947922	$\bar{\bar{X}}$ =.718396

$\bar{X}_N$ = .569049 $\bar{X}_E$ = .662815

$\bar{X}_S$ = .867743 $\bar{X}_W$ = .773977

TABLE 33 ANALYSIS OF VARIANCE FOR MERRIMACK RIVER FYKE NET CATCHES OF *CATOSTOMUS COMMERSONI* (AFTER LOG TRANSFORMATION). HOOKSETT POND, MERRIMACK RIVER, 1975.

SOURCE OF VARIATION	DEGREES OF FREEDOM	MEAN SQUARE	F
Month (M)	4	3171.0352	1.753^{NS}
Station (S)	3	3145.3024	1.739^{NS}
N/S	1		
E/W	1		
N/S x E/W	1		
M x S	12	1544.0406	0.854^{NS}
Error	18	1808.6960	
Total	37		

TABLE OF MEANS

MONTH	NE	NW	SE	SW	$\bar{X}$
	LOCATION				
May	.650514	.740362	1.278753	.301030	.653701
June	.176091	.661109	.287016	.881713	.501482
July	.389075	.877937	.389075	.690105	.586548
August	.520696	.437530	.088046	.520696	.391742
September	.627636	1.461362	.650514	.940406	.919980
$\bar{X}$	.472802	.846248	.456450	.666790	$\bar{\bar{X}}$ =.608427

$\bar{X}_N$ = .649697 $\bar{X}_E$ = .465056

$\bar{X}_S$ = .567155 $\bar{X}_W$ = .751796

that the mean catch per fyke net-night, averaged over the season, differed significantly between stations north and south of the discharge. Similarly, east/west significance indicates that the mean catch on one river bank was greater than on the other. Significance of the east/west x north/south interaction term indicates a general inconsistency in the pattern of the catch rates at the four stations with peak catches occurring at different locations at different times. This interaction significance suggests species mobility because the greatest numbers do not occur consistently at any sampling location. Variation among months is expected; this represents the contributions of recruitment and mortality to the monthly catches. Significance of the month x station interaction term further indicates an inconsistent pattern in the catch at each location throughout the fyke net season.

Monthly differences were significant ($p < .01$) for yellow perch and brown bullheads, but were not significant ($p > .05$) for smallmouth bass, pumpkinseed or white suckers. In contrast to this, monthly differences were significant ($p < .05$) for all five species during 1974 (NAI, 1975). During 1975, yellow perch were captured in greatest numbers during May, while brown bullheads were most frequently netted during September (Tables 29 and 30). Brown bullheads were least abundant during May, whereas fewest yellow perch were captured in July.

A progressive seasonal increase in number of fish captured reflects recruitment and growth of the young fish, which become more vulnerable to fyke netting as the season progresses. The high capture rate of yellow perch during May 1975, which was not noticed in 1973 or 1974 (NAI, 1974; 1975), may have been the result of increased activity during the spawning period. An autumnal decline in smallmouth bass catch which was observed in 1972 through 1974 (NAI, 1973; 1974; 1975) also occurred during 1975 (Table 31). Reasons for this decline may include (1) reduced abundance due to mortality (natural, sport fishing, and injury related to previous fyke netting and handling) (2) reduced catchability as a result of either decreasing water temperatures as the season progresses, which would tend to reduce smallmouth bass activity, or the learning on the part of the fish (net avoidance).

Station differences were significant ($p < .05$) for all major species except white suckers. This indicates that suckers occurred at all of the stations in approximately equal abundance when averaged throughout the fyke netting season. Analysis of station differences by partitioning into north/south and east/west components revealed that north/south differences were significant ($p < .01$) for yellow perch, pumpkinseed and brown bullheads, but were not significant ($p > .05$) for smallmouth bass. East/west differences were significant for smallmouth bass ($p < .01$) and brown bullheads ($p < .05$), but were not significant for yellow perch or pumpkinseed. The interaction term was significant only for brown bullheads (Table 30). Of the three species which exhibited significant north/south differences, yellow perch and brown bullheads were captured more frequently to the north, while pumpkinseed predominated south of the discharge (Tables 29,30,32). During 1974, yellow perch were caught in significantly greater numbers south of the discharge canal (NAI, 1975). As in 1974, the interaction terms for smallmouth bass and pumpkinseed were not significant, implying little movement around the pond. This adds further credence to the arguments expressed previously that the distribution of these species is affected more by available habitat than by changing water temperature. Unlike 1974, however, the interaction term for yellow perch was not significant in 1975, suggesting that yellow perch did not move around Hooksett Pond in response to changing temperatures as reported for the 1974 study year (NAI, 1975). Neill and Magnuson (1974), Ferguson (1958), and Kelso (1974, 1976) report that yellow perch and brown bullheads exhibit this form of thermoregulatory behavior.

Constants computed for the length-weight relationship, log Weight (g) = log C + n log Length (mm), for the three major fish species in 1975 are presented in the following table:

SPECIES	STATION	Log C	n	r	N
Lepomis gibbosus	N-10-E	-4.83	3.08	.97	89
	N-10-W	-4.72	3.03	.97	77
	S- 3-E	-4.03	2.70	.95	161
	S- 2-W	-4.46	2.91	.98	217
Micropterus dolomieui	N-10-E	-5.12	3.12	.99	55
	N-10-W	-4.15	2.73	.99	10
	S- 3-E	-4.99	3.06	.99	52
	S- 2-W	-4.60	2.91	.99	8
Perca flavescens	N-10-E	-4.84	2.97	.96	93
	N-10-W	-4.49	2.82	.96	107
	S- 3-E	-4.49	2.82	.95	69
	S- 2-W	-3.75	2.48	.93	12

The magnitude of the slope (n) in this relationship reflects the condition or robustness of the fish; a higher slope indicates a greater weight gain relative to a constant increase in length. However, since juveniles usually display a lower slope than older individuals, variation in the length-weight slope may also result from changes in age composition of the samples. Comparison of the robustness of the fish from the four fyke net stations reveals only a few differences. Low values at Station N-10-W for smallmouth bass and at Station S-2-W for yellow perch probably result from small sample sizes at these locations. The low slope for pumpkinseed at Station S-3-E may reflect the preponderance of younger individuals captured at that location (Table 36). With these few exceptions, length-weight relationships were similar throughout Hooksett Pond in 1975. Similarly, among-station differences were slight in 1974 (NAI, 1975).

Length-at-capture data for smallmouth bass, yellow perch, and pumpkinseed captured by fyke netting during 1975 are presented in Table 34. These data represent mean lengths at capture and the results of one-way analysis-of-variance (Kirk, 1968) grouped by species and season. For this analysis, June, July, and August samples were grouped "summer" and September and October samples grouped "fall". These tests were employed to test the hypothesis that the size distribution of fishes within a given species varied among locations in Hooksett Pond and that this heterogeneity may have been related to plant operation.

As Table 34 indicates, length-at-capture differences among stations were not significant ($p > .05$) for all tested contrasts involving smallmouth bass. For fall-caught yellow perch, specimens captured at northern stations averaged significantly larger ($p < .001$) than those at S-2-W. For all other summer and fall comparisons, differences were not significant ($p > .05$). For pumpkinseed, significant length-at-capture differences ($p < .001$) were observed between north and south stations ($p < .01$) during the fall. All other comparisons were not significant.

Prior to 1974, young specimens of all three species were more abundant south than north of the discharge, whereas older individuals were more evenly distributed. In 1974 the older yellow perch and pumpkinseed also predominated south of the discharge (NAI, 1974; 1975). As shown in Tables 34-37, the distribution of these three species in 1975 varied from that observed previously. Both younger and older smallmouth bass were sampled evenly throughout Hooksett Pond. All pumpkinseed age groups predominated south of the discharge, while both older and younger yellow perch were most abundant north of the discharge. These data not only reinforce the species distributions previously established (Tables 29-33), but also indicate the homogeneous distribution of all age groups throughout Hooksett Pond in 1975.

Back-calculated length comparisons using data from earlier study years was evaluated to detect any location-specific differences in growth history which may have been related to plant operation. Table 38 a-c presents mean back-calculated lengths at annulus formation for smallmouth bass, yellow perch, and pumpkinseed. The values for the years 1967 to 1969 were adapted from Wightman (1971). When using tables of mean back-calculated lengths, it must be remembered that each value is influenced by the lengths of several year-classes. Therefore, variation within particular growing seasons are not clearly delineated in any particular year. Because of this, when looking for growth changes

TABLE 34. TABLE OF MEAN TOTAL LENGTHS (mm), WITH SIGNIFICANCE LEVELS FOR MERRIMACK RIVER GAMEFISH LENGTH-AT-CAPTURE DATA FROM THE 1975 STUDY PERIOD. NUMBERS IN PARENTHESES REPRESENT THE NUMBER OF OBSERVATIONS IN EACH MEAN. HOOKSETT POND, MERRIMACK RIVER, 1975.

		STATIONS			
SPECIES	SEASON	N-10E	N-10	S-3E	S-2W
Smallmouth bass	Summer	263.2(40)	240.2(9)	262.1(49)	284.5(9)
	Fall	262.7(16)	304.8(1)	263.5(4)	---(0)
Yellow perch	Summer	180.7(47)	184.6(72)	176.1(61)	171.6(11)
	Fall	220.0(48)	221.9(39)	209.6(8)	160.0(1)
Pumpkinseed	Summer	149.0(44)	143.4(34)	142.6(94)	169.4(195)
	Fall	123.8(46)	130.2(44)	116.0(74)	116.4(27)

SPECIES	SEASON	OVERALL SIGNIF. ALL STATIONS	NORTH VERSUS SOUTH STATIONS	NORTHEAST VERSUS NORTHWEST	SOUTHEAST VERSUS SOUTHWEST
Smallmouth bass	Summer	NS	NS	NS	NS
	Fall	NS	NS	NS	---
Yellow perch	Summer	NS	NS	NS	NS
	Fall	NS	.001	NS	.001
Pumpkinseed	Summer	.001	NS	NS	.001
	Fall	NS	.01	NS	NS

TABLE 35. MONTHLY AGE DISTRIBUTION, BY SPECIES AND STATION, FOR MERRIMACK RIVER SMALLMOUTH BASS CAPTURED BY FYKE NETTING DURING 1975.

		AGE									
MONTH	STATION	0	1	2	3	4	5	6	7	8	9
May	N-10W		1								
	N-10E		1	1				1	1		
	S-2W		1				2				
	S-3E	1	4	1			1	1			
June	N-10W		1								
	N-10E					1	2				
	S-2W					1					
	S-3E		1		4		4	2			
July	N-10W										
	N-10E		3	1	2	2	5	2			
	S-2W	1					1				
	S-3E			1	1	6	3	7	1		
August	N-10W		1	1		1		4			
	N-10E			1	5	4	6	1			
	S-2W						1	1			
	S-3E			1	3	3	2				
September	N-10W							1			
	N-10E			1	5	1	3	1	4		
	S-2W										
	S-3E				1		1	1			
October	N-10W										
	N-10E										1
	S-2W										
	S-3E										
All	N-10W		3	1		1		5			
	N-10E		4	4	12	8	16	5	5		1
	S-2W	1	1			1	4	1			
	S-3E	1	5	3	9	9	11	11	1		
TOTAL		2	13	8	21	19	31	22	6	0	1

TABLE 36. MONTHLY AGE DISTRIBUTION, BY SPECIES AND STATION, FOR MERRIMACK RIVER PUMPKINSEED CAPTURED BY FYKE NETTING DURING 1975.

		AGE									
MONTH	STATION	0	1	2	3	4	5	6	7	8	9
May	N-10W					2					
	N-10E						1				
	S-2W		5	7	1	8	13	6	1		
	S-3E		8	23	6	6	3	1	1		
June	N-10W			1	1	3	3	2			
	N-10E			1	2	1	2	1			
	S-2W		2	6	11	11	33	11	6		1
	S-3E				1	3	2	1			
July	N-10W			5	2		3				
	N-10E			3	1		2	1			
	S-2W		1	4			3				
	S-3E			1	4	5	3				
August	N-10W			6	2	2	2				
	N-10E			9	5		9	4			
	S-2W			2	9	17	21	9			
	S-3E			1	3	8	9	2			
September	N-10W		1	4	11	11	6	3			
	N-10E		1	3	23	6	3				
	S-2W			1	16	7					
	S-3E			1	9	4	5	6			
October	N-10W		1	2	3		1				
	N-10E			1	2	5		1			
	S-2W				2						
	S-3E		5	25	14	4					
All	N-10W		2	18	19	18	15	5			
	N-10E		1	17	33	12	17	7			
	S-2W		8	20	39	43	70	26	7		1
	S-3E		13	51	37	30	22	10	1		
TOTAL			24	106	128	103	124	48	8	0	1

TABLE 37. MONTHLY AGE DISTRIBUTION, BY SPECIES AND STATION, FOR MERRIMACK RIVER YELLOW PERCH CAPTURED BY FYKE NETTING DURING 1975.

		AGE									
MONTH	STATION	0	1	2	3	4	5	6	7	8	9
May	N-10W		2	6	6	2	4	5			
	N-10E			3	4	6	3	3			
	S-2W										
	S-3E		3	9	12	8	1	1			
June	N-10W			3	9	6	8	4	1		
	N-10E		1	1	3	2					
	S-2W			1	5	3					
	S-3E			1	3	6	6	2			
July	N-10W				1	2	3	2	1		
	N-10E			3		2	5				
	S-2W										
	S-3E					2	1	1			
August	N-10W			3	3				1		
	N-10E			4	5	1					
	S-2W				1			1			
	S-3E			1	1	1	1	1			
September	N-10W			3	4	1	7	3	4	4	1
	N-10E				6	9	9	5	3	1	
	S-2W					1					
	S-3E			1			2	1	1		
October	N-10W						2	5	1		
	N-10E				1		4	3	2	3	
	S-2W										
	S-3E					1	1			1	
All	N-10W		2	15	23	11	24	19	8	5	1
	N-10E		1	11	19	20	21	11	5	3	
	S-2W			1	6	4		1			
	S-3E		3	12	16	18	12	6	1	1	
TOTAL		0	6	39	64	53	57	37	14	9	1

TABLE 38 a. MEAN BACK-CALCULATED LENGTHS (mm) AT ANNULUS FORMATION FOR SMALLMOUTH BASS, HOOKSETT POND, MERRIMACK RIVER, 1975.

STATION	ANNULUS	1967*	1968*	1969*	1972	1973	1974	1975
NORTH	1			111.8	148.8	193.1	162.9	117.6
	2	152.4	149.9	185.4	200.2	237.2	206.4	164.8
	3	213.3	198.1	223.5	247.0	271.2	237.0	206.3
	4	266.7	259.1	294.6	295.8	292.4	262.6	256.2
	5	348.0	309.9	307.3	337.8	315.9	287.5	298.0
	6	358.1	350.5	358.1	374.6	381.2	319.0	322.0
	7	383.5	396.2	388.6	400.8			333.5
	8		442.0	414.0	428.0			398.0
	9							414.0
SOUTH	1	104.1	91.4	109.2	99.3	157.8	145.7	118.3
	2	167.6	139.7	167.6	163.3	212.3	196.9	164.0
	3	218.4	228.6	213.4	224.7	259.2	237.6	207.8
	4	274.3	266.7	292.1	252.8	289.0	279.6	252.4
	5	337.8	287.0	317.5	317.9	307.4	317.4	298.5
	6	375.9	363.2		345.6	333.4	335.0	326.0
	7				365.0	355.0		363.5
	8				402.0			
	9							

*Adapted from Wightman (1971)

TABLE 38 b. MEAN BACK-CALCULATED LENGTHS (mm) AT ANNULUS FORMATION FOR YELLOW PERCH, HOOKSETT POND, MERRIMACK RIVER, 1975.

STATION	ANNULUS	1967*	1968*	1969*	1972	1973	1974	1975
NORTH	1	91.4	94.0	94.0	185.2	143.7	179.7	118.3
	2	134.6	142.2	142.2	196.6	170.5	191.2	143.9
	3	193.0	180.3	180.3	205.8	192.3	202.7	169.5
	4	226.1	218.4	210.8	216.7	212.1	211.6	195.0
	5	254.0	248.9		229.0	230.0	225.7	212.9
	6	274.3			239.3	239.0	241.3	233.0
	7				249.7	265.0	250.3	239.0
	8				268.8			272.2
	9				274.0			250.0
SOUTH	1	94.0	88.9	94.0	185.4	158.1	160.6	110.8
	2	124.0	134.6	139.7	187.3	179.4	177.2	137.3
	3	177.8	175.2	172.7	190.1	191.2	190.5	165.5
	4	228.6	213.4	208.3	195.8	205.0	204.1	185.7
	5	254.0	231.1		203.1	221.7	218.7	205.0
	6	274.3	264.2		224.5	222.0	231.2	210.9
	7				236.2		249.0	233.5
	8				251.0			255.0
	9				261.0			

*Adapted from Wightman (1971)

TABLE 38 c. MEAN BACK-CALCULATED LENGTHS (mm) AT ANNULUS FORMATION FOR PUMPKINSEED, HOOKSETT POND, MERRIMACK RIVER, 1975.

STATION	ANNULUS	1967*	1968*	1969*	1972	1973	1974	1975
NORTH	1	58.4	66.0	66.0	85.9	100.7	95.4	71.7
	2	99.1	101.6	109.2	117.0	125.5	118.8	97.1
	3	147.3	144.8	144.8	133.5	144.0	141.0	120.2
	4		180.3	170.2	162.1	164.7	157.4	147.6
	5				171.3	179.6	171.6	170.0
	6				178.1	186.8	177.3	182.1
	7				189.2	185.5		
	8				198.0			
	9							
SOUTH	1	60.9	73.7	63.5	96.1	102.8	111.9	71.0
	2	109.2	101.6	119.4	119.9	130.3	134.5	101.4
	3	134.6	147.3	144.8	138.7	149.3	151.2	132.1
	4	180.3	172.7	175.3	152.6	162.1	163.5	158.8
	5				170.9	173.0	172.1	175.2
	6				172.2	179.6	178.1	185.4
	7				192.7	175.0	205.0	173.9
	8				195.0		215.0	201.0
	9							213.0

*Adapted from Wightman (1971)

in Hooksett Pond fishes as related to the operation of Merrimack Generating Station Unit II, which became operational in May 1968, it is necessary to view Table 38a-c as the results of both pre- and post-operational seasons. All lengths presented for 1967 and 1968, and all but Age I for 1969 were influenced by pre-operational seasons. Post-operational seasons influenced all lengths presented for 1972 through 1975. There is also, however, a small component of pre-operation years contributed by the fish older than Age V in 1972. With each successive year through 1975 this component became smaller as the older fish were removed from the population through mortality. Therefore, this discussion of age and growth of Hooksett Pond fishes emphasizes Age I to IV individuals, and assumes that the influence of growing seasons before 1968 on total length at annulus formation is minimal in the fishes collected after 1969. Table 38 a-c represents length-weight relationships for the three major species caught by fyke-netting from 1972 through 1975.

Back-calculated lengths for smallmouth bass (Table 39 a) show a peak for Ages I-III in 1973. Since this peak occurs in the groups from both north and south of the discharge, the cause is probably not related to Merrimack Station operation. Rather, it may have been caused by the fish sampling program. Before 1974, all fish were sexed by dissection and therefore removed from the population. Enough individuals may have been removed to significantly reduce the population such that growth rates of the remaining individuals increased. Cessation of sexing the fish in 1974 may then have allowed the populations to increase and thus lower their growth rates to those observed in 1975.

Wightman (1971) reported variable growth for smallmouth bass from 1967 to 1969, with most age-classes growing faster south of the discharge during 1968 and 1969. Our data show that back-calculated lengths for Ages II-IV reached a maximum during 1972 and 1973, and then in 1974 and 1975 approached the values observed by Wightman (1971) for 1967 to 1969 (Table 38a). By 1975 the lengths-at-annulus approximated those of 1967 and 1968 for the group captured north of the discharge, and were slightly smaller than the 1967 values south of the generating plant. Smallmouth bass older than Age IV in 1975 were smaller at annulus formation than similar age bass captured during 1967 both north and south of the thermal discharge. Individuals collected at the northern stations during 1972 through 1974 had larger back-calculated lengths at Annuli I through III than those collected at the southern stations. In 1975, lengths at annulus formation were almost identical for northern and southern groups.

Length-weight relationships for smallmouth bass collected from northern stations during 1972 through 1975 revealed a very consistent slope approximating 3.0 (Table 39 a). There were low values at Station N-10E in 1973 and at N-10W in 1974, but the small number of fish collected at these locations makes the use of their length-weight relationships somewhat unrealistic. This same consistency was observed at the southern stations, except that the slope was slightly higher than those of the northern populations during 1972 and 1973.

Age-and-growth analysis for yellow perch (Table 38 b) revealed the same trend as that found for smallmouth bass; a maximum in length at annulus formation for Ages I to III occurred during 1972 through 1974, although 1973 values were slightly lower than those of 1972 or 1974. As with the smallmouth bass, sexing of the perch through 1973 may have been the probable cause. By 1975, the length-at-annulus values for yellow perch at both northern and southern stations approached the 1967-1969 values for Age II, but were somewhat lower than the 1967-1969 values at Ages III to VI. During 1972, 1974, and 1975 Age I to V lengths were slightly larger in the northern group. During 1973 the lengths were more variable, with those from the north being larger at Ages III to V. Wightman (1971) reported that the yellow perch south of the discharge had a smaller back-calculated length than those from the northern stations; since this phenomenon was observed before 1968 it was felt that this was not the result of thermal effects.

Length-weight relationships for northern stations from 1972 to 1975 had slopes varying from 2.56 in 1974 to 3.16 in 1972 (Table 39 b). Slopes for the southern groups ranged from 2.51 to 3.13. Although the overall range of values was the same for the four years, the maxima and minima do not coincide. Therefore, these values may reflect the natural variation in the length-weight relationship for the Hooksett Pond yellow perch population.

Age-and-growth analysis for pumpkinseed (Table 38 c) revealed length maxima in 1973 and 1974 as was observed for yellow perch and smallmouth bass. For pumpkinseed, however, this peak was evident only at Annuli I and II. 1972 through 1974 values for lengths at Annuli I and II were higher than those of 1967 to 1969, but the 1975 lengths at the same annuli approximate the 1967 to 1969 values. Above Annulus III, the 1972 to 1975 lengths were consistently smaller than those from 1967 to 1969 north of the discharge. At the southern stations the same holds true above Annulus IV. This indicates that as of 1975 the pumpkinseed were slightly smaller at a given age than the pumpkinseed from the same regions in 1967. The difference, however, is slight. Wightman (1971) reported little variation in pumpkinseed length among stations from 1967 to 1969, although there was a tendency for southern fish to be slightly larger at Ages II and III. This trend continued into the 1972 to 1975 study period, when lengths at Annuli I to IV were slightly larger for fish captured at southern stations.

Slopes calculated for the length-weight relationships at the northern stations ranged from 3.03 to 3.44, excluding (because of the small sample size) the 2.54 obtained at N-10W for 1974 (Table 39 c). In the south the range was lower: 2.57 to 3.28. This lower slope may have been the result of (1) increased metabolic demand caused by the warmer water, (2) the greater density of pumpkinseed south of the discharge competing for available resources, or (3) a combination of the two. Whichever is the case, the difference in length-weight relationships between northern and southern pumpkinseed groups was quite small.

TABLE 39 a. LENGTH-WEIGHT RELATIONSHIPS FOR SMALLMOUTH BASS, 1972-1975 HOOKSETT POND, MERRIMACK RIVER.

YEAR	STATION	LOG C	n	r	N
1972	N-10E	-6.58	3.19	.89	42
	N-10W	-5.88	2.94	.98	48
	S-3E	-6.22	3.07	.97	20
	S-2W	-6.34	3.11	.99	42
1973	N-10E	-4.19	2.77	.92	3
	N-10W	-5.59	3.30	.98	48
	S-3E	-4.93	3.02	.99	52
	S-2W	-5.77	3.37	.98	30
1974	N-10E	-5.24	3.17	.99	35
	N-10W	-3.43	2.45	.99	4
	S-3E	-5.24	3.17	.99	47
	S-2W	-4.08	2.69	.98	52
1975	N-10E	-5.12	3.12	.99	55
	N-10W	-4.15	2.73	.99	10
	S-3E	-4.99	3.06	.99	52
	S-2W	-4.60	2.91	.99	8

TABLE 39 b. LENGTH-WEIGHT RELATIONSHIPS FOR YELLOW PERCH 1972-1975, HOOKSETT POND, MERRIMACK RIVER .

YEAR	STATION	LOG C	n	r	N
1972	N-10E	-6.55	3.16	.93	63
	N-10W	-6.53	3.16	.96	111
	S-3E	-5.81	2.85	.97	22
	S-2W	-6.35	3.09	.93	113
1973	N-10E	-4.16	2.67	1.00	2
	N-10W	-4.78	2.92	.95	49
	S-3E	-3.83	2.51	.81	87
	S-2W	-5.29	3.13	.84	41
1974	N-10E	-3.90	2.56	.93	86
	N-10W	--	--	--	1
	S-3E	-6.18	3.56	.96	83
	S-2W	-5.07	3.08	.95	117
1975	N-10E	-4.84	2.97	.96	93
	N-10W	-4.49	2.82	.96	107
	S-3E	-4.49	2.82	.95	69
	S-2W	-3.75	2.48	.93	12

TABLE 39 c. LENGTH-WEIGHT RELATIONSHIPS FOR PUMPKINSEED, 1972-1975, HOOKSETT POND, MERRIMACK RIVER.

YEAR	STATION	LOG C	n	r	N
1972	N-10E	-6.90	3.44	.90	27
	N-10W	-6.06	3.05	.93	33
	S-3E	-6.13	3.12	.98	39
	S-2W	-5.60	2.88	.92	187
1973	N-10E	-5.17	3.25	.95	8
	N-10W	-5.07	3.17	.94	40
	S-3E				97
	S-2W	-5.31	3.28	.89	128
1974	N-10E	-4.92	3.13	.96	69
	N-10W	-3.61	2.54	.81	6
	S-3E	-4.07	2.75	.96	133
	S-2W	-3.64	2.57	.90	322
1975	N-10E	-4.83	3.08	.97	89
	N-10W	-4.72	3.03	.97	77
	S-3E	-4.03	2.70	.95	101
	S-2W	-4.46	2.91	.98	217

d. Summary and Conclusions

Electrofishing during 1975 essentially reinforced conclusions of earlier years. That is, certain species such as pumpkinseed, largemouth bass and redbreast sunfish tend to be captured more frequently at warmer temperatures than do such species as yellow perch, as would be expected based on published temperature preferences. These conclusions were further reinforced by data based on seining. However, as has been stated for several years previous to 1976, habitat differences between areas north and south of Merrimack Station most likely contribute substantially to observed differences in fish density, age structure, and community composition.

Fyke-netting, which is the most quantifiable sampling technique employed in the Merrimack Monitoring Program, indicated that pumpkinseed were most abundant south of the Merrimack Station discharge, bullheads and yellow perch most abundant north of the plant, and that smallmouth bass and white suckers were distributed in a less predictable fashion. East-west differences were less noticeable. These results are generally consistent with those of earlier years in that pumpkinseed have been predictably more abundant south of the plant with other species being distributed in a less obvious manner. Again, however, the effect of habitat differences north and south of the plant must be weighed along with temperature differences before any cause-effect relationships are postulated.

Back-calculated age and growth analysis was performed using smallmouth bass, pumpkinseed and yellow perch. This technique, which has not been utilized for Hooksett Pond fishes since the New Hampshire Fish and Game Studies of 1967-1969, was employed to determine whether or not any long-term growth alterations have occurred in Hooksett Pond game fish populations. In general, growth rates for 1972-1975 were found to be similar to those of earlier years. A peculiar increase observed for the years during 1972-1973 was attributed to population reductions associated with the destructive sampling involved in sexing specimens during the monitoring program's earlier years.

7. Preliminary Fish Toxicity Study

A preliminary fish toxicity study was performed to determine if conditions in the discharge water of the Merrimack Generating facility were acutely toxic to representative fish species. This study was conducted three times during 1975; August 22-September 4; September 4-September 17; and September 17-September 29. Results are presented in Table 40 to 42. Continuous temperature monitoring data for each of the series are presented in Table 43.

During the first test of the series (August 22-September 4), almost all of the control fish died during the three-day acclimation period (Table 40 . This rapid mortality was likely a result of overcrowding, especially of pumpkinseed, and of stress caused by collection and handling. The treatment fish at the discharge canal also exhibited high mortality during the acclimation period. All yellow perch and pumpkinseed as well as half (5) of the smallmouth bass died during this initial period, yet all of the remaining smallmouth bass present (4) survived the remainder of the test.

In the second series of tests (September 4-17), initial control mortality was not as great as in the first series (Table 41). During the actual test, however, over half of the yellow perch and pumpkinseed control fish died. Approximately half of the yellow perch and pumpkinseed treatment fish died during the initial acclimation period. During the actual test, however, mortality was no greater than 3 out of 9 for any of the three species. A number of treatment fish were unaccounted for at the end of this test, perhaps because of predation by other test fish (pen partitions had become unattached and mixing of species was occurring) or birds (great blue herons were perched on the pens, wire mesh tops were subsequently constructed).

During the acclimation period for the third test (September 17-29), all control smallmouth bass and most of the control yellow perch (31) and pumpkinseeds (37) survived (Table 42). The acclimation period

TABLE 40. PRELIMINARY FISH TOXICITY STUDY, FIRST SERIES. HOOKSETT POND, MERRIMACK RIVER, AUGUST 22-SEPTEMBER 4, 1975.

Species	Location	Total Tested	Number Dead in 3-day acclimation period	Number dead in remainder of test	Number unaccounted for	Number alive at end of test	MORTALITY INDEX: number dead / total - dead during acclimation - unaccounted for
Smallmouth bass	intake	10	9	1	-	0	1/1 = 100%
Yellow perch	intake	11	11	0	-	0	0/0 = 100%
Pumpkinseed	intake	51	51	0	-	0	0/0 = 100%
Smallmouth bass	discharge	10	5	0	1	4	0/4 = 0%
Yellow perch	discharge	6	5	0	1	0	0/0 = 100%
Pumpkinseed	discharge	20	20	0	-	0	0/0 = 100%

TABLE 41. PRELIMINARY FISH TOXICITY STUDY, SECOND SERIES, HOOKSETT POND, MERRIMACK RIVER, SEPTEMBER 4-17, 1975.

Species	Location	Total Tested	Number Dead in 3-day acclimation period	Number dead in remainder of test	Number unaccounted for	Number alive at end of test	MORTALITY INDEX: number dead / total - dead during acclimation - unaccounted for
Smallmouth bass	intake	11	0	1	5	5	1/6 = 16.7%
Yellow perch	intake	18	5	7	3	3	7/10 = 70%
Pumpkinseed	intake	20	1	10	4	5	10/15 = 66.7%
Smallmouth bass	discharge	12	1	1	1	9	1/10 = 10%
Yellow perch	discharge	20	11	3	6	0	3/3 = 100%
Pumpkinseed	discharge	20	10	1	7	2	1/3 = 33.3%

TABLE 42. PRELIMINARY FISH TOXICITY STUDY, THIRD SERIES, HOOKSETT POND, MERRIMACK RIVER, SEPTEMBER 17-29, 1975.

Species	Location	Total Tested	Number dead in 3-day acclimation period	Number dead in remainder of test	Number unaccounted for	Number alive at end of test	MORTALITY INDEX: number dead / total-dead during acclimation - un-accounted for
Smallmouth bass	intake	8	0	0	-	8	0/8 = 0%
Yellow perch	intake	32	1	3	-	28	3/31 = 9.7%
Pumkinseed	intake	38	1	5	-	32	5/37 = 13.5%
Smallmouth bass	discharge	12	0	12	-	0	12/12 = 100%
Yellow perch	discharge	26	8	16	1	0	16/17 = 94.1%
Pumpkinseed	discharge	32	10	17	1	4	17/21 = 81%
Restocked from intake to discharge after fish kill							
Smallmouth bass		3	0	0	-	3	0/3 = 0%
Yellow perch		15	1	9	1	4	9/13 =69.2%
Pumpkinseed		16	1	1	-	14	1/15 = 6.7%

TABLE 43. RESULTS OF CONTINUOUS TEMPERATURE MONITORING -- PRELIMINARY FISH TOXICITY STUDY. HOOKSETT POND, MERRIMACK RIVER, 1975.

RANGE	MEAN	VARIANCE	STANDARD DEVIATION
AUGUST 25 - SEPTEMBER 4			
70.04-84.68	80.70	3.367	1.924
SEPTEMBER 7-17			
70.10-83.12	76.89	12.681	3.735
SEPTEMBER 20-29			
69.86-79.58	74.14	5.876	2.555

for the treatment fish was over and the actual test had begun when a number of dead fish were noted within the discharge canal. At this time, treatment fish exhibited the following mortality: 12 of 12 smallmouth bass, 14 of 16 yellow perch, and 7 of 21 pumpkinseed. Apparently pumpkinseed were better able to survive the causative agent than either of the other two species. Continuous temperature monitoring data (Table 43) appeared to rule out temperature as a causative agent as no temperature extremes or rapid temperature changes were noted during the test. It is therefore believed that the high mortality noted was the result of a chemical agent. In an attempt to continue the test with an adequate number of fish, one of the control pens was brought downstream from the intake and placed in the discharge canal. Of the treatment fish in this new pen, the only species which exhibited substantial mortality was the yellow perch (9 of 14).

In summary, the first two tests were inconclusive because of high control mortality during acclimation in the first test, and during the actual test period of the second test. In test three, however, a significant and abrupt mortality was observed among the smallmouth bass and yellow perch test fish and, to a lesser degree, the pumpkinseed test fish. When one of the control fish pens was relocated to the discharge canal, only the yellow perch exhibited substantial mortality (9 of 13), though this could be related to stress caused by towing the pen downriver from the control station. Results indicate that the major impact of the causative agent was of short duration.

The 1975 fish toxicity test were of a preliminary nature and will be resumed during July and August of 1976, incorporating changes based on experience gained during 1975. For example, 1) more pens will be employed in 1976 (one pen per species at each location, to provide greater holding volume for each fish and prevent interspecific mixing of fish) and 2) control pens will be placed closer to shore to reduce exposure to current.

SUMMARY: MERRIMACK RIVER MONITORING PROGRAM 1975.

As in past years, concentrations of nutrients in Hooksett Pond showed no major between-station differences and generally paralleled seasonal trends in phytoplankton biomass. In 1975 total phosphate, and to a lesser degree, nitrate levels were higher than in earlier studies. This could be the result of nutrient input above the generating station and/or a lower biomass of primary producers (phytoplankton and periphyton) noted at all stations during the study season. Low concentrations of chlorophyll *a* in river samples supported this hypothesis.

With the exception of August and October, mean monthly pH showed no between-station differences and generally were below neutrality. Dissolved oxygen concentrations were slightly reduced at Station Zero-West when compared to N-10, but in general were higher at all stations than in past years. These higher concentrations appeared to be related to greater flows during the late summer months of 1975. The lowest dissolved oxygen concentration noted was 5.5 mg/l.

Concentrations of chlorophyll *a* in 1975 were lower than those of 1971-1974. Among-station differences were found, with Station Zero-West and S-4 tending to have lower concentrations than did Station N-10. The greatest reduction was found during August, the month of lowest flows and highest ambient temperature. Levels of chlorophyll *a* generally followed the trends noted for phytoplankton populations.

Results of plankton studies showed responses of organisms to vary among groups. Entrainment data showed higher mortality at the discharge weir than at the intake structure for both diatoms and green algae, with a trend toward recovery noted at the canal mouth. These data were largely substantiated by the river plankton data which showed a slight reduction of diatoms at Station Zero-West with numbers at Station S-4 comparable to those at N-10. Blue-green algae occurred in limited numbers at all stations in 1975. Significantly greater numbers of blue-green occurred at Station Zero-West than at Station N-10 over the season. Zooplankton showed no significant entrainment mortality and were found in higher numbers at Station Zero-West than at N-10 in river monitoring studies.

Periphyton data indicated that productivity, in terms of numbers of cells, was lower during the summer months than during the same period in past years. Weekly slides showed a higher abundance of total organisms at Station S-4. A lower percentage of diatoms and higher percentage of green algae were found at Station Zero-West than at N-10. Monthly data showed no statistically significant differences among stations over the season.

Benthic macroinvertebrate surveys produced results similar to past years. Dipterans and oligochaetes dominated all samples. Reduction in total numbers of organisms and taxa were noted during some sampling months, primarily at Station Zero. As in the past, habitat differences between stations did not allow the drawing of definitive conclusions concerning the degree of impact of the Merrimack Station.

Electrofishing and seining results reinforced findings of past years in that certain species (pumpkinseed, largemouth bass, redbreast sunfish) tended to be captured more frequently at warmer temperatures than do species such as yellow perch. Fyke netting indicated that pumpkinseeds were most abundant south of the Merrimack Station discharge, bullheads and yellow perch were most abundant north of the plant, and that smallmouth bass and white suckers were distributed in a less predictable fashion. Habitat differences north and south of the plant undoubtedly played a role in all of the fisheries surveys.

Results of the preliminary fish toxicity study revealed an abrupt mortality during the September 17-29 test. It was felt that the causative agent was chemical in nature and likely moved down the canal as a "slug" of short duration.

LITERATURE CITED

American Public Health Association. 1971. Standard methods for the examination of water and wastewater. 14th edition. Washington, D. C. 874 pp.

Anonymous. 1974. Relationships between drainage area characteristics and non-point source nutrients in streams. Working Paper No. 25, U.S. Environmental Protection Agency. 49 pp.

Barans, C. A. and R. A. Tubb. 1973. Temperatures selected seasonally by four fishes from western Lake Erie. Jour. Fish. Res. Bd. Canada. 30(11):1697-1703.

Basch, R. E. and J. G. Truchan. 1974. Calculated residual chlorine concentrations safe for fish. Michigan Water Resources Comm. Bureau of Water Management., Dept. of Nat. Resources. Water Quality Appraisal Section, Tech. Bull. 74-2.

Brauer, G. A., W. H. Neill and J. J. Magnuson. 1972. The effect of a power plant on the distribution and abundance of zooplankton near the plant's thermal outfall. Univ. Wisconsin Water Res. Ctr. Tech. Rpt. OWRR B-028-Wis. 33 pp.

Cairns, J., Jr. 1956. Effects of increased temperatures on aquatic organisms. Ind. Wastes. 1(4):150-152.

Crippen, R. W. and J. L. Perrier. 1974. The use of neutral red and Evans blue for live-dead determinations of marine plankton. Stain. Tech. 49(2):97-104.

Dickson, K. L., A. C. Hendricks, J. S. Crossman and J. Cairns, Jr. 1974. Effects of intermittently chlorinated cooling tower blowdown on fish and invertebrates. Environ. Sci. and Technol. 8:845-849.

Faber, D. J. 1967. Limnetic larval fish in northern Wisconsin lakes. Jour. Fish. Res. Bd. Canada. 24(5):927-937.

Ferguson, R. G. 1958. The preferred temperature of fish and their midsummer distribution in temperate lakes and streams. Jour. Fish. Res. Bd. Canada. 15(4):607-624.

Gaff, D. F. and O. Okong'O-Ogola. 1971. The use of non-permeating pigments for testing the survival of cells. J. Exp. Bot. 22:756-758.

Guenther, W. C. 1964. Analysis of variance. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 199 pp.

Gurtz, M. E. and C. M. Weiss. 1974. Effect of thermal stress on phytoplankton productivity in condenser cooling water. IN: J. W. Gibbons and R. R. Sharitz (eds.), Thermal Ecology. Tech. Info. Ctr, US Atomic Energy Comm., Oak Ridge, Tennessee. 670 pp.

Hatfield, H. F., M. G. Pfeiffer and C. B. Wurtz. 1966. The effect of the Brunner Island steam electric stations's condenser discharge water on the aquatic life of the Susquehanna River. ASME Paper 66-WA/DWR-10, Amer. Soc. Mech. Eng., New York.

Hawkes, H. A. 1969. Ecological changes of applied significance induced by the discharge of heated waters. IN: F. L. Parker and P. A. Krenkel (eds.), Engineering Aspects of Thermal Pollution. Vanderbilt Univ. Press, Nashville, Tennessee.

Hynes, H. B. W. 1970. The ecology of running waters. Univ. of Toronto Press. 555 pp.

Kelso, J. R. M. 1974. Influence of a thermal effluent on movement of brown bullhead (*Ictalurus nebulosus*) as determined by ultrasonic tracking. J. Fish. Res. Bd. Can. 31(9):1507-1513.

Kelso, J. R. M. 1976. Movement of yellow perch (*Perca flavescens*) and white sucker (*Catostomus commersoni*) in a nearshore Great Lakes habitat subject to a thermal discharge. J. Fish. Res. Bd. Can. 33(1):42-53.

Kempthorne, O. 1952. The design and analysis of experiments. John Wiley and Sons, Inc., New York. 63 pp.

Kirk, R. E. 1968. Experimental design: Procedures for the behavioral sciences. Brooks/Cole Pub. Co., Belmont, California. 597 pp.

Lagler, K. F. 1956. Freshwater fishery biology. 2nd edition. W. C. Brown Co., Dubuque, Iowa. 421 pp.

Lorenzen, C. J. 1967. Determination of chlorophyll and pheopigments: Spectrophotometric equations. Limnol. & Oceanog. 12(2):343-346.

Mann, K. H. 1965. Heated effluents and their effects on the invertebrate fauna of rivers. Proc. Soc. Water Treatment Exam. 14:45-53.

Markowski, S. 1959. The cooling water of power stations: a new factor in the environment of marine and fresh water invertebrates. Jour. Anim. Ecol. 28:243-258.

National Technical Advisory Committee. 1968. Water quality criteria. Federal Water Pollution Control Administration. 234 pp.

Needham, J. G., J. R. Traver and Yon-Chi Hsu. 1935. The biology of mayflies. Comstock Publ. Co., Inc., New York. 759 pp.

Neill, W. and J. J. Magnuson. 1974. Distributional ecology and behavioral thermoregulation of fishes in relation to heated effluent from a power plant at Lake Monona, Wisconsin. Trans. Amer. Fish. Soc. 103(4):663-710.

Normandeau Associates, Inc. 1972. Merrimack River monitoring program. A report for the study period 1971. 108 pp.

Normandeau Associates, Inc. 1973. Merrimack River monitoring program. A report for the study period 1972. 91 pp.

Normandeau Associates, Inc. 1974. Merrimack River monitoring program. A report for the study period 1973. 109 pp. plus appendix.

Normandeau Associates, Inc. 1975. Merrimack River monitoring program. A report for the study period 1974. 112 pp. plus appendix.

Patrick, R. 1969. Some effects of temperature on freshwater algae. IN: P. A. Krenkel and F. L. Parker (eds.), Biological aspects of thermal pollution. Vanderbilt Univ. Press.

Patrick, R. 1974. Effects of abnormal temperatures on algal communities. IN: J. W. Gibbons and R. R. Sharitz (eds.), Thermal ecology. Tech. Info. Ctr, U.S. Atomic Energy Comm., Oak Ridge, Tenn. 670 pp.

Proffitt, M. A. 1969. Effects of heated discharge upon aquatic resources of White River at Petersburg, Indiana. Water Resources Res. Center, Univ. Indiana, Indiana State University Ref. No. 3. 101 pp.

Reid, G. K. 1961. Ecology of inland waters and estuaries. Reinhold Publishing Corp., New York. 375 pp.

Richardson, R. E. 1913. Observations on the breeding habits of fishes at Havana, Illinois, 1910 and 1911. Bull. Ill. State Lab. Nat. Hist.

Siegel, S. 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill Book Company, New York. 312 pp.

Slattum, H. 1975. Personal communication. System Dispatcher, Public Service Company of New Hampshire.

Smith, G. M. 1950. The freshwater algae of the United States. McGraw-Hill Book Company, New York. 719 pp.

Smith, R. A., A. S. Brooks and L. D. Jensen. 1974. Primary Production. IN: L. D. Jensen (ed.), Environmental responses to thermal discharges from Marshall Steam Station, Lake Norman, North Carolina. Cooling Water Studies for Electric Power Research Institute, Report No. 11.

Snedecor, G. W. and W. G. Cochran. 1967. Statistical methods. Iowa State University Press, Ames, Iowa. 593 pp.

Sokal, R. R. and F. J. Rohlf. 1969. Biometry: The principles and practice of statistics in biological research. W. H. Freeman and Co., San Francisco. 776 pp.

Stauffer, J. R., D. S. Cherry, K. L. Kickson and J. Cairns, Jr. 1975. Laboratory and field temperature preference and avoidance data of fish related to the establishment of standards. pp. 119-139. IN: S. B. Saila (ed.), Fisheries and energy production: A symposium. D.C. Heath Co., Lexington, Massachusetts.

Storr, J. F. 1974. Plankton entrainment by the condenser systems of nuclear power stations on Lake Ontario. IN: J. W. Gibbons and R. R. Sharitz (eds.), Thermal ecology. Tech. Info. Ctr, US Atomic Energy Comm., Oak Ridge, Tennessee. 670 pp.

Trembly, F. J. 1961. Research project on effects of condenser discharge water on aquatic life. Inst. Res., Lehigh Univ. Progress Report 1960. 6 chapters.

Tucker, G. H. 1951. The relation of fishes and other organisms to the scattering of underwater sound. J. Mar. Res. 10:215-238.

Verduin, J. 1973. Testimony for the Atomic Energy Comm. Operating Permit of the Commonwealth Edison Zion Nuclear Electric Generating Station. 18 pp.

Wightman, P. 1971. Merrimack River thermal study. NH Fish and Game Department, Div. Inland and Mar. Fish. 111 pp.

APPENDIX I

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK N-10

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 APR 75	NO DATA FOR THIS DAY					
2 APR 75	NO DATA FOR THIS DAY					
3 APR 75	NO DATA FOR THIS DAY					
4 APR 75	NO DATA FOR THIS DAY					
5 APR 75	NO DATA FOR THIS DAY					
6 APR 75	NO DATA FOR THIS DAY					
7 APR 75	NO DATA FOR THIS DAY					
8 APR 75	NO DATA FOR THIS DAY					
9 APR 75	NO DATA FOR THIS DAY					
10 APR 75	39.02	1815	38.88	38.42	1500	36
11 APR 75	47.00	1100	39.80	38.36	830	96
12 APR 75	42.08	1830	41.04	39.92	830	96
13 APR 75	41.66	15	41.21	40.64	815	96
14 APR 75	42.44	1845	41.13	39.74	815	96
15 APR 75	43.10	1915	42.18	41.12	830	92
16 APR 75	44.42	1800	43.37	42.32	800	96
17 APR 75	45.62	1830	44.43	43.22	845	96
18 APR 75	45.38	1415	44.77	43.88	745	96
19 APR 75	45.14	600	44.77	44.48	1145	96
20 APR 75	44.78	15	43.87	43.16	2315	96
21 APR 75	43.10	15	42.12	41.48	1000	96
22 APR 75	42.62	2030	41.60	40.58	800	96
23 APR 75	44.12	2400	42.78	41.48	745	88
24 APR 75	44.36	2400	44.00	43.82	945	94
25 APR 75	44.54	145	44.30	43.94	945	37
26 APR 75	NO DATA FOR THIS DAY					
27 APR 75	NO DATA FOR THIS DAY					
28 APR 75	NO DATA FOR THIS DAY					
29 APR 75	NO DATA FOR THIS DAY					
30 APR 75	NO DATA FOR THIS DAY					
AVERAGE	43.71		42.51	41.65		
STND DEV.	1.90		1.81	1.97		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK N-10

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 MAY 75	47.96	1600	47.91	47.84	1930	33
2 MAY 75	48.38	900	47.95	47.60	1730	96
3 MAY 75	50.54	1915	49.30	48.02	15	96
4 MAY 75	50.42	15	49.43	48.92	2345	96
5 MAY 75	49.10	2345	48.25	47.42	1015	96
6 MAY 75	50.84	1800	49.87	49.04	545	87
7 MAY 75	50.90	215	50.64	50.30	2015	92
8 MAY 75	52.82	2130	51.75	50.54	15	96
9 MAY 75	54.26	1715	53.35	52.52	730	91
10 MAY 75	54.98	1445	54.43	54.14	430	96
11 MAY 75	55.52	1530	54.63	53.84	545	96
12 MAY 75	56.78	1530	55.68	54.74	115	96
13 MAY 75	56.90	1615	56.36	55.82	15	96
14 MAY 75	57.74	2345	56.87	55.88	15	96
15 MAY 75	58.64	1745	57.91	57.14	900	96
16 MAY 75	59.00	1615	58.52	58.04	2400	96
17 MAY 75	60.80	1715	59.24	57.86	515	96
18 MAY 75	61.46	1615	60.34	59.60	645	96
19 MAY 75	63.86	1745	61.85	59.90	300	96
20 MAY 75	65.72	1815	63.95	62.12	630	96
21 MAY 75	66.80	1700	65.78	64.64	700	96
22 MAY 75	66.44	100	65.87	65.06	930	96
23 MAY 75	68.24	2400	66.61	65.18	730	95
24 MAY 75	70.16	1700	69.05	68.06	715	96
25 MAY 75	70.10	1715	69.19	68.48	815	96
26 MAY 75	68.84	15	68.10	67.40	845	96
27 MAY 75	68.36	1515	67.76	67.40	1030	71
28 MAY 75	69.20	1645	68.10	66.50	915	55
29 MAY 75	69.62	1700	68.02	65.96	645	96
30 MAY 75	69.56	1230	68.70	67.82	615	96
31 MAY 75	69.68	1545	68.39	67.58	645	96
AVERAGE	60.11		59.15	58.23		
STND DEV.	7.80		7.62	7.44		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK N-10

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 JUN 75	69.08	1730	68.69	68.30	2400	96
2 JUN 75	70.04	1830	68.84	67.52	600	96
3 JUN 75	69.14	15	68.13	67.52	2300	93
4 JUN 75	68.12	1545	65.91	65.00	2345	54
5 JUN 75	65.78	1530	64.98	64.22	530	96
6 JUN 75	64.70	15	63.47	62.36	2400	96
7 JUN 75	62.42	15	61.89	61.40	645	96
8 JUN 75	61.52	30	60.58	59.36	2400	96
9 JUN 75	60.32	1900	59.59	58.76	630	96
10 JUN 75	61.28	1730	60.02	58.64	630	94
11 JUN 75	63.68	1715	61.86	60.08	615	96
12 JUN 75	62.90	15	62.49	62.06	2330	96
13 JUN 75	62.06	30	61.66	61.34	1945	96
14 JUN 75	61.94	2330	61.45	61.16	730	96
15 JUN 75	62.12	230	61.67	61.16	1000	96
16 JUN 75	63.08	1945	61.94	61.22	530	96
17 JUN 75	65.48	1845	64.08	62.48	745	94
18 JUN 75	67.82	1830	66.58	65.42	15	96
19 JUN 75	69.92	1830	68.61	67.28	600	96
20 JUN 75	71.12	1645	69.83	68.72	645	96
21 JUN 75	71.54	1815	69.94	68.36	700	96
22 JUN 75	72.56	1730	71.04	69.50	700	96
23 JUN 75	75.68	1815	73.36	71.18	645	96
24 JUN 75	77.42	1530	75.82	74.12	645	96
25 JUN 75	78.38	1745	77.08	75.68	745	96
26 JUN 75	78.50	1615	76.83	74.90	730	96
27 JUN 75	78.44	1645	76.73	74.96	730	96
28 JUN 75	78.98	1730	77.17	75.38	715	96
29 JUN 75	79.28	1600	77.70	76.70	915	96
30 JUN 75	88.58	730	83.42	78.02	1600	96
AVERAGE	69.39		68.04	66.75		
STND DEV.	7.22		6.60	6.03		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK N-10

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 JUL 75	93.74	915	87.72	78.98	1615	96
2 JUL 75	93.38	800	85.64	77.36	2100	96
3 JUL 75	88.70	800	82.69	77.36	2115	88
4 JUL 75	89.06	645	81.20	76.46	1530	96
5 JUL 75	84.86	800	78.39	76.22	1515	96
6 JUL 75	78.50	715	77.21	76.40	1415	96
7 JUL 75	78.74	1100	77.39	76.64	1700	96
8 JUL 75	81.92	945	78.42	76.58	1630	96
9 JUL 75	78.44	530	77.82	76.52	1200	50
10 JUL 75	NO DATA FOR THIS DAY					
11 JUL 75	80.36X	1630	79.66	78.38	1115	52
12 JUL 75	79.22	15	78.53	77.36	2345	96
13 JUL 75	77.78	1300	77.27	76.94	600	96
14 JUL 75	76.88	15	75.73	74.78	2400	96
15 JUL 75	75.50	1515	74.45	73.64	730	96
16 JUL 75	74.00	15	72.53	71.72	2345	96
17 JUL 75	72.80	2330	71.90	70.88	700	96
18 JUL 75	75.92	1815	74.26	72.80	15	96
19 JUL 75	77.60	1830	76.30	75.02	600	96
20 JUL 75	78.08	1645	77.40	76.76	700	96
21 JUL 75	78.74	1745	77.73	76.76	745	96
22 JUL 75	79.64	1630	78.51	77.48	745	96
23 JUL 75	79.82	1730	78.74	77.60	715	96
24 JUL 75	80.12	1700	79.12	78.14	700	96
25 JUL 75	79.34	15	78.48	77.72	2400	96
26 JUL 75	77.72	15	76.74	75.98	815	96
27 JUL 75	77.12	1630	75.91	74.36	730	96
28 JUL 75	76.70	1600	75.80	74.42	730	96
29 JUL 75	76.88	1600	75.99	74.96	715	96
30 JUL 75	77.84	1745	76.23	74.36	745	96
31 JUL 75	79.46	1715	77.71	76.04	730	96
AVERAGE	79.96		77.84	75.95		
STND DEV.	5.08		3.27	1.92		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK N-10

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 AUG 75	81.92	1800	79.84	77.60	645	96
2 AUG 75	84.08	1815	82.08	80.18	715	96
3 AUG 75	83.78	1330	82.83	81.92	2400	96
4 AUG 75	82.22	1045	81.22	79.58	2345	96
5 AUG 75	82.88	1500	80.42	78.98	800	96
6 AUG 75	80.36	15	78.92	77.42	2345	96
7 AUG 75	77.42	15	75.56	73.64	2400	96
8 AUG 75	73.64	15	72.60	71.78	2400	96
9 AUG 75	74.06	1745	72.52	70.88	730	96
10 AUG 75	75.62	1730	74.02	72.20	530	96
11 AUG 75	77.72	1615	75.98	74.54	700	96
12 AUG 75	78.38	1615	76.82	75.32	700	96
13 AUG 75	78.92	1615	77.31	75.68	715	96
14 AUG 75	79.22	1530	77.93	76.64	700	96
15 AUG 75	78.56	1630	77.41	76.22	745	96
16 AUG 75	78.38	1645	77.15	75.68	730	96
17 AUG 75	77.54	15	76.44	75.86	2400	96
18 AUG 75	77.00	1630	75.99	75.08	800	96
19 AUG 75	76.10	1615	75.03	74.12	730	96
20 AUG 75	74.96	1530	73.79	72.74	2400	96
21 AUG 75	74.72	1400	73.01	71.48	645	96
22 AUG 75	73.64	1500	72.53	71.06	2345	96
23 AUG 75	72.98	1700	71.62	70.46	645	96
24 AUG 75	71.12	15	70.01	68.66	2400	96
25 AUG 75	69.38	1445	68.93	68.60	200	96
26 AUG 75	69.20	1830	68.61	68.00	645	96
27 AUG 75	71.48	1615	69.96	68.60	645	96
28 AUG 75	72.74	1415	70.86	69.26	700	96
29 AUG 75	71.90	1415	70.89	70.04	445	96
30 AUG 75	70.16	15	68.71	67.04	2400	96
31 AUG 75	67.58	1645	66.55	65.30	815	96
AVERAGE	76.05		74.69	73.37		
STND DEV.	4.48		4.30	4.18		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK N-10

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 SEP 75	67.40	1630	65.90	64.28	900	96
2 SEP 75	67.10	1900	66.20	65.30	1030	95
3 SEP 75	67.10	1515	66.36	65.54	745	96
4 SEP 75	67.34	1430	66.14	64.82	615	96
5 SEP 75	68.54	1645	67.08	65.54	715	96
6 SEP 75	68.00	1600	67.18	66.62	745	96
7 SEP 75	68.42	1615	67.21	66.02	645	96
8 SEP 75	67.52	1615	66.80	66.02	900	96
9 SEP 75	67.76	1400	66.83	66.14	930	96
10 SEP 75	68.96	1530	65.83	64.58	830	96
11 SEP 75	66.98	1645	65.73	64.46	845	96
12 SEP 75	66.26	1545	65.74	65.18	2330	96
13 SEP 75	66.50	1600	65.31	64.28	730	96
14 SEP 75	65.18	15	63.89	62.60	2400	96
15 SEP 75	63.20	1500	62.21	61.22	815	96
16 SEP 75	62.00	1445	61.41	60.50	715	96
17 SEP 75	61.94	1700	61.11	60.20	845	96
18 SEP 75	62.24	1530	61.25	60.32	715	96
19 SEP 75	61.52	15	61.32	61.04	2400	95
20 SEP 75	62.12	1600	61.64	61.04	45	96
21 SEP 75	63.86	1815	62.84	62.06	645	96
22 SEP 75	64.10	2100	63.48	62.78	600	96
23 SEP 75	64.04	15	63.14	62.48	2345	96
24 SEP 75	62.48	15	61.54	60.56	2330	96
25 SEP 75	60.50	15	59.83	59.42	2345	96
26 SEP 75	59.48	15	59.15	58.94	845	96
27 SEP 75	60.50	1545	59.85	59.18	15	96
28 SEP 75	60.32	15	59.61	59.12	2400	96
29 SEP 75	59.36	1645	58.80	57.98	845	96
30 SEP 75	59.72	1645	58.99	58.28	800	96
AVERAGE	64.34		63.41	62.54		
STND DEV.	3.15		2.88	2.72		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK N-10

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 OCT 75	60.14	1630	59.53	58.82	800	93
2 OCT 75	60.14	15	59.68	58.34	2400	95
3 OCT 75	58.40	1515	57.89	57.38	800	96
4 OCT 75	58.22	1430	57.47	56.84	645	96
5 OCT 75	57.26	1330	56.83	56.24	730	96
6 OCT 75	57.68	1645	57.00	56.30	545	96
7 OCT 75	57.14	15	56.62	55.88	2345	96
8 OCT 75	56.48	1500	55.77	55.10	730	96
9 OCT 75	55.70	1300	55.13	54.56	645	96
10 OCT 75	55.04	1545	54.35	53.66	900	96
11 OCT 75	54.50	1100	54.28	53.84	2345	96
12 OCT 75	53.90	15	53.51	53.18	2330	96
13 OCT 75	53.30	1400	53.06	52.58	715	96
14 OCT 75	54.20	1600	53.52	52.88	715	96
15 OCT 75	54.56	1600	54.03	53.36	715	96
16 OCT 75	55.34	1430	54.76	54.26	645	96
17 OCT 75	55.22	1330	54.74	54.38	645	96
18 OCT 75	54.68	345	54.18	53.72	2345	96
19 OCT 75	53.72	15	52.75	52.10	2330	96
20 OCT 75	52.04	15	51.34	50.66	2400	96
21 OCT 75	50.66	15	50.19	49.82	2300	96
22 OCT 75	50.84	2245	50.11	49.46	600	96
23 OCT 75	51.26	1530	50.77	50.12	715	96
24 OCT 75	51.74	1500	51.28	50.60	730	96
25 OCT 75	51.86	1815	51.67	51.44	415	96
26 OCT 75	52.16	1300	51.94	51.56	2400	96
27 OCT 75	51.62	1515	51.18	50.66	830	96
28 OCT 75	51.14	1445	50.73	50.36	845	96
29 OCT 75	51.08	1630	50.54	49.88	715	96
30 OCT 75	51.02	15	50.12	48.74	2345	96
31 OCT 75	48.68	15	47.48	46.58	2300	96
AVERAGE	54.18		53.62	53.00		
STND DEV.	2.97		3.00	2.98		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK N-10

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 NOV 75	46.52	15	46.15	45.74	800	96
2 NOV 75	47.00	1530	46.37	45.62	730	96
3 NOV 75	47.96	1415	47.18	46.58	815	95
4 NOV 75	49.10	1400	48.37	47.48	15	96
5 NOV 75	49.16	1445	48.74	48.32	830	96
6 NOV 75	48.50	30	48.07	47.54	800	96
7 NOV 75	48.20	2345	47.73	47.06	815	96
8 NOV 75	49.64	1700	48.86	48.14	30	96
9 NOV 75	50.12	1715	49.58	48.92	715	96
10 NOV 75	50.00	15	49.71	49.40	800	96
11 NOV 75	49.76	15	49.34	48.98	2315	96
12 NOV 75	48.92	15	48.19	47.72	900	96
13 NOV 75	48.26	1245	48.09	47.90	330	96
14 NOV 75	48.02	15	47.56	46.52	2330	96
15 NOV 75	46.46	15	45.55	44.96	2330	96
16 NOV 75	44.96	30	44.16	43.46	2345	96
17 NOV 75	43.40	15	42.90	42.50	900	96
18 NOV 75	43.16	1445	42.69	42.20	800	96
19 NOV 75	43.16	1945	42.70	42.08	800	96
20 NOV 75	43.52	1515	43.09	42.50	845	96
21 NOV 75	44.00	2330	43.38	43.04	1100	96
22 NOV 75	44.00	15	43.74	43.34	2400	96
23 NOV 75	43.28	15	42.56	42.02	2345	96
24 NOV 75	42.02	15	41.17	40.52	2400	96
25 NOV 75	40.70	1300	40.48	40.16	845	96
26 NOV 75	40.58	1430	40.29	39.98	845	96
27 NOV 75	40.16	15	39.91	39.50	2400	96
28 NOV 75	39.50	15	39.12	38.84	2400	96
29 NOV 75	38.84	15	38.19	37.82	830	96
30 NOV 75	38.60	2315	38.09	37.76	845	96
AVERAGE	45.24		44.73	44.21		
STND DEV.	3.70		3.68	3.61		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK N-10

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 DEC 75	40.04	1430	39.52	38.60	15	96
2 DEC 75	39.32	15	38.85	38.48	2400	96
3 DEC 75	38.54	15	38.03	37.16	2345	96
4 DEC 75	37.10	15	36.44	36.02	930	55
5 DEC 75	NO DATA FOR THIS DAY					
6 DEC 75	NO DATA FOR THIS DAY					
7 DEC 75	NO DATA FOR THIS DAY					
8 DEC 75	NO DATA FOR THIS DAY					
9 DEC 75	NO DATA FOR THIS DAY					
10 DEC 75	NO DATA FOR THIS DAY					
11 DEC 75	NO DATA FOR THIS DAY					
12 DEC 75	NO DATA FOR THIS DAY					
13 DEC 75	NO DATA FOR THIS DAY					
14 DEC 75	NO DATA FOR THIS DAY					
15 DEC 75	NO DATA FOR THIS DAY					
16 DEC 75	NO DATA FOR THIS DAY					
17 DEC 75	NO DATA FOR THIS DAY					
18 DEC 75	NO DATA FOR THIS DAY					
19 DEC 75	NO DATA FOR THIS DAY					
20 DEC 75	NO DATA FOR THIS DAY					
21 DEC 75	NO DATA FOR THIS DAY					
22 DEC 75	NO DATA FOR THIS DAY					
23 DEC 75	NO DATA FOR THIS DAY					
24 DEC 75	NO DATA FOR THIS DAY					
25 DEC 75	NO DATA FOR THIS DAY					
26 DEC 75	NO DATA FOR THIS DAY					
27 DEC 75	NO DATA FOR THIS DAY					
28 DEC 75	NO DATA FOR THIS DAY					
29 DEC 75	NO DATA FOR THIS DAY					
30 DEC 75	NO DATA FOR THIS DAY					
31 DEC 75	NO DATA FOR THIS DAY					
AVERAGE	38.75		38.20	37.56		
STND DEV.	1.25		1.32	1.21		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-0

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 JAN 75	NO DATA FOR THIS DAY					
2 JAN 75	NO DATA FOR THIS DAY					
3 JAN 75	NO DATA FOR THIS DAY					
4 JAN 75	NO DATA FOR THIS DAY					
5 JAN 75	NO DATA FOR THIS DAY					
6 JAN 75	NO DATA FOR THIS DAY					
7 JAN 75	NO DATA FOR THIS DAY					
8 JAN 75	64.70	1800	61.30	47.66	1130	51
9 JAN 75	65.18	2400	59.07	48.14	1015	96
10 JAN 75	70.70	2400	63.02	50.54	1015	96
11 JAN 75	71.66	2145	66.38	55.16	1045	96
12 JAN 75	71.96	100	56.18	48.98	1945	96
13 JAN 75	66.32	2245	57.84	51.68	415	90
14 JAN 75	68.24	2245	62.77	51.02	930	95
15 JAN 75	68.30	145	62.44	51.74	945	94
16 JAN 75	68.96	2000	63.77	51.74	915	96
17 JAN 75	68.66	15	61.58	50.06	915	96
18 JAN 75	68.84	2400	67.78	67.22	715	96
19 JAN 75	69.08	45	54.34	50.06	1915	96
20 JAN 75	66.96	2315	59.00	48.20	930	96
21 JAN 75	68.54	1730	67.27	66.26	930	96
22 JAN 75	68.18	45	63.79	52.40	930	96
23 JAN 75	67.82	2330	63.30	52.28	945	96
24 JAN 75	70.28	1630	67.71	63.62	915	94
25 JAN 75	68.36	15	45.02	36.08	1200	96
26 JAN 75	41.48	30	36.66	35.06	830	96
27 JAN 75	40.88	1800	38.29	34.28	900	96
28 JAN 75	70.40	2030	54.08	38.36	800	96
29 JAN 75	70.46	1600	68.94	64.40	2115	96
30 JAN 75	69.44	2400	66.99	64.52	630	96
31 JAN 75	70.28	1545	69.62	68.54	500	96
AVERAGE	66.48		59.83	51.99		
STND DEV.	7.99		8.92	9.94		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-0

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 FEB 75	69.92	15	56.22	41.00	2345	94
2 FEB 75	42.62	1215	41.44	40.34	515	91
3 FEB 75	66.20	2400	54.70	40.70	445	88
4 FEB 75	72.02	1845	69.96	66.44	15	92
5 FEB 75	71.60	45	66.56	53.78	945	92
6 FEB 75	71.54	2330	66.47	51.86	915	92
7 FEB 75	71.60	15	66.18	54.62	845	91
8 FEB 75	71.18	2400	68.10	63.20	730	91
9 FEB 75	71.30	100	59.79	50.12	1330	92
10 FEB 75	69.14	2230	61.83	49.04	845	93
11 FEB 75	70.52	2400	66.78	56.36	815	91
12 FEB 75	71.12	115	65.67	53.42	815	88
13 FEB 75	70.04	1215	69.00	66.02	2400	90
14 FEB 75	65.72	15	57.39	49.76	700	88
15 FEB 75	69.74	2200	65.62	57.98	15	90
16 FEB 75	69.20	15	54.02	49.58	1945	91
17 FEB 75	66.02	1200	52.30	42.50	2400	95
18 FEB 75	42.32	15	41.44	40.82	545	92
19 FEB 75	42.26	1600	40.22	35.42	930	93
20 FEB 75	42.98	1530	40.83	37.04	845	95
21 FEB 75	47.30	2400	40.39	35.24	615	93
22 FEB 75	55.04	230	41.87	35.18	2345	92
23 FEB 75	68.24	2245	53.56	34.94	300	89
24 FEB 75	70.58	1700	66.70	57.56	530	89
25 FEB 75	70.58	30	67.65	60.32	2400	90
26 FEB 75	59.90	15	43.84	40.22	1100	87
27 FEB 75	41.60	2045	39.02	34.52	945	93
28 FEB 75	66.38	2330	46.37	35.12	945	88
AVERAGE	63.09		55.85	47.61		
STND DEV.	11.24		11.11	10.29		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-0

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 MAR 75	67.88	2345	63.18	54.56	515	85
2 MAR 75	67.94	15	57.66	49.94	1145	38
3 MAR 75	66.56	2245	59.72	49.16	630	89
4 MAR 75	66.56	15	60.52	49.40	845	95
5 MAR 75	58.52	1700	55.14	46.52	945	96
6 MAR 75	69.50	2300	62.36	50.72	600	95
7 MAR 75	70.34	1730	64.99	52.16	930	96
8 MAR 75	71.00	115	64.80	55.58	1015	95
9 MAR 75	65.54	230	56.06	47.90	1030	95
10 MAR 75	69.92	2345	58.62	48.56	515	94
11 MAR 75	71.36	2330	66.23	53.30	930	96
12 MAR 75	71.24	15	64.63	53.78	845	96
13 MAR 75	71.78	1445	66.85	54.08	945	95
14 MAR 75	70.64	130	66.04	52.34	915	95
15 MAR 75	70.40	15	65.14	51.56	900	95
16 MAR 75	70.22	130	56.63	52.22	2130	95
17 MAR 75	74.84	1630	65.16	51.86	845	91
18 MAR 75	75.02	2315	71.15	61.76	915	96
19 MAR 75	74.96	15	68.76	60.62	915	96
20 MAR 75	71.72	15	66.01	56.78	930	96
21 MAR 75	66.62	15	48.14	39.56	1030	96
22 MAR 75	41.66	545	39.62	35.60	1515	96
23 MAR 75	39.14	15	32.85	31.04	800	96
24 MAR 75	42.26	2015	39.41	32.12	200	96
25 MAR 75	44.72	1645	42.19	38.30	1145	96
26 MAR 75	53.30	1230	50.77	43.34	15	96
27 MAR 75	50.00	1700	48.24	46.88	645	96
28 MAR 75	52.64	1730	50.65	48.32	100	96
29 MAR 75	53.84	1030	52.33	49.64	2345	96
30 MAR 75	57.08	1815	54.57	49.52	45	96
31 MAR 75	55.52	115	50.80	47.54	2300	96
AVERAGE	62.99		57.03	48.85		
STND DEV.	10.86		9.73	7.27		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-0

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 APR 75	50.96	2315	49.79	47.84	15	96
2 APR 75	50.90	15	43.96	36.32	2400	95
3 APR 75	51.02	2400	43.04	35.42	400	96
4 APR 75	51.08	15	49.30	47.54	2000	96
5 APR 75	48.26	600	47.23	44.90	2000	96
6 APR 75	48.50	1445	47.54	45.32	15	96
7 APR 75	50.48	1530	49.10	47.30	15	96
8 APR 75	52.40	1530	50.47	48.92	630	96
9 APR 75	50.48	15	49.85	48.68	2100	94
10 APR 75	52.04	1330	50.82	49.40	115	96
11 APR 75	55.10	1715	53.87	51.74	15	96
12 APR 75	57.32	1430	55.74	54.74	15	61
13 APR 75	NO DATA FOR THIS DAY					
14 APR 75	NO DATA FOR THIS DAY					
15 APR 75	58.40	1445	57.83	57.32	1600	38
16 APR 75	58.82	130	57.85	56.30	2145	96
17 APR 75	58.34	145	57.61	57.02	1130	96
18 APR 75	58.94	500	57.01	53.18	1330	96
19 APR 75	59.72	2045	58.46	56.36	1415	96
20 APR 75	59.30	15	55.14	49.22	2400	96
21 APR 75	50.00	1815	49.40	48.32	200	96
22 APR 75	53.00	1600	51.94	49.64	45	96
23 APR 75	59.36	1730	56.01	53.06	15	96
24 APR 75	57.98	2245	56.68	54.92	930	96
25 APR 75	65.18	1315	58.11	55.76	1145	95
26 APR 75	59.42	345	57.02	52.64	2400	96
27 APR 75	52.22	15	47.43	45.20	1100	96
28 APR 75	49.22	145	47.51	44.42	1015	96
29 APR 75	51.56	2330	48.54	43.88	1015	96
30 APR 75	52.34	1600	51.05	48.20	930	96
AVERAGE	54.36		52.08	49.41		
STND DEV.	4.45		4.60	5.61		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-0

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 MAY 75	56.42	1300	52.91	49.46	715	95
2 MAY 75	53.60	15	52.09	49.22	800	96
3 MAY 75	55.34	1645	53.38	51.20	815	96
4 MAY 75	55.16	1900	51.83	48.56	1200	96
5 MAY 75	62.48	1730	58.56	51.20	45	96
6 MAY 75	71.66	2330	65.45	61.52	715	87
7 MAY 75	71.66	415	69.38	63.86	1130	87
8 MAY 75	75.50	1515	69.33	64.34	45	96
9 MAY 75	68.90	1500	66.16	59.84	845	96
10 MAY 75	69.26	1300	66.96	61.52	915	96
11 MAY 75	69.98	1515	67.28	63.20	515	96
12 MAY 75	71.06	1430	68.09	61.82	2400	96
13 MAY 75	61.34	15	59.56	58.58	615	96
14 MAY 75	61.88	1615	59.35	54.80	730	96
15 MAY 75	75.62	1600	71.36	61.82	15	96
16 MAY 75	75.62	1615	73.41	70.34	730	96
17 MAY 75	74.84	1500	71.59	67.52	445	96
18 MAY 75	74.78	1830	72.49	69.62	930	96
19 MAY 75	78.02	1630	74.74	71.36	630	96
20 MAY 75	75.68	15	67.07	62.24	830	96
21 MAY 75	83.60	1545	77.58	69.14	15	96
22 MAY 75	81.44	1530	80.06	78.56	815	96
23 MAY 75	85.04	1630	81.26	78.74	530	96
24 MAY 75	83.48	1300	80.20	71.30	2345	96
25 MAY 75	71.48	1600	70.34	69.26	730	96
26 MAY 75	82.94	2230	73.05	65.54	715	96
27 MAY 75	83.84	1715	80.32	73.64	545	96
28 MAY 75	83.12	2145	80.76	77.54	645	96
29 MAY 75	85.10	1415	81.59	75.50	715	96
30 MAY 75	84.38	1530	80.92	71.78	645	96
31 MAY 75	87.02	1745	83.66	78.44	630	96
AVERAGE	73.23		69.70	64.88		
STND DEV.	9.98		9.55	9.09		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-0

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 AUG 75	NO DATA FOR THIS DAY					
2 AUG 75	NO DATA FOR THIS DAY					
3 AUG 75	NO DATA FOR THIS DAY					
4 AUG 75	95.42	1630	93.30	31.28	1000	56
5 AUG 75	95.78	1400	92.10	83.72	2400	96
6 AUG 75	83.66	30	82.13	80.36	2400	96
7 AUG 75	80.36	15	78.88	77.00	2330	96
8 AUG 75	87.38	2200	81.60	76.10	545	96
9 AUG 75	89.48	1745	87.10	83.84	700	96
10 AUG 75	91.40	1645	88.46	85.76	630	96
11 AUG 75	93.20	1600	91.05	88.76	715	96
12 AUG 75	93.74	1830	91.67	89.78	600	96
13 AUG 75	94.04	1715	91.96	88.22	2400	96
14 AUG 75	89.96	100	83.79	81.50	2045	96
15 AUG 75	85.34	45	84.90	84.44	15	3
16 AUG 75	NO DATA FOR THIS DAY					
17 AUG 75	NO DATA FOR THIS DAY					
18 AUG 75	NO DATA FOR THIS DAY					
19 AUG 75	NO DATA FOR THIS DAY					
20 AUG 75	NO DATA FOR THIS DAY					
21 AUG 75	86.42	1845	84.22	78.08	1400	57
22 AUG 75	87.56	1545	84.86	82.76	830	96
23 AUG 75	86.30	1945	83.88	80.42	745	96
24 AUG 75	84.62	15	83.35	81.92	745	96
25 AUG 75	84.68	1645	83.57	82.46	600	96
26 AUG 75	83.90	15	82.32	79.40	345	96
27 AUG 75	82.76	1800	81.44	80.24	2400	96
28 AUG 75	83.30	830	81.73	79.58	300	96
29 AUG 75	82.28	1545	81.34	79.88	2200	96
30 AUG 75	83.72	215	81.83	79.34	2130	96
31 AUG 75	80.96	1600	77.10	70.94	815	96
AVERAGE	87.22		84.89	79.38		
STND DEV.	4.74		4.50	11.31		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-0

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 SEP 75	81.14	1645	77.70	70.04	345	96
2 SEP 75	81.86	2230	80.23	78.92	745	96
3 SEP 75	81.86	15	79.87	78.08	1345	96
4 SEP 75	82.52	1930	80.58	78.68	630	96
5 SEP 75	83.12	1830	81.33	79.40	800	96
6 SEP 75	83.54	2030	81.66	80.72	815	96
7 SEP 75	83.12	1930	81.14	78.62	2400	96
8 SEP 75	81.20	2400	77.57	72.68	530	96
9 SEP 75	82.76	130	80.85	79.70	1200	96
10 SEP 75	80.00	1930	78.95	77.66	1130	95
11 SEP 75	82.34	2045	79.87	77.36	915	96
12 SEP 75	82.46	1615	81.09	79.70	2345	96
13 SEP 75	79.58	15	75.61	74.30	745	96
14 SEP 75	75.08	15	73.50	71.12	1100	96
15 SEP 75	73.22	1830	71.88	70.10	900	96
16 SEP 75	73.88	2315	72.03	70.64	830	96
17 SEP 75	74.00	1630	73.33	72.50	1015	96
18 SEP 75	73.40	15	71.34	66.62	2030	96
19 SEP 75	76.04	1615	75.44	71.90	15	95
20 SEP 75	78.26	2300	76.57	75.26	430	96
21 SEP 75	79.58	1630	78.38	76.82	2400	96
22 SEP 75	76.76	15	74.95	73.52	1145	96
23 SEP 75	77.12	415	76.77	76.40	2300	96
24 SEP 75	76.46	15	74.98	72.20	2245	96
25 SEP 75	72.74	30	71.39	70.88	745	96
26 SEP 75	72.20	2345	71.42	70.82	215	96
27 SEP 75	74.30	1630	73.20	72.20	15	96
28 SEP 75	73.28	15	72.25	71.48	2400	96
29 SEP 75	73.10	1800	71.46	69.86	745	96
30 SEP 75	74.24	1945	71.58	69.08	745	96
AVERAGE	77.97		76.23	74.24		
STND DEV.	3.95		3.70	3.93		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-0

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 OCT 75	76.16	1615	74.25	72.14	815	96
2 OCT 75	74.78	15	72.51	59.12	2400	95
3 OCT 75	58.10	15	55.68	54.50	345	96
4 OCT 75	55.94	1445	55.17	54.44	645	96
5 OCT 75	55.28	1615	54.46	53.60	715	96
6 OCT 75	55.70	1515	54.63	53.72	745	96
7 OCT 75	54.74	1530	53.92	53.12	830	96
8 OCT 75	58.82	2400	54.32	52.46	715	96
9 OCT 75	69.38	1700	67.45	59.84	15	96
10 OCT 75	69.32	1445	67.67	65.84	830	96
11 OCT 75	69.62	1945	68.96	67.94	15	96
12 OCT 75	69.32	15	67.10	63.68	830	96
13 OCT 75	68.48	1415	66.40	62.00	800	96
14 OCT 75	68.12	1830	66.16	61.76	730	96
15 OCT 75	70.82	1700	67.20	62.24	630	96
16 OCT 75	69.38	15	68.02	64.46	645	96
17 OCT 75	69.86	2345	67.65	62.36	700	96
18 OCT 75	69.62	15	65.29	62.42	800	96
19 OCT 75	68.36	100	63.97	58.04	730	96
20 OCT 75	69.20	1530	65.57	59.42	715	96
21 OCT 75	68.42	15	62.40	58.58	830	36
22 OCT 75	NO DATA FOR THIS DAY					
23 OCT 75	NO DATA FOR THIS DAY					
24 OCT 75	NO DATA FOR THIS DAY					
25 OCT 75	NO DATA FOR THIS DAY					
26 OCT 75	NO DATA FOR THIS DAY					
27 OCT 75	NO DATA FOR THIS DAY					
28 OCT 75	49.16	1830	47.80	27.68	1545	33
29 OCT 75	48.26	15	47.24	45.32	2230	93
30 OCT 75	52.22	930	50.48	35.12	1345	55
31 OCT 75	NO DATA FOR THIS DAY					
AVERAGE	64.12		61.84	57.07		
STND DEV.	8.31		7.88	9.84		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-0

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 NOV 75	NO DATA FOR THIS DAY					
2 NOV 75	NO DATA FOR THIS DAY					
3 NOV 75	46.10	1530	45.25	44.64	1115	52
4 NOV 75	46.70	1415	45.61	44.78	30	96
5 NOV 75	54.02	2315	49.32	45.50	530	96
6 NOV 75	56.18	2400	53.91	53.12	1015	96
7 NOV 75	75.68	2200	64.11	55.64	1000	96
8 NOV 75	79.04	1615	77.72	75.50	15	91
9 NOV 75	NO DATA FOR THIS DAY					
10 NOV 75	NO DATA FOR THIS DAY					
11 NOV 75	NO DATA FOR THIS DAY					
12 NOV 75	NO DATA FOR THIS DAY					
13 NOV 75	NO DATA FOR THIS DAY					
14 NOV 75	75.20	1445	74.00	73.40	2000	38
15 NOV 75	74.90	315	74.48	74.12	15	13
16 NOV 75	NO DATA FOR THIS DAY					
17 NOV 75	NO DATA FOR THIS DAY					
18 NOV 75	NO DATA FOR THIS DAY					
19 NOV 75	75.08	2345	73.96	73.46	1715	34
20 NOV 75	75.26	30	73.75	72.14	945	96
21 NOV 75	75.38	2315	74.27	73.10	1900	96
22 NOV 75	75.56	115	72.34	70.34	1845	96
23 NOV 75	73.46	400	73.01	72.26	2345	96
24 NOV 75	72.26	15	71.42	70.64	1200	96
25 NOV 75	72.62	1830	72.00	71.36	145	96
26 NOV 75	72.74	1345	68.07	52.58	2400	96
27 NOV 75	52.52	15	49.27	48.74	1030	96
28 NOV 75	48.80	30	48.44	48.08	900	96
29 NOV 75	48.14	15	47.56	47.12	900	96
30 NOV 75	47.84	2400	47.09	45.38	1900	96
AVERAGE	64.87		62.77	60.60		
STND DEV.	12.70		12.51	12.67		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-0

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 DEC 75	49.34	1645	48.96	48.02	15	95
2 DEC 75	70.82	2400	60.52	49.04	15	96
3 DEC 75	71.72	900	71.06	69.98	2400	96
4 DEC 75	70.16	200	67.39	62.66	930	96
5 DEC 75	72.32	2345	70.50	69.32	815	96
6 DEC 75	75.08	2015	73.29	72.08	630	96
7 DEC 75	73.22	15	70.80	67.46	945	96
8 DEC 75	73.82	2015	72.49	71.60	815	96
9 DEC 75	73.58	15	55.82	44.60	2145	96
10 DEC 75	45.98	1800	45.40	44.84	30	96
11 DEC 75	66.20	2400	52.71	45.26	400	96
12 DEC 75	68.72	530	64.48	60.44	1800	96
13 DEC 75	70.40	2315	64.47	63.02	1500	96
14 DEC 75	71.12	500	59.50	44.24	2400	96
15 DEC 75	57.32	2400	45.50	44.00	415	96
16 DEC 75	72.20	2345	69.10	59.66	15	96
17 DEC 75	73.64	2315	71.95	68.66	930	96
18 DEC 75	73.58	15	72.22	69.98	2400	96
19 DEC 75	71.18	745	69.97	68.48	2000	96
20 DEC 75	71.60	445	66.91	58.46	1415	96
21 DEC 75	70.34	15	48.12	41.54	2400	96
22 DEC 75	68.00	2400	52.40	41.00	500	96
23 DEC 75	70.16	1815	68.80	66.08	330	96
24 DEC 75	70.76	2115	67.88	62.66	500	96
25 DEC 75	72.02	2145	70.58	65.48	30	96
26 DEC 75	72.02	2030	70.86	68.54	230	96
27 DEC 75	70.76	15	59.96	56.54	2030	96
28 DEC 75	60.93	1615	60.21	59.18	15	96
29 DEC 75	72.20	1600	69.60	60.68	30	96
30 DEC 75	72.62	1345	71.60	70.46	2345	96
31 DEC 75	73.40	1200	72.39	70.40	15	54
AVERAGE	69.20		64.04	59.49		
STND DEV.	6.80		8.86	10.50		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-4

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 APR 75	NO DATA FOR THIS DAY					
2 APR 75	NO DATA FOR THIS DAY					
3 APR 75	NO DATA FOR THIS DAY					
4 APR 75	NO DATA FOR THIS DAY					
5 APR 75	NO DATA FOR THIS DAY					
6 APR 75	NO DATA FOR THIS DAY					
7 APR 75	NO DATA FOR THIS DAY					
8 APR 75	NO DATA FOR THIS DAY					
9 APR 75	NO DATA FOR THIS DAY					
10 APR 75	NO DATA FOR THIS DAY					
11 APR 75	NO DATA FOR THIS DAY					
12 APR 75	NO DATA FOR THIS DAY					
13 APR 75	NO DATA FOR THIS DAY					
14 APR 75	NO DATA FOR THIS DAY					
15 APR 75	42.86	1730	42.75	42.20	1615	32
16 APR 75	44.36	1730	43.22	42.20	730	96
17 APR 75	45.56	1830	44.31	43.16	800	96
18 APR 75	45.56	1430	44.66	43.64	800	96
19 APR 75	44.96	730	44.63	44.42	1400	96
20 APR 75	44.60	15	43.76	42.92	2300	96
21 APR 75	42.92	15	41.91	41.24	2345	96
22 APR 75	43.46	1600	41.42	40.34	715	96
23 APR 75	43.88	2400	42.56	41.24	730	96
24 APR 75	44.00	2400	43.79	43.64	845	96
25 APR 75	45.62	2315	44.65	43.94	800	96
26 APR 75	46.10	1345	45.58	45.14	800	96
27 APR 75	45.32	1900	44.64	43.88	800	96
28 APR 75	45.14	30	44.59	44.12	2400	96
29 APR 75	45.02	1545	44.12	43.04	715	96
30 APR 75	46.28	1715	45.08	43.82	745	96
AVERAGE	44.72		43.85	43.05		
STND DEV.	1.06		1.17	1.30		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-4

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 MAY 75	48.68	1530	47.12	46.04	500	95
2 MAY 75	48.32	1300	47.78	47.00	2115	96
3 MAY 75	50.60	1800	49.22	47.72	30	96
4 MAY 75	50.36	45	49.26	48.32	2345	96
5 MAY 75	49.64	2400	48.57	47.72	945	96
6 MAY 75	52.40	1630	50.90	49.52	15	96
7 MAY 75	52.46	1500	52.09	51.50	2315	79
8 MAY 75	55.16	1630	53.40	51.44	145	96
9 MAY 75	56.60	1715	55.21	53.96	630	96
10 MAY 75	57.38	1315	56.20	55.46	715	96
11 MAY 75	58.22	1730	56.43	55.10	530	96
12 MAY 75	59.36	1545	57.48	56.06	430	96
13 MAY 75	58.40	1530	57.17	55.94	2215	96
14 MAY 75	59.00	1500	57.50	56.06	615	96
15 MAY 75	61.22	1815	59.62	57.38	45	96
16 MAY 75	61.34	1645	60.38	59.66	100	96
17 MAY 75	62.84	1800	60.85	58.52	130	96
18 MAY 75	64.04	1745	62.03	60.80	800	96
19 MAY 75	65.78	1845	63.33	61.04	415	96
20 MAY 75	67.16	1730	65.04	62.84	715	96
21 MAY 75	73.52	1415	68.44	64.94	200	96
22 MAY 75	73.04	1100	68.84	66.44	1000	96
23 MAY 75	76.94	1700	70.96	66.38	745	78
24 MAY 75	76.22	1200	72.67	69.26	715	96
25 MAY 75	70.94	1715	69.39	68.30	700	96
26 MAY 75	76.70	1945	70.18	67.04	815	96
27 MAY 75	77.72	300	75.25	72.26	700	96
28 MAY 75	78.50	2130	75.34	68.60	1045	96
29 MAY 75	79.70	1900	75.80	67.88	930	96
30 MAY 75	80.06	1600	76.37	68.66	730	96
31 MAY 75	82.64	1900	78.94	73.88	800	96
AVERAGE	64.03		61.66	59.21		
STND DEV.	10.93		9.76	8.26		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-4

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 JUN 75	81.74	15	78.77	75.62	400	96
2 JUN 75	79.94	100	72.09	68.60	930	96
3 JUN 75	70.10	2230	69.08	67.58	2345	96
4 JUN 75	75.98	600	71.48	66.98	900	96
5 JUN 75	72.62	1545	71.10	68.60	1115	96
6 JUN 75	72.02	200	66.33	62.48	2130	96
7 JUN 75	65.54	200	63.34	62.36	2200	96
8 JUN 75	64.40	915	63.19	60.74	2245	96
9 JUN 75	64.94	1900	62.82	61.22	800	96
10 JUN 75	67.64	2100	62.97	61.04	745	96
11 JUN 75	74.30	1630	68.68	62.66	800	96
12 JUN 75	70.88	15	68.65	66.80	2145	96
13 JUN 75	69.08	1630	67.48	65.00	2115	96
14 JUN 75	66.62	45	65.48	64.46	2200	96
15 JUN 75	66.86	1515	65.43	64.46	100	96
16 JUN 75	66.98	1645	65.65	64.34	1030	96
17 JUN 75	68.96	1700	67.08	65.30	145	96
18 JUN 75	74.00	2145	70.24	67.40	415	96
19 JUN 75	76.82	1945	72.59	69.20	545	96
20 JUN 75	77.18	1600	72.00	69.50	945	96
21 JUN 75	71.36	1800	70.35	69.08	615	96
22 JUN 75	73.04	1600	71.19	69.32	630	96
23 JUN 75	75.98	1730	73.30	70.88	615	96
24 JUN 75	80.90	1415	76.69	74.54	530	96
25 JUN 75	87.44	1400	84.31	77.96	30	96
26 JUN 75	87.86	1415	84.84	81.74	1130	96
27 JUN 75	88.16	2030	84.93	81.32	645	96
28 JUN 75	86.72	100	80.73	78.38	700	96
29 JUN 75	90.38	1700	86.12	79.46	15	96
30 JUN 75	86.66	1715	84.33	81.56	445	96
AVERAGE	75.16		72.04	69.28		
STND DEV.	7.92		7.28	6.56		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-4

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 JUL 75	87.38	2100	84.58	81.62	745	96
2 JUL 75	88.94	1500	86.07	81.38	900	96
3 JUL 75	88.76	30	87.41	84.92	1315	96
4 JUL 75	90.20	1445	88.04	85.40	745	96
5 JUL 75	91.34	1745	89.24	86.96	700	96
6 JUL 75	92.42	1600	89.91	86.60	2330	96
7 JUL 75	91.34	1545	89.16	87.98	45	96
8 JUL 75	91.10	1645	89.43	87.98	715	96
9 JUL 75	90.26	1145	86.52	55.88	1230	52
10 JUL 75	91.94	1430	90.72	88.94	2315	47
11 JUL 75	91.04	1715	89.75	88.64	630	96
12 JUL 75	90.02	1600	88.71	86.84	1115	96
13 JUL 75	89.42	1345	87.67	86.00	1130	96
14 JUL 75	87.08	215	83.20	78.86	2015	96
15 JUL 75	79.40	200	78.22	77.24	1345	96
16 JUL 75	77.78	1315	76.53	75.56	1945	96
17 JUL 75	77.42	2315	75.87	74.48	715	96
18 JUL 75	81.56	2300	78.74	75.26	845	96
19 JUL 75	81.92	2345	80.98	80.00	1245	96
20 JUL 75	83.96	1915	82.24	80.78	1300	96
21 JUL 75	88.52	1930	84.44	81.86	1445	96
22 JUL 75	87.44	1400	86.01	83.90	945	96
23 JUL 75	87.56	1300	85.56	82.94	745	96
24 JUL 75	86.66	2400	84.21	80.72	815	96
25 JUL 75	88.40	1830	86.54	84.38	2330	96
26 JUL 75	84.02	15	82.62	80.66	1045	96
27 JUL 75	84.44	1345	82.01	78.86	830	96
28 JUL 75	85.52	1545	83.45	80.84	400	96
29 JUL 75	86.84	930	84.40	82.52	1300	96
30 JUL 75	88.58	2245	85.89	83.78	630	96
31 JUL 75	90.56	2345	88.42	86.48	730	96
AVERAGE	87.15		85.04	81.87		
STND DEV.	4.09		3.98	6.27		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-4

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 AUG 75	93.80	1430	90.63	87.50	1645	96
2 AUG 75	94.22	2200	92.00	90.14	530	96
3 AUG 75	94.52	1600	93.03	91.52	2400	96
4 AUG 75	91.94	1845	91.06	90.02	800	89
5 AUG 75	93.50	1615	90.75	88.40	1000	96
6 AUG 75	87.86	15	82.26	80.36	2345	96
7 AUG 75	80.48	30	78.66	76.94	2400	96
8 AUG 75	83.54	1945	78.29	75.50	915	96
9 AUG 75	84.92	2200	82.86	80.54	845	96
10 AUG 75	87.62	2330	83.99	80.90	930	96
11 AUG 75	90.32	1915	87.07	82.76	1215	96
12 AUG 75	90.26	2215	87.33	84.50	1600	96
13 AUG 75	90.44	2115	88.10	86.06	1000	96
14 AUG 75	89.24	215	83.57	79.28	1615	96
15 AUG 75	87.86	2345	84.71	80.00	15	96
16 AUG 75	87.74	45	85.45	83.18	1015	96
17 AUG 75	85.28	1500	84.06	83.30	1715	96
18 AUG 75	87.92	1715	84.52	82.58	1000	96
19 AUG 75	85.76	100	84.30	82.28	1000	96
20 AUG 75	84.56	1515	83.19	81.62	2100	96
21 AUG 75	83.72	2215	81.56	79.64	830	96
22 AUG 75	84.20	1500	81.41	77.96	1930	96
23 AUG 75	82.76	2345	80.53	78.44	945	96
24 AUG 75	83.30	200	80.94	79.40	945	96
25 AUG 75	83.00	1930	81.60	80.42	730	96
26 AUG 75	82.64	45	81.45	79.58	1245	96
27 AUG 75	95.66	1815	80.46	79.16	845	80
28 AUG 75	85.76	1345	80.62	73.70	1330	96
29 AUG 75	82.16	15	80.94	79.46	1115	96
30 AUG 75	81.20	815	78.51	75.26	1900	96
31 AUG 75	78.92	1930	75.42	71.00	1045	96
AVERAGE	86.93		83.84	81.33		
STND DEV.	4.53		4.37	4.79		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-4

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 SEP 75	79.76	2030	75.70	70.52	1200	96
2 SEP 75	78.44	15	77.31	75.98	1100	56
3 SEP 75	NO DATA FOR THIS DAY					
4 SEP 75	78.86	1845	76.83	74.78	1215	54
5 SEP 75	80.84	2100	78.64	75.38	1300	96
6 SEP 75	81.14	2145	78.87	76.16	1030	96
7 SEP 75	80.72	2015	78.47	75.08	1100	96
8 SEP 75	77.18	2345	75.13	72.26	1045	96
9 SEP 75	80.42	345	77.15	74.06	1445	96
10 SEP 75	77.60	30	74.86	71.96	1615	95
11 SEP 75	77.78	1830	75.35	72.68	500	96
12 SEP 75	78.38	1645	76.32	73.70	2300	96
13 SEP 75	75.02	45	72.55	69.26	2345	96
14 SEP 75	72.50	100	70.13	65.72	1800	96
15 SEP 75	71.36	1615	69.95	68.12	715	96
16 SEP 75	71.66	1830	70.17	68.72	2400	96
17 SEP 75	72.38	1415	69.76	66.20	2400	96
18 SEP 75	71.42	1730	68.81	63.50	2400	96
19 SEP 75	72.56	2230	70.25	65.12	15	94
20 SEP 75	73.64	1430	71.38	66.32	245	96
21 SEP 75	75.68	1615	72.95	69.38	2115	96
22 SEP 75	73.16	1230	70.83	68.00	2100	96
23 SEP 75	72.86	1445	69.55	67.22	1745	96
24 SEP 75	68.30	515	66.37	63.56	1415	96
25 SEP 75	67.46	2115	65.99	64.40	930	96
26 SEP 75	68.24	330	66.15	64.64	2330	96
27 SEP 75	66.74	230	63.08	61.04	730	96
28 SEP 75	63.26	30	62.61	61.76	1115	96
29 SEP 75	63.80	1745	62.70	61.58	1230	96
30 SEP 75	64.88	2200	63.58	62.42	615	96
AVERAGE	73.65		71.42	68.60		
STND DEV.	5.37		5.10	4.81		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- OK S-4

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 OCT 75	66.08	2215	64.87	64.22	1345	96
2 OCT 75	65.90	15	63.20	59.54	2400	96
3 OCT 75	59.42	15	59.33	57.80	730	96
4 OCT 75	59.54	1400	57.85	57.20	700	96
5 OCT 75	57.86	1315	57.29	55.66	730	96
6 OCT 75	58.28	1500	57.41	56.60	645	96
7 OCT 75	57.68	1415	56.91	56.24	715	96
8 OCT 75	57.32	1515	56.53	55.52	700	96
9 OCT 75	64.70	1500	61.49	56.72	30	96
10 OCT 75	66.32	1745	63.11	59.60	600	96
11 OCT 75	65.48	500	63.75	60.68	2100	96
12 OCT 75	60.98	15	57.65	56.06	1930	96
13 OCT 75	59.78	2245	57.96	55.04	915	96
14 OCT 75	60.08	2015	58.57	56.90	1345	96
15 OCT 75	61.70	1745	60.02	58.22	700	96
16 OCT 75	61.46	2215	58.81	56.42	945	96
17 OCT 75	62.66	1945	60.15	57.26	930	96
18 OCT 75	62.42	230	58.35	56.84	930	96
19 OCT 75	58.34	30	56.23	55.10	1015	96
20 OCT 75	56.36	30	54.02	52.82	2100	80
21 OCT 75	51.32	1345	50.91	50.48	2400	58
22 OCT 75	51.50	2115	50.81	50.18	815	96
23 OCT 75	52.34	2200	51.66	51.02	830	96
24 OCT 75	53.00	1500	52.54	51.92	830	96
25 OCT 75	52.94	15	52.45	52.16	930	96
26 OCT 75	53.00	900	52.66	52.22	2315	96
27 OCT 75	52.16	15	51.73	51.26	830	96
28 OCT 75	51.56	15	51.33	51.08	745	34
29 OCT 75	51.26	1815	50.99	50.36	845	62
30 OCT 75	51.26	30	50.37	49.34	2145	96
31 OCT 75	49.46	15	48.59	33.92	900	36
AVERAGE	57.78		56.33	54.49		
STND DEV.	5.22		4.48	5.21		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-4

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 NOV 75	NO DATA FOR THIS DAY					
2 NOV 75	NO DATA FOR THIS DAY					
3 NOV 75	48.20	1430	47.80	47.00	1030	55
4 NOV 75	49.58	1445	48.63	47.72	15	96
5 NOV 75	50.18	1445	49.42	48.74	800	96
6 NOV 75	50.24	1515	49.55	48.92	815	96
7 NOV 75	52.04	2400	49.69	48.38	900	96
8 NOV 75	54.08	1415	51.99	50.42	500	96
9 NOV 75	52.46	1930	51.85	51.26	745	96
10 NOV 75	52.04	15	51.26	50.60	915	96
11 NOV 75	50.96	15	50.52	50.00	2345	96
12 NOV 75	50.84	2345	49.82	48.86	945	96
13 NOV 75	50.78	115	50.47	50.12	2145	96
14 NOV 75	50.24	15	49.12	47.36	2400	96
15 NOV 75	47.30	15	46.22	45.44	2400	96
16 NOV 75	45.62	15	45.17	44.72	2215	96
17 NOV 75	45.32	2000	44.88	44.06	830	96
18 NOV 75	45.50	1715	45.04	44.72	615	96
19 NOV 75	45.98	2315	45.23	44.00	800	96
20 NOV 75	46.40	2115	45.92	45.38	1000	96
21 NOV 75	47.18	745	46.29	45.20	800	96
22 NOV 75	46.40	15	45.70	44.90	2345	96
23 NOV 75	45.08	45	44.09	43.34	2345	96
24 NOV 75	43.76	30	43.10	42.68	1230	95
25 NOV 75	43.64	1730	43.07	42.68	115	96
26 NOV 75	43.52	1545	42.60	40.76	2345	96
27 NOV 75	40.82	15	40.30	39.92	2330	96
28 NOV 75	39.92	15	39.52	39.26	2400	96
29 NOV 75	39.26	15	38.53	38.12	845	96
30 NOV 75	38.96	2400	38.39	38.12	315	96
AVERAGE	47.01		46.22	45.45		
STND DEV.	4.18		4.00	3.87		

ALL TEMPERATURE READINGS IN DEGREES F

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

ENVIRONMENTAL TEMPERATURE TAPE -- MERRIMACK RIVER -- MK S-4

DAY	MAX. TEMP.	TIME	DAILY AVE.	MIN. TEMP.	TIME	NO. INT
1 DEC 75	40.64	1500	39.94	38.96	15	96
2 DEC 75	41.48	1600	40.30	39.14	845	96
3 DEC 75	41.66	315	40.81	39.86	2245	96
4 DEC 75	39.86	15	38.15	32.96	1500	96
5 DEC 75	39.26	1500	36.70	35.66	845	96
6 DEC 75	40.28	1845	38.34	36.56	845	96
7 DEC 75	39.86	45	38.85	37.40	2215	96
8 DEC 75	38.84	15	36.55	35.12	2115	96
9 DEC 75	38.60	500	35.13	34.22	945	96
10 DEC 75	36.14	1445	35.18	34.40	1515	61
11 DEC 75	NO DATA FOR THIS DAY					
12 DEC 75	NO DATA FOR THIS DAY					
13 DEC 75	NO DATA FOR THIS DAY					
14 DEC 75	NO DATA FOR THIS DAY					
15 DEC 75	NO DATA FOR THIS DAY					
16 DEC 75	NO DATA FOR THIS DAY					
17 DEC 75	NO DATA FOR THIS DAY					
18 DEC 75	NO DATA FOR THIS DAY					
19 DEC 75	NO DATA FOR THIS DAY					
20 DEC 75	NO DATA FOR THIS DAY					
21 DEC 75	NO DATA FOR THIS DAY					
22 DEC 75	NO DATA FOR THIS DAY					
23 DEC 75	NO DATA FOR THIS DAY					
24 DEC 75	NO DATA FOR THIS DAY					
25 DEC 75	NO DATA FOR THIS DAY					
26 DEC 75	NO DATA FOR THIS DAY					
27 DEC 75	NO DATA FOR THIS DAY					
28 DEC 75	NO DATA FOR THIS DAY					
29 DEC 75	NO DATA FOR THIS DAY					
30 DEC 75	NO DATA FOR THIS DAY					
31 DEC 75	NO DATA FOR THIS DAY					
AVERAGE	39.66		37.99	36.42		
STND DEV.	1.60		2.04	2.35		

ALL TEMPERATURE READINGS IN DEGREES F

APPENDIX II

APPENDIX II.

TABLE 1 A. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF DIATOMS FROM SURFACE TOWS, 1975, AFTER LOG_e (x + 1) TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	6.68124	26.54159 **
2	Station	3	0.65406	2.59833
3	Date*Station	90	0.25172	
4	TOTAL	123	1.82971	

TABLE 1 B. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF GREENS FROM SURFACE TOWS, 1975, AFTER LOG_e (x + 1) TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	1.51803	5.29604 **
2	Station	3	0.33936	1.18394
3	Date*Station	90	0.28663	
4	TOTAL	123	0.58826	

TABLE 1 C. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF BLUE-GREENS FROM SURFACE TOWS, 1975, AFTER LOG_e (x + 1) TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	126.18573	10.28703 **
2	Station	3	3.93328	0.32065
3	Date*Station	90	12.26648	
4	TOTAL	123	39.84841	

TABLE 1 D. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF YELLOWGREENS FROM SURFACE TOWS, 1975, AFTER LOG_e (x + 1) TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	73.12608	6.42084 **
2	Station	3	17.93056	1.57440
3	Date*Station	90	11.38885	
4	TOTAL	123	26.60627	

* $p < .05$

** $p < .01$

TABLE 1 E. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF TOTAL PHYTOPLANKTON FROM SURFACE TOWS, 1975, AFTER $\log_e (x + 1)$ TRANSFORMATION.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	2.30333	16.14310 **
2	Station	3	0.20419	1.43110
3	Date*Station	90	0.14268	
4	TOTAL	123	0.67117	

TABLE 1 F. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF ZOOPLANKTON FROM SURFACE TOWS, 1975, AFTER $\log_e (x + 1)$ TRANSFORMATION.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	2.10493	9.73041 **
2	Station	3	0.66899	3.09252
3	Date*Station	90	0.21632	
4	TOTAL	123	0.68800	

TABLE 1 G. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF DIATOMS FROM SURFACE TOWS, 1975, AFTER ARCSIN $\sqrt{P}$ TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	0.21625	10.82905 **
2	Station	3	0.06085	3.04709 *
3	Date*Station	90	0.01996	
4	TOTAL	123	0.06884	

TABLE 1 H. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF GREENS FROM SURFACE TOWS, 1975, AFTER ARCSIN $\sqrt{P}$ TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	0.40666	22.21496 **
2	Station	3	0.00282	0.15432
3	Date*Station	90	0.01830	
4	TOTAL	123	0.11264	

TABLE 1 I. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF BLUE-GREENS FROM SURFACE TOWS, 1975, AFTER ARCSIN $\sqrt{P}$ TRANSFORMATION.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	0.19852	9.20855 **
2	Station	3	0.08932	4.14326 **
3	Date*Station	90	0.02155	
4	TOTAL	123	0.06637	

TABLE 1 J. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF YELLOW-GREENS FROM SURFACE TOWS, 1975, AFTER ARCSIN $\sqrt{P}$ TRANSFORMATION.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	0.09269	13.41365 **
2	Station	3	0.02611	3.77840 *
3	Date*Station	90	0.00691	
4	TOTAL	123	0.02830	

TABLE 1 K. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF DIATOMS FROM SURFACE AND BOTTOM TOWS AT N-10 AND S-4, 1975, AFTER LOG_e (x + 1) TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	7.16077	26.51094 **
2	Station	1	0.22024	0.81540
3	Depth	1	0.00169	0.00626
4	Date*Station	30	0.25114	0.92981
5	Date*Depth	30	0.10531	0.38992
6	Station*Depth	1	0.05429	0.20103
7	Date*Station*Depth	30	0.27010	
8	TOTAL	123	1.90159	

TABLE 1 L. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF GREENS FROM SURFACE AND BOTTOM TOWS AT N-10 AND S-4, 1975, AFTER LOG_e (x + 1) TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	1.63285	11.83207 **
2	Station	1	0.06753	0.48936
3	Depth	1	0.17424	1.26259
4	Date*Station	30	0.18948	1.37305
5	Date*Depth	30	0.17626	1.27724
6	Station*Depth	1	0.05244	0.38005
7	Date*Station*Depth	30	0.13800	
8	TOTAL	123	0.52351	

TABLE 1 M. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF BLUE-GREENS FROM SURFACE AND BOTTOM TOWS AT N-10 AND S-4, 1975, AFTER LOG_e (x + 1) TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	111.12321	8.20692 **
2	Station	1	3.86883	0.28573
3	Depth	1	10.12174	0.74753
4	Date*Station	30	13.97673	1.03224
5	Date*Depth	30	16.40835	1.21183
6	Station*Depth	1	4.63846	0.34257
7	Date*Station*Depth	30	13.54019	
8	TOTAL	123	37.96816	

TABLE 1 N. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF YELLOW-GREENS FROM SURFACE AND BOTTOM TOWS AT N-10 AND S-4, 1975, AFTER LOG_e (x + 1) TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	79.57910	9.68435 **
2	Station	1	3.79380	0.46169
3	Depth	1	2.20548	0.26840
4	Date*Station	30	5.85279	0.71225
5	Date*Depth	30	9.45016	1.15004
6	Station*Depth	1	1.78684	0.21745
7	Date*Station*Depth	30	8.21728	
8	TOTAL	123	25.20948	

TABLE 1 O. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF TOTAL PHYTOPLANKTON FROM SURFACE AND BOTTOM TOWS AT N-10 AND S-4, 1975, AFTER LOG_e (x + 1) TRANSFORMATION.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	2.10099	58.28830 **
2	Station	1	0.12189	3.38177
3	Depth	1	0.00053	0.01495
4	Date*Station	30	0.09835	2.72877 **
5	Date*Depth	30	0.05282	1.46560
6	Station*Depth	1	0.09485	2.63146
7	Date*Station*Depth	30	0.03604	
8	TOTAL	123	0.55986	

TABLE 1 P. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF ZOOPLANKTON FROM SURFACE AND BOTTOM TOWS AT N-10 AND S-4, 1975, AFTER LOG_e (x + 1) TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	1.99098	8.63819 **
2	Station	1	0.45347	1.96745
3	Depth	1	0.00955	0.04146
4	Date*Station	30	0.29310	1.27169
5	Date*Depth	30	0.16158	0.70107
6	Station*Depth	1	0.02919	0.12666
7	Date*Station*Depth	30	0.23048	
8	TOTAL	123	0.65672	

TABLE 1 Q. ANALYSIS OF VARIANCE FOR PERCENTAGE OF DIATOMS FROM SURFACE AND BOTTOM TOWS AT N-10 AND S-4, 1975, AFTER ARCSIN $\sqrt{P}$ TRANSFORMATION.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	0.25297	23.04866 **
2	Station	1	0.00764	0.69638
3	Depth	1	0.00982	0.89544
4	Date*Station	30	0.01048	0.95534
5	Date*Depth	30	0.00569	0.51888
6	Station*Depth	1	0.00744	0.67873
7	Date*Station*Depth	30	0.01097	
8	TOTAL	123	0.06852	

TABLE 1 R. ANALYSIS OF VARIANCE FOR PERCENTAGE OF GREENS FROM SURFACE AND BOTTOM TOWS AT N-10 AND S-4, 1975, AFTER ARCSIN $\sqrt{P}$ TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	0.39181	39.84774 **
2	Station	1	0.00043	0.04406
3	Depth	1	0.01946	1.97992
4	Date*Station	30	0.01056	1.07490
5	Date*Depth	30	0.00959	0.97613
6	Station*Depth	1	0.00362	0.36872
7	Date*Station*Depth	30	0.00983	
8	TOTAL	123	0.10307	

TABLE 1 S. ANALYSIS OF VARIANCE FOR PERCENTAGE OF BLUE-GREENS FROM SURFACE AND BOTTOM TOWS AT N-10 AND S-4, 1975, AFTER ARCSIN $\sqrt{P}$ TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	0.11786	9.31092 **
2	Station	1	0.07517	5.93854 *
3	Depth	1	0.00121	0.09593
4	Date*Station	30	0.01937	1.53033
5	Date*Depth	30	0.01149	0.90781
6	Station*Depth	1	0.00191	0.15107
7	Date*Station*Depth	30	0.01265	
8	TOTAL	123	0.03999	

TABLE 1 T. ANALYSIS OF VARIANCE FOR PERCENTAGE OF YELLOW-GREENS FROM SURFACE AND BOTTOM TOWS AT N-10 AND S-4, 1975, AFTER ARCSIN $\sqrt{P}$ TRANSFORMATION

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Date	30	0.10698	24.28582 **
2	Station	1	0.01691	3.83914
3	Depth	1	0.00010	0.02450
4	Date*Station	30	0.00568	1.29071
5	Date*Depth	30	0.00409	0.92990
6	Station*Depth	1	0.00026	0.06129
7	Date*Station*Depth	30	0.00440	
8	TOTAL	123	0.02969	

APPENDIX III.

APPENDIX III, TABLE 1. RESULTS OF WILCOXIN MATCHED-PAIRS SIGNED-RANKS TEST (ONE-TAILED TEST) COMPARING % MORTALITY AT INTAKE AND DISCHARGE WEIR.

SPECIES	N	T	P
Diatoms	8	4	0.0273
Green Algae	11	12	.05>p>.025
Bluegreen Algae	4	SAMPLE TOO SMALL	
Total Zooplankton	11	17	>.05

APPENDIX III.

TABLE 2. RESULTS OF LINEAR REGRESSION COMPARING THE CHANGE IN PERCENT MORTALITY BETWEEN THE INTAKE AND THE DISCHARGE WEIR TO AMBIENT RIVER TEMPERATURE AND THE EXPERIENCED Δt.

DIATOMS

Model 1†

SOURCE	DF	SS	MS	F	R^2
Regression	2	4767.637	2383.818	6.213*	0.5799
Deviation	9	3453.008	383.667		
TOTAL	11	8220.645			

Model 2††

SOURCE	DF	SS	MS	F	R^2
Regression	1	1980.498	1980.498	3.174NS	0.241
Deviation	10	6240.145	624.014		
TOTAL	11	8220.643			

Model 1 Adjusted For Model 2

SOURCE	DF	SS	MS	F	R^2
Regression	1	2787.139	2787.139	5.129*	0.339
Deviation	10	5433.506	543.3506		
TOTAL	11	8220.645			

Continued

TABLE 2. (Continued)

GREEN ALGAE

Model 1

SOURCE	DF	SS	MS	F	R^2
Regression	2	1518.331	759.165	2.350^{NS}	0.2774
Deviation	9	2907.255	323.028		
TOTAL	11	4425.586			

Model 2

SOURCE	DF	SS	MS	F	R^2
Regression	1	1449.515	1449.515	4.871^{NS}	0.328
Deviation	10	2976.071	397.6071		
TOTAL	11	4425.586			

Model 1 Adjusted For Model 2

SOURCE	DF	SS	MS	F	R^2
Regression	1	68.816	68.816	0.158^{NS}	0.050
Deviation	10	4356.77	435.677		
TOTAL	11	4425.586			

Continued

TABLE 2. (Continued)

TOTAL ZOOPLANKTON

Model 1

SOURCE	DF	SS	MS	F	R^2
Regression	2	412.186	206.093	0.426^{NS}	0.0962
Deviation	8	3871.023	483.878		
TOTAL	10	4283.199			

Model 2

SOURCE	DF	SS	MS	F	R^2
Regression	1	118.357	118.357	0.256^{NS}	0.0276
Deviation	9	4164.840	462.760		
TOTAL	10	4283.199			

Model 1 Adjusted For Model 2

SOURCE	DF	SS	MS	F	R^2
Regression	1	293.829	293.829	0.663^{NS}	0.0686
Deviation	9	3989.370	443.263		
TOTAL	10	4283.199			

† Model 1 Δ Mortality = a + b_1 (Ambient °F) + b_2 (Δt °F)

†† Model 2 Δ Mortality = a + b_1 (Ambient °F)

* $p < .05$

APPENDIX IV.

APPENDIX IV.

TABLE 2A. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF DIATOMS FROM WEEKLY TWO-FOOT DEPTH PERIPHYTON PANELS AFTER LOG$_e$ (X+1) TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Weeks	24	1.13270	2.905625 **
2	Stations	3	1.28768	3.303183 *
3	W x S	72	0.38983	
	Total	99		

TABLE 2B. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF CHLOROPHYTA FROM WEEKLY TWO-FOOT DEPTH PERIPHYTON PANELS AFTER LOG$_e$ (X+1) TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Weeks	24	11.48890	3.637926 **
2	Stations	3	7.20702	2.282081
3	W x S	72	3.15809	
	Total	99		

TABLE 2C. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF CYANOPHYTA FROM WEEKLY TWO-FOOT DEPTH PERIPHYTON PANELS AFTER LOG$_e$ (X+1) TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Weeks	18	68.19812	6.294667 **
2	Stations	3	6.89985	0.636854
3	W x S	54	10.83427	
	Total	75		

Continued

TABLE 2D. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF ZOOPLANKTON FROM WEEKLY TWO-FOOT DEPTH PERIPHYTON PANELS AFTER LOG_e (X+1) TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Weeks	24	20.62120	2.370906 **
2	Stations	3	6.95207	0.799309
3	W x S	72	8.69760	
	Total	99		

TABLE 2E. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF ZOOFLAGELLATES FROM WEEKLY TWO-FOOT DEPTH PERIPHYTON PANELS AFTER LOG_e (X+1) TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Weeks	7	5.40972	1.708390
2	Stations	3	8.42247	2.659817
3	W x S	21	3.16656	
	Total	31		

TABLE 2F. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF TOTAL PERIPHYTON FROM WEEKLY TWO-FOOT DEPTH PERIPHYTON PANELS AFTER LOG_e(X+1) TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Weeks	24	2.75843	20.348406 **
2	Stations	3	0.08733	0.644216
3	W x S	72	0.13556	
	Total	99		

* $0.05 \geq p \geq 0.01$
** $p \leq 0.01$

TABLE 2G. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF DIATOMS FROM WEEKLY TWO-FOOT DEPTH PERIPHYTON PANELS AFTER ARCSIN$\sqrt{P}$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Weeks	24	0.30595	13.7074 **
2	Stations	3	0.12414	5.5618 **
3	W x S	72	0.02232	
	Total	99		

TABLE 2H. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF CHLOROPHYTA FROM WEEKLY TWO-FOOT DEPTH PERIPHYTON PANELS AFTER ARCSIN$\sqrt{P}$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Weeks	24	0.26751	14.02044 **
2	Stations	3	0.11186	5.8626934 **
3	W x S	72	0.01908	
	Total	99		

TABLE 2I. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF CYANOPHYTA FROM WEEKLY TWO-FOOT DEPTH PERIPHYTON PANELS AFTER ARCSIN$\sqrt{P}$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Weeks	18	0.51881	12.477392 **
2	Stations	3	0.00953	0.22919672
3	W x S	54	0.04158	
	Total	75		

Continued

TABLE 2J. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF ZOOPLANKTON FROM WEEKLY TWO-FOOT DEPTH PERIPHYTON PANELS AFTER ARCSIN $\sqrt{P}$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Weeks	24	0.02279	2.9293059 **
2	Stations	3	0.00570	0.73264781
3	W x S	72	0.00778	
	Total	99		

TABLE 2K. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF ZOOFLAGELLATES FROM WEEKLY TWO-FOOT DEPTH PERIPHYTON PANELS AFTER ARCSIN $\sqrt{P}$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Weeks	7	0.00386	1.2697368
2	Stations	3	0.00993	3.2664473
3	W x S	21	0.00304	
	Total	31		

TABLE 2L. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF DIATOMS FROM WEEKLY TWO-FOOT AND SIX-FOOT DEPTH PERIPHYTON PANELS AFTER $LOG_e(X+1)$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Weeks	25	1.30281	6.985950	**
2	Stations	1	0.00001	0.00005362	
3	Depths	1	4.17369	22.380234	*
12	W x S	25	0.57393	3.077538	**
13	W x D	25	0.13068	0.700735	
23	S x D	1	0.14140	0.758218	
123	W x S x D	25	0.18649		
	Total	103			

TABLE 2M. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF CHLOROPHYTA FROM WEEKLY TWO-FOOT AND SIX-FOOT DEPTH PERIPHYTON PANELS AFTER $LOG_e(X+1)$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Weeks	25	7.40841	6.971375	**
2	Stations	1	1.86292	1.753023	
3	Depths	1	0.02495	0.023478	
12	W x S	25	2.43576	2.292070	*
13	W x D	25	0.39531	0.371990	
23	S x D	1	0.71173	0.669744	
123	W x S x D	25	1.06269		
	Total	103			

Continued

TABLE 2N. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF CYANOPHYTA FROM WEEKLY TWO-FOOT AND SIX-FOOT DEPTH PERIPHYTON PANELS AFTER $LOG_e(X+1)$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Weeks	19	99.10091	14.548161	**
2	Stations	1	44.95786	6.599881	*
3	Depths	1	16.70999	2.453051	
12	W x S	19	17.11185	2.512045	*
13	W x D	19	6.72077	0.987636	
23	S x D	1	28.67993	4.210256	*
123	W x S x D	19	6.81192		
	Total	79			

TABLE 2P. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF ZOOPLANKTON FROM WEEKLY TWO-FOOT AND SIX-FOOT DEPTH PERIPHYTON PANELS AFTER $LOG_e(X+1)$ TRANSFORMATION, 1975.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Weeks	25	19.41296	3.771045	**
2	Stations	1	0.39089	0.075932	
3	Depths	1	15.78215	3.065745	
12	W x S	25	6.70655	1.302774	
13	W x D	25	9.37779	1.821673	
23	S x D	1	13.86312	2.692966	
123	W x S x D	25	5.14790		
	Total	103			

Continued

TABLE 2Q. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF ZOOFLAGELLATES FROM WEEKLY TWO-FOOT AND SIX-FOOT DEPTH PERIPHYTON PANELS AFTER $LOG_e(X+1)$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Weeks	8	6.35066	2.874447	
2	Stations	1	4.16017	1.882984	
3	Depths	1	1.13881	0.515450	
12	W x S	8	3.02415	1.368796	
13	W x D	8	2.21596	1.002992	
23	S x D	1	11.26151	5.097205	**
123	W x S x D	8	2.20935		
	Total	35			

TABLE 2R. ANALYSIS OF VARIANCE FOR THE ABUNDANCE OF TOTAL PERIPHYTON FROM WEEKLY TWO-FOOT AND SIX-FOOT DEPTH PERIPHYTON PANELS AFTER $LOG_e(X+1)$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Weeks	25	3.42734	40.231717	**
2	Stations	1	0.44646	5.240756	*
3	Depths	1	2.04904	24.052588	**
12	W x S	25	0.18801	2.206949	*
13	W x D	25	0.07216	0.847048	
23	S x D	1	0.01174	0.137809	
123	W x S x D	25	0.08519		
	Total	103			

* $0.05 \geq P \geq 0.01$
** $P \leq 0.01$

TABLE 2S. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF DIATOMS FROM WEEKLY TWO-FOOT AND SIX-FOOT DEPTH PERIPHYTON PANELS AFTER ARCSIN$\sqrt{P}$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Weeks	25	0.26747	16.551361	**
2	Stations	1	0.05612	3.472772	
3	Depths	1	0.09020	5.581683	*
12	W x S	25	0.04172	2.581683	*
13	W x D	25	0.00664	0.410891	
23	S x D	1	0.00454	0.280940	
123	W x S x D	25	0.01616		
	Total	103			

TABLE 2T. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF CHLOROPHYTA FROM WEEKLY TWO-FOOT AND SIX-FOOT DEPTH PERIPHYTON PANELS AFTER ARCSIN$\sqrt{P}$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Weeks	25	0.30021	28.188732	**
2	Stations	1	0.00052	0.048826	
3	Depths	1	0.02968	2.786854	
12	W x S	25	0.03050	2.863849	**
13	W x D	25	0.00923	0.866666	
23	S x D	1	0.01609	1.510798	
123	W x S x D	25	0.01065		
	Total	103			

Continued

TABLE 2U. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF CYANOPHYTA FROM WEEKLY TWO-FOOT AND SIX-FOOT DEPTH PERIPHYTON PANELS AFTER ARCSIN$\sqrt{P}$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Weeks	19	0.65862	21.650887	**
2	Stations	1	0.08018	2.635765	
3	Depths	1	0.00522	0.171597	
12	W x S	19	0.05548	1.823800	
13	W x D	19	0.01660	0.545693	
23	S x D	1	0.03308	1.087442	
123	W x S x D	19	0.03042		
	Total	79			

TABLE 2V. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF ZOOPLANKTON FROM WEEKLY TWO-FOOT AND SIX-FOOT DEPTH PERIPHYTON PANELS AFTER ARCSIN$\sqrt{P}$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Weeks	25	0.02863	5.703187	**
2	Stations	1	0.00274	0.545816	
3	Depths	1	0.06010	11.972111	**
12	W x S	25	0.00807	1.607569	
13	W x D	25	0.01090	2.171314	*
23	S x D	1	0.00485	0.966135	
123	W x S x D	25	0.00502		
	Total	103			

Continued

TABLE 2W. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF ZOOFLAGELLATES FROM WEEKLY TWO-FOOT AND SIX-FOOT DEPTH PERIPHYTON PANELS AFTER ARCSIN P TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Weeks	8	0.00645	3.241206	
2	Stations	1	0.00261	1.311557	
3	Depths	1	0.00307	1.542713	
12	W x S	8	0.00288	1.447236	
13	W x D	8	0.00323	1.623115	
23	S x D	1	0.01321	6.638190	*
123	W x S x D	8	0.00199		
	Total	35			

* $0.05 \geq P \geq 0.01$
** $P \leq 0.01$

TABLE 3A. ANALYSIS OF VARIANCE OF NUMBER OF DIATOMS/mm^2 AT TWO-FOOT DEPTH ON MONTHLY PERIPHYTON PANELS AT STATIONS N-10, ZERO-WEST, S-4 AND S-17, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Months	5	1.54739	3.744	*
2	Stations	3	0.07722	0.187	
3	M x S	15	0.41327		
	Total	23			

TABLE 3B. ANALYSIS OF VARIANCE OF NUMBER OF CHLOROPHYTA/mm^2 AT TWO-FOOT DEPTH ON MONTHLY PERIPHYTON PANELS AT STATIONS N-10, ZERO-WEST, S-4 AND S-17, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Months	5	2.77279	8.225	**
2	Stations	3	0.09499	0.282	
3	M x S	15	0.33712		
	Total 23				

TABLE 3C. ANALYSIS OF VARIANCE OF TOTAL NUMBER OF ORGANISMS/mm^2 AT TWO-FOOT DEPTH ON MONTHLY PERIPHYTON PANELS AT STATIONS N-10, ZERO-WEST, S-4 AND S-17, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Months	5	1.67676	10.013	**
2	Stations	3	0.08217	0.491	
3	M x S	15	0.16745		
	Total	23			

* Significant at $0.05 \geq P \geq 0.01$

** Significant at $\alpha \leq 0.01$

TABLE 3D. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF DIATOMS FROM MONTHLY TWO-FOOT DEPTH PERIPHYTON PANELS AT STATIONS N-10, ZERO-WEST, S-4 AND S-17 AFTER ARCSIN $\sqrt{P}$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Months	5	0.32794	10.6578	**
2	Stations	3	0.00956	0.3107	
2	M x S	15	0.03077		
	Total	23			

TABLE 3E. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF CHLOROPHYTA FROM MONTHLY TWO-FOOT DEPTH PERIPHYTON PANELS AT STATIONS N-10, ZERO-WEST, S-4 AND S-17 AFTER ARCSIN $\sqrt{P}$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Months	5	0.27895	12.537	**
2	Stations	3	0.01511	0.679	
3	M x S	15	0.02225		
	Total	23			

** $P \leq 0.01$

TABLE 3F. ANALYSIS OF VARIANCE OF NUMBER OF DIATOMS/mm^2 AT TWO-FOOT AND SIX-FOOT DEPTHS ON MONTHLY PERIPHYTON PANELS AT STATIONS N-10 AND S-4, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Months	4	0.67622	4.9176
2	Stations	1	0.12125	0.8817
3	Depths	1	0.66818	4.8590
12	M x S	4	0.58092	4.2250
13	M x D	4	0.15059	1.0950
23	S x D	1	0.00605	0.044
123	M x S x D	4	0.13751	
	Total	19		

TABLE 3G. ANALYSIS OF VARIANCE OF NUMBER OF CHLOROPHYTA/mm^2 AT TWO-FOOT AND SIX-FOOT DEPTHS ON MONTHLY PERIPHYTON PANELS AT STATIONS N-10 AND S-4, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO
1	Months	4	6.23650	30.067 **
2	Stations	1	0.06875	0.331
3	Depths	1	1.81468	8.749 *
12	M x S	4	1.87140	9.022 *
13	M x D	4	1.30864	6.309
23	S x D	1	0.00037	0.002
123	M x S x D	4	0.20742	
	Total	19		

Continued

TABLE 3H. ANALYSIS OF VARIANCE OF TOTAL NUMBER OF ORGANISMS/mm^2 AT TWO-FOOT AND SIX-FOOT DEPTHS ON MONTHLY PERIPHYTON PANELS AT STATIONS N-10 AND S-4, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Months	4	1.44374	14.404	**
2	Stations	1	0.03886	0.388	
3	Depths	1	0.32938	3.286	
12	M x S	4	0.42611	4.251	
13	M x D	4	0.25535	2.548	
23	S x D	1	0.00115	0.011	
123	M x S x D	4	0.10023		
	Total	19			

* $0.05 \geq P \geq 0.01$
** $P \leq 0.01$

TABLE 3I. ANALYSIS OF VARIANCE FOR THE PERCENTAGE OF DIATOMS FROM TWO-FOOT AND SIX-FOOT DEPTH MONTHLY PERIPHYTON PANELS AT STATIONS N-10 AND S-4 AFTER ARCSIN$\sqrt{P}$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Months	4	0.26226	20.267	**
2	Stations	1	0.02213	1.710	
3	Depths	1	0.01223	0.945	
12	M x S	4	0.07126	5.507	
13	M x D	4	0.00309	0.239	
23	S x D	1	0.00001	0.001	
123	M x S x D	4	0.01294		
	Total	19			

TABLE 3J. ANALYSIS OF VARIANCE FOR THE PERCENTAG OF CHLOROPHYTA FROM TWO-FOOT AND SIX-FOOT DEPTH MONTHLY PERIPHYTON PANELS AT STATIONS N-10 AND S-4 AFTER ARCSIN$\sqrt{P}$ TRANSFORMATION, 1975. MERRIMACK RIVER MONITORING PROGRAM, 1976.

	SOURCE OF VARIATION	D.F.	MEAN SQUARE	F-RATIO	
1	Months	4	0.35479	35.657	**
2	Stations	1	0.01024	1.025	
3	Depths	1	0.00259	0.260	
12	M x S	4	0.05112	5.138	
13	M x D	4	0.01732	1.741	
23	S x D	1	0.00319	0.321	
123	M x S x D	4	0.00995		
	Total	19			

* $0.05 \geq P \geq 0.01$
** $P \leq 0.01$