ECOLOGICAL STUDY OF AN IMPOUNDED ESTUARY

HOLLY POND, STAMFORD, CT

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TABLE OF CONTENTS

Page No.

INTRODUCTION

Holly Pond is a small impounded salt pond (about 0.7 km^2) at the end of the Noroton River estuary on the Connecticut shore of Long Island Sound (Figure 1). The Noroton River drains a watershed of 20 km^2 and flows south into the Sound between the City of Stamford and the Town of Darien, about 30 mi east of New York City. Hydrologic characteristics of Holly Pond and the Noroton River derived from previous reports, together with the dimensions of the dam, are shown in Table 1 (Harris 1973, Clark, et al. 1983).

The Pond serves as a scenic resource for shoreline residents and for the many walkers and joggers in a nearby city park and beach area. It is heavily used for recreation by Stamford and Darien residents, particularly for fishing, sailing and other boating (King's Mark Environmental Review Team, 1985). The Pond also harbors a large bird population of mute swans, Canada geese, mallards, mergansers, sea gulls, egrets and various other wading birds.

The dam impounding the Pond was originally constructed in 1796. It was destroyed by the 1938 hurricane and was rebuilt about 1960. The new dam was 550 ft long and contained 6 wooden tide gates (3 each on the Stamford and Darien sides) designed to control the level of the Pond. However, these gates were soon inoperable and permanently closed. This created a subtidal system with a long flushing time. Consequently, the pond has experienced serious siltation problems over many years due to erosion, sediment input from the Noroton River and net import of sediments from Long Island Sound.

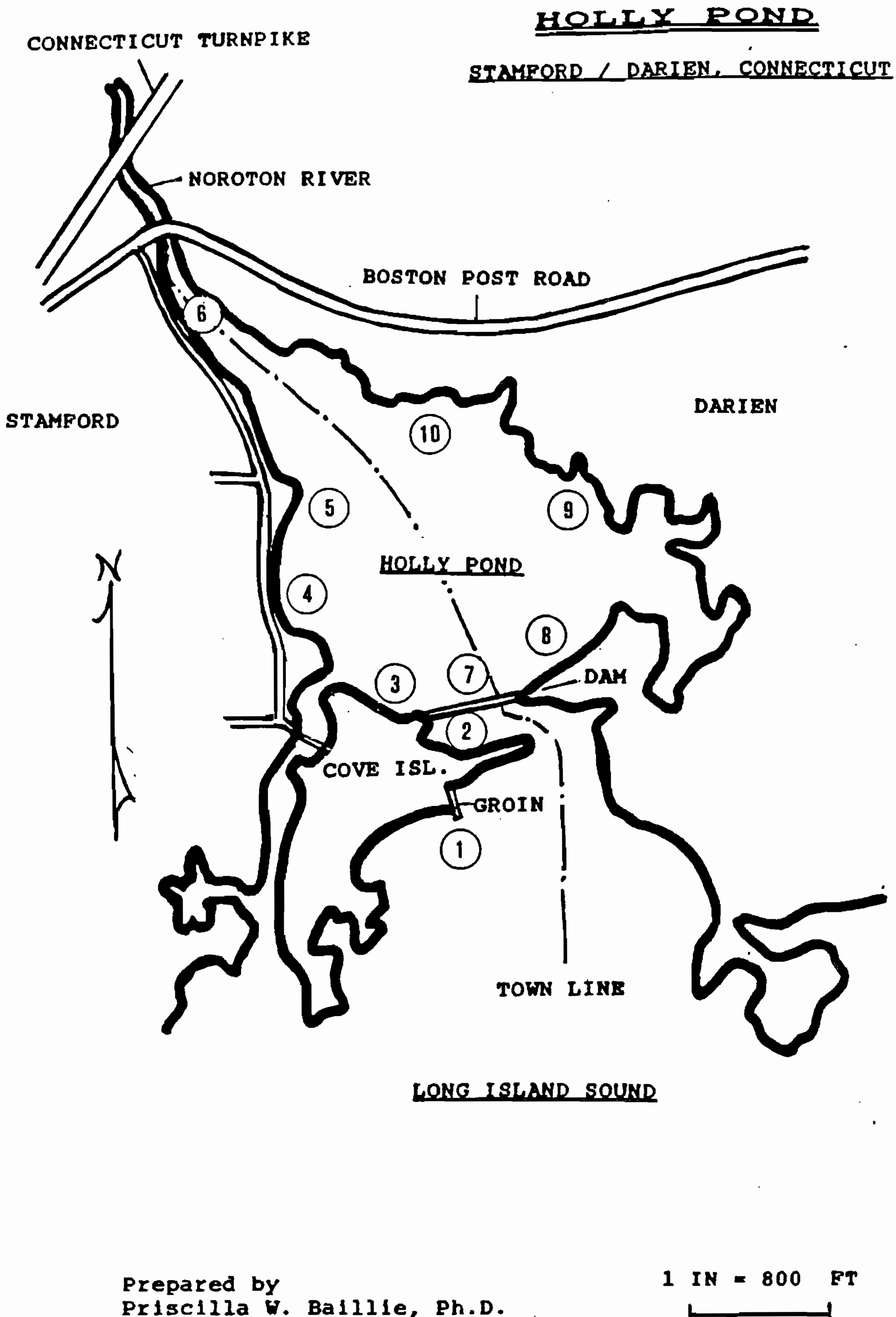
As the depth of the Pond decreased, reduced circulation and increased nutrient supply from the urban watershed stimulated the growth of seaweeds. Episodes of oxygen depletion during hot eather led to fish and shellfish kills. This circumstance is typical of estuaries where there is excessive growth and subsequent decay of seaweeds (Sawyer, 1965; Steffensen, 1976). As oxygen and pH levels decline, hydrogen sulfide is produced by sulfate reducing bacteria (Bella, 1972). In Holly Pond, the rotten egg odor of hydrogen sulfide was overwhelming during calm conditions, especially at the northern end of the estuary (Harris, 1973; King's Mark Environmental Review Team, 1985).

The Connecticut Coastal Embayment Advisory Board in 1985 reported that Holly Pond had a history of severe pollution problems. The consensus of all reports on the condition of the

Pond was that tidal flushing of the system was critical and that the dam gates should be repaired to improve tidal flux. Holly Pond was selected by the Connecticut Department of Environmental Protection under State of Connecticut Special Act 83-13, as one of three coastal systems to be funded for a pilot restoration project.

The purpose of this study was to develop baseline data describing the Pond before the tide gates were opened and the hydrology of the Pond was altered. However, in early September, four months into the study, a gate on the Darien side of the dam collapsed, resulting in a sudden, uncontrolled and dramatic change in the hydrology of the Pond. The low tide level of the Pond dropped about 20 centimeters. Large areas of the bottom were exposed at low tide, especially at the freshwater end. These sediments were converted overnight from subtidal to intertidal habitats.

Figure 1. Map of the Noroton River Estuary and Holly Pond, Stamford/Darien, Connecticut. Stations 1-6 along the Stamford shoreline and Stations 8-10 along the Darien shoreline. Station 7 in deepest section of Holly Pond near the dam.



Prepared by
Priscilla W. Baillie, Ph.D.
Adapted from
F.R. Harris, 1973

Table 1. Summary of dimensions and hydrology of Holly Pond.

Table 1

DIMENSIONS and HYDROLOGY

HOLLY POND, STAMFORD, CT

LONG ISLAND SOUND	
Mean High Tide:	2.20 m > M.L.W.
Mean Tide Level:	1.10 m > M.L.W.
Spring Tide Range:	2.53 m
HOLLY POND	
Low Tide Surface Area:	0.78 km^2
Maximum Depth:	2.44 m > M.L.W.
Low Tide Volume:	0.90 million m^3
Mean Tidal Prism:	0.62 million $m^3 da^{-1}$
Approximate Daily Tidal Exchange:	30% Total Volume
DAM	
Spillway Height:	1.92 m > M.L.W.
Spillway Length:	168 m
Maximum Estimated Flow:	68 $m^3\ s^{-1}$
Maximum Estimated Velocity:	1.06 $m\ s^{-1}$
Mean Velocity:	0.79 $m\ s^{-1}$
NOROTON RIVER	
Watershed Area:	20.31 km^2
Mean Annual Flow:	0.51 $m^3\ s^{-1}$
Maximum Flow (1964-66):	7.02 $m^3\ s^{-1}$
Minimum Flow (1964-66):	0.01 $m^3\ s^{-1}$
Average Daily Discharge:	0.05 million m^3

PART I: PHYSICAL AND CHEMICAL STUDIES

MATERIALS AND METHODS

The Monitoring Program

This 18 month study encompassed 4 months prior to the collapse of the tide gate (May through August, 1986), 10 months while the tide gate was open (September, 1986 through June, 1987) and a 4 month period following repair of the dam and restoration of the original tidal regime (July, 1987 through October 1987). A final sampling trip was conducted in June, 1988.

At the beginning of the study, Stations 1 through 6 were established along the length of the Noroton River estuary. (See Section II for further descriptions of Stations 1 - 6.) Two control stations represented conditions outside the Pond and four stations were located in the Pond on the Stamford side (Figure 1). Station 7 was situated in the deepest area of the Pond above the dam. After the dam was breached, Stations 8 - 10 were added on the Darien side.

Station 1: Beach and rocky groin outside the Pond

Station 2: Below the dam

Station 3: West shore, just above the dam

Station 4: West shore, mid pond area at large *Ulva* bed

Station 5: West shore, area of congregating birds

Station 6: Noroton River, near Route 1

Station 7: Center of the Pond near the dam

Station 8: Southeastern shore of the Pond

Station 9: Eastern shore at widest area of the Pond

Station 10: Northeastern shore at the Y.M.C.A.

At each station surface and bottom measurements were made of temperature and dissolved oxygen concentrations (Y.S.I. oxygen meter, model 54A), salinity (optical refractometer), pH, (Macalaster Bicknell field pH meter) light, (Licor light meter and submersible sensor) and total suspended solids. All sampling was conducted on the outgoing tide in the Pond. As with all impounded estuaries, Holly pond has an asymmetrical tidal cycle. Even with the tidal gate open, the Pond experienced a short dynamic flood tide and a relatively long ebb.

Tidal Studies

Four tidal studies were carried out at the deep water station (Station 7) over a 3 to 8 hr period from late ebb tide and early flood through high tide to early ebb. These studies documented changes in the Pond as the water came over the dam. Surface and bottom readings of temperature, oxygen, salinity, pH, total suspended solids and light were coupled with frequent secchi readings of turbidity.

Plant Nutrients

Measurements of ammonia and nitrate-nitrogen concentrations were made on July 16, 1986, September 12, 1986 and February 6, 1987 at the surface and at 1.2 m depth on the Stamford side of the Pond. The analysis followed standard oceanographic techniques (Strickland and Parsons, 1972; Solorzano, 1969).

RESULTS

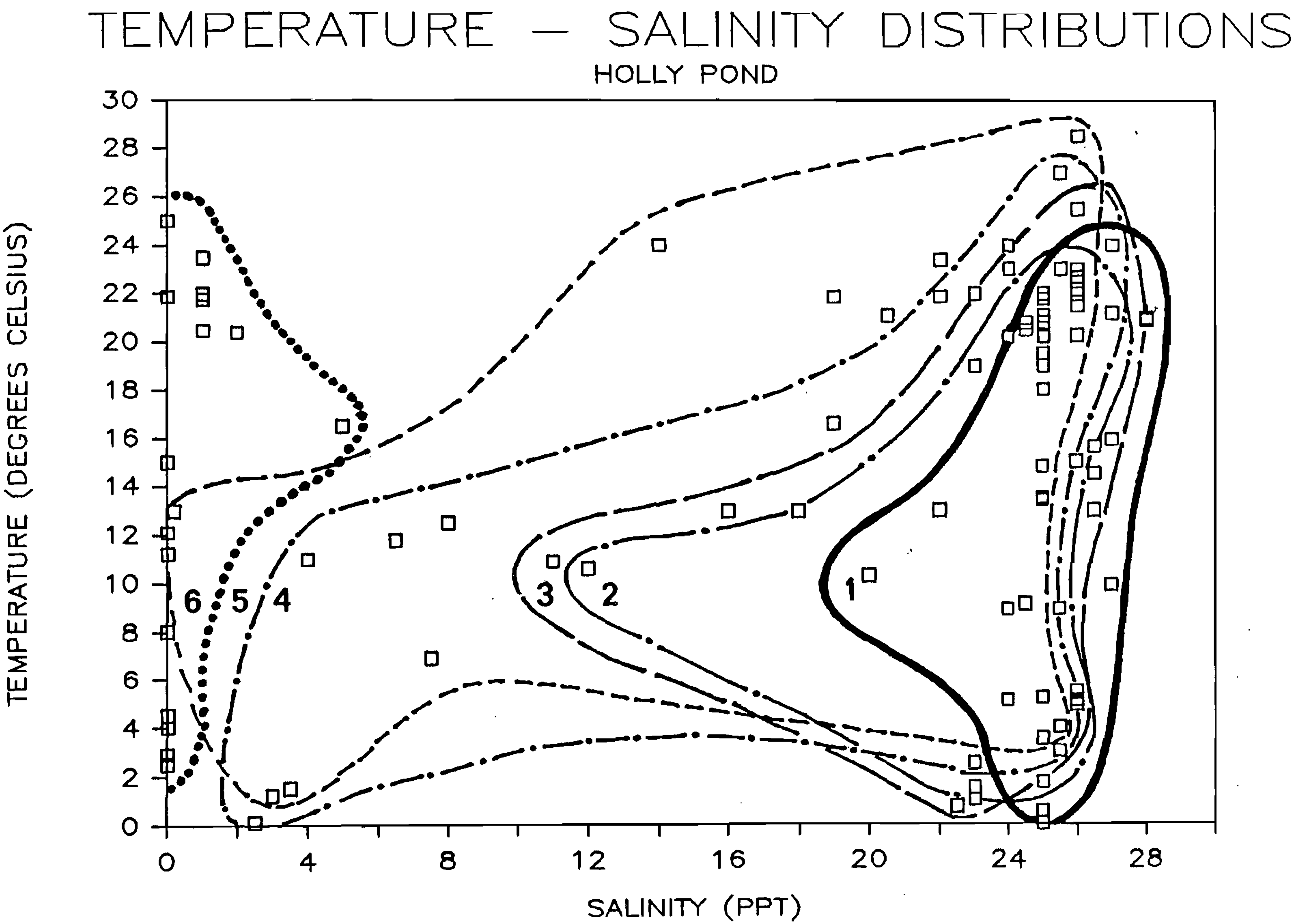
Description of the Estuary

Comparisons between stations indicated that there was virtually no difference laterally between the Stamford side and the Darien side of the Pond. As expected in an estuarine system, the major gradients in physical and chemical characteristics occurred longitudinally along the north/south axis from the river to the sound, and vertically between surface and bottom waters. In the following discussion of seasonal trends, changes along the length of the estuary were represented by Stations 1 through 6.

Temperature and Salinity Distributions

The range of salinity in Long Island Sound waters throughout the study was rather narrow, generally between 24 and 28 ppt (Figure 2). On two occasions during periods of high spring runoff, salinity dropped to 20 - 22 ppt outside the Pond. Salinity and temperatures at Stations 2 and 3, below and above the dam, were very similar; temperatures above the dam were slightly warmer in summer. The inner pond stations 4 and 5 showed wide variation in temperature and salinity, and were

Figure 2. Temperature and salinity distributions for Stations 1-6 over the entire study. The outlines represent the range of temperature-salinity combinations for each of the six stations.



TEMPERATURE — SALINITY DISTRIBUTIONS
HOLLY POND
TEMPERATURE (DEGREES CELSIUS)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
SALINITY (PPT)
0
4
8
12
16
20
24
28
1
2
3
4
5
6

generally warmer than either the sound or the river. The river station showed little tidal influence; salinities above zero occurred only during periods of low flow in summer.

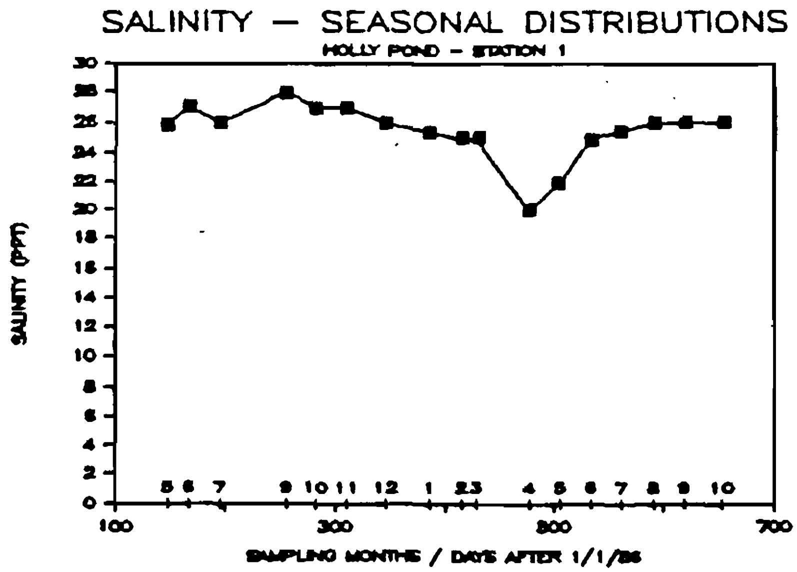
Seasonal Patterns

Salinity outside the Pond was quite stable except for one period of high runoff in April and May, 1987 (Figure 3). A second runoff peak in February, 1987 was noticeable at Station 3 and 4 inside the Pond. At station 5, salinity was highly variable throughout the study period. Of all the stations measured in the pond, Station 5 was most influenced by the Noroton River.

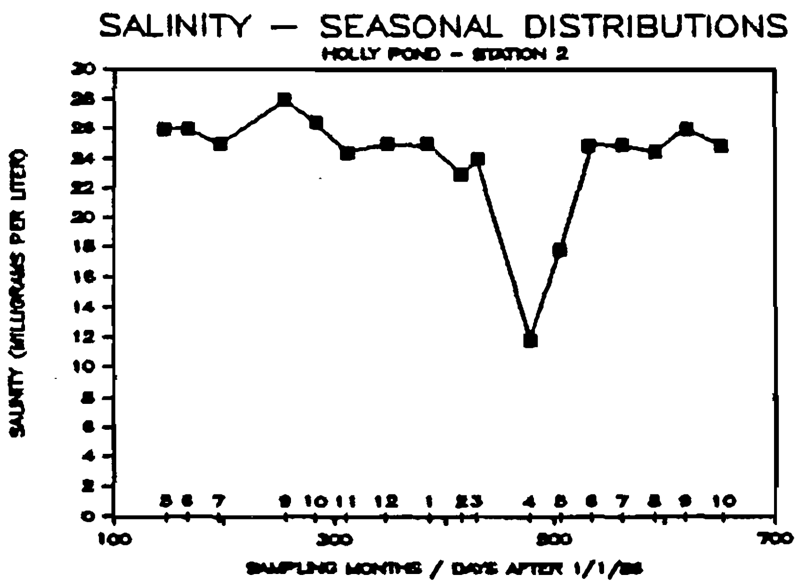
The buffering capacity of salt water precludes significant changes in pH levels. At the Sound end of the system, pH only varied by 0.8 units, ranging between 7.8 and 8.6 (Figure 4). However, progressing up the estuary toward the freshwater end, pH became increasingly variable. At the river station, pH ranged between 6.5 and 8.4. Such variability may limit the number of species that inhabit the upper end of the system.

Dissolved oxygen concentrations in the Sound ranged from 8 to 15 milligrams per liter, with highest levels during the cold

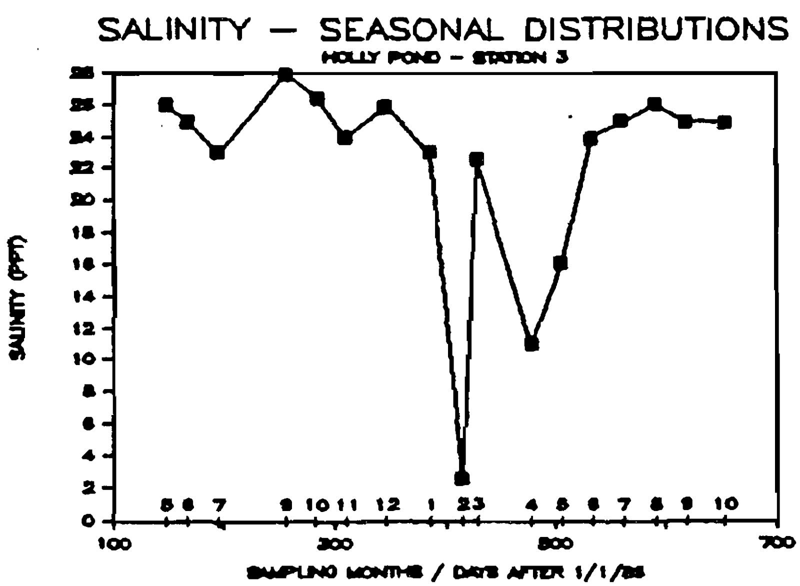
Figure 3. Seasonal salinity distributions for Stations 1-6. Since the sampling date varied from month to month, time is plotted as the number of days following January 1, 1986. The months are also indicated.


SALINITY — SEASONAL DISTRIBUTIONS
HOLLY POND — STATION 1
SALINITY (PPT)
100
300
500
700

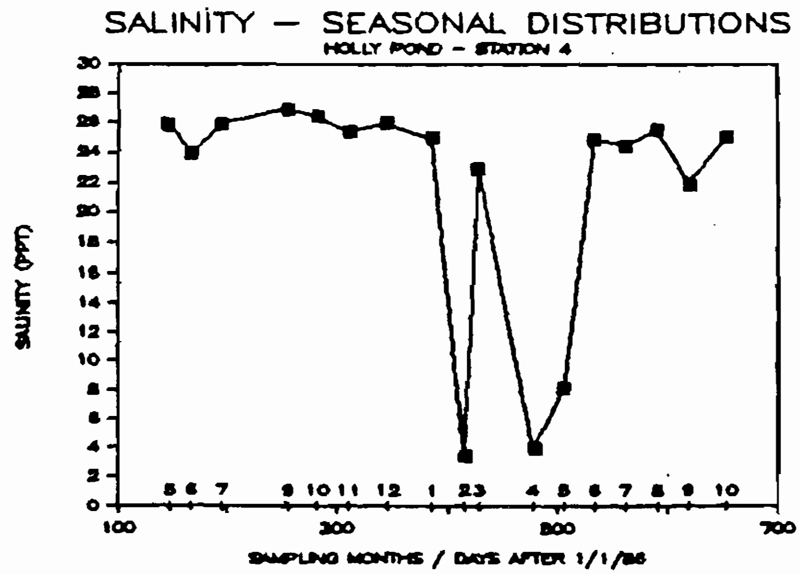
1


SALINITY — SEASONAL DISTRIBUTIONS
HOLLY POND — STATION 2
SALINITY (MILLIGRAMS PER LITER)
100
300
500
700

2

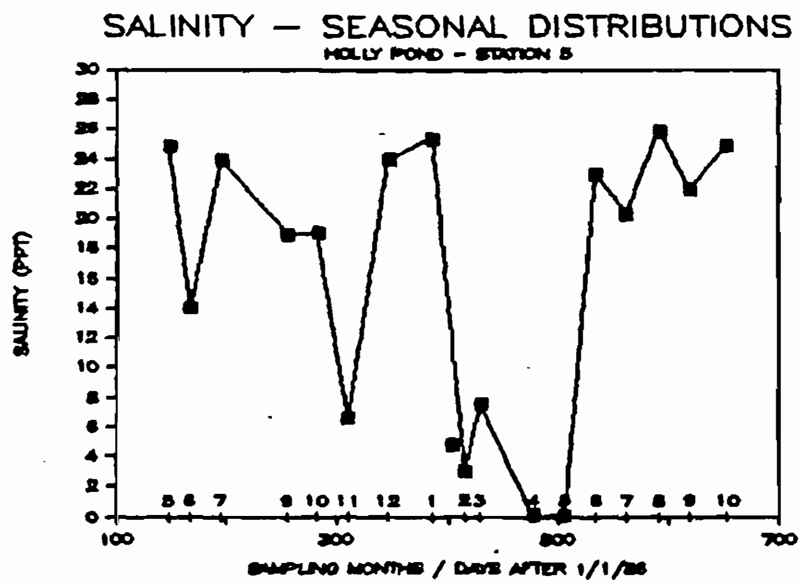

SALINITY — SEASONAL DISTRIBUTIONS
HOLLY POND — STATION 3
SALINITY (PPT)
100
300
500
700

3



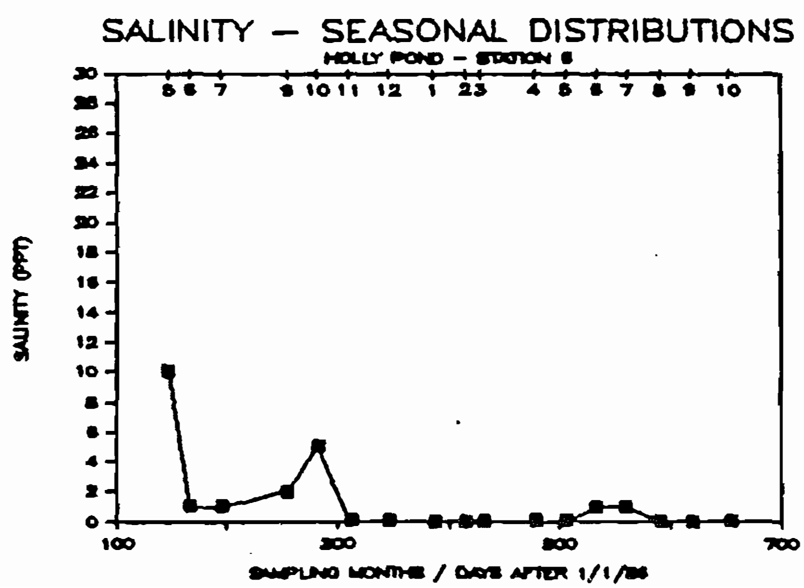
SALINITY — SEASONAL DISTRIBUTIONS
HOLLY POND – STATION 4
SALINITY (PPT)
SAMPLING MONTHS / DAYS AFTER 1/1/86

4



SALINITY — SEASONAL DISTRIBUTIONS
HOLLY POND – STATION 5
SALINITY (PPT)
SAMPLING MONTHS / DAYS AFTER 1/1/86

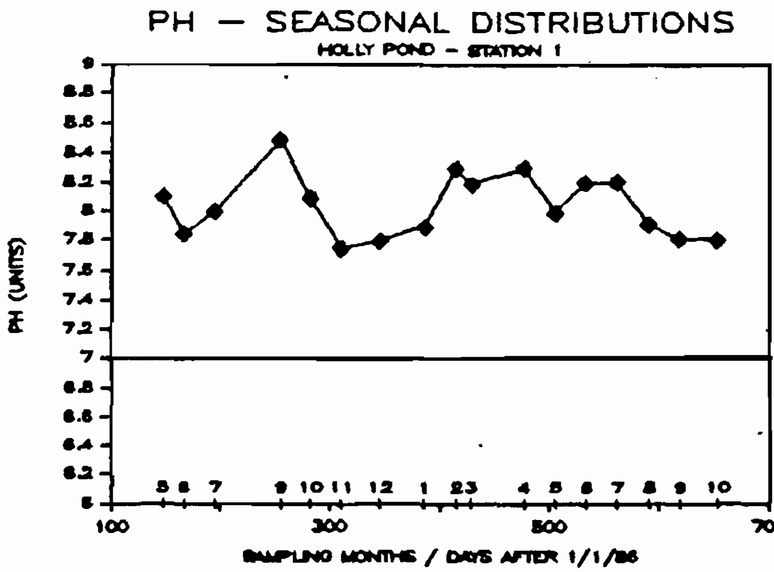
5



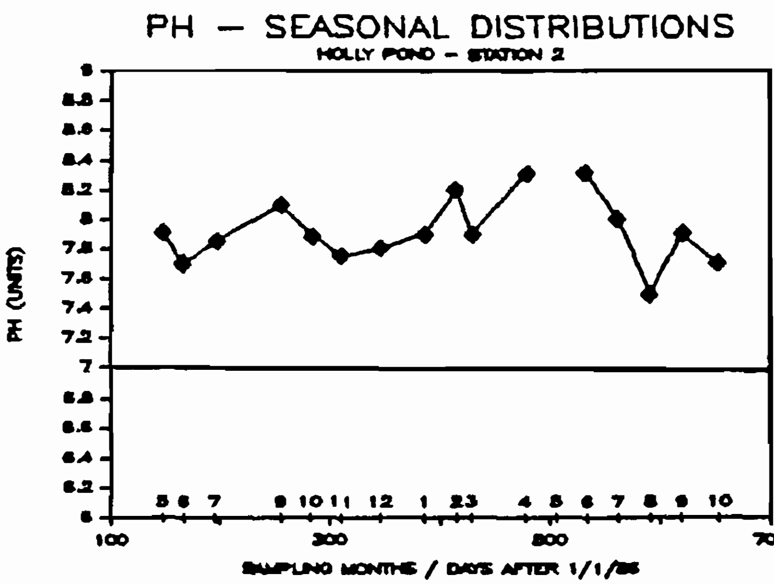
SALINITY — SEASONAL DISTRIBUTIONS
HOLLY POND – STATION 6
SALINITY (PPT)
SAMPLING MONTHS / DAYS AFTER 1/1/86

6

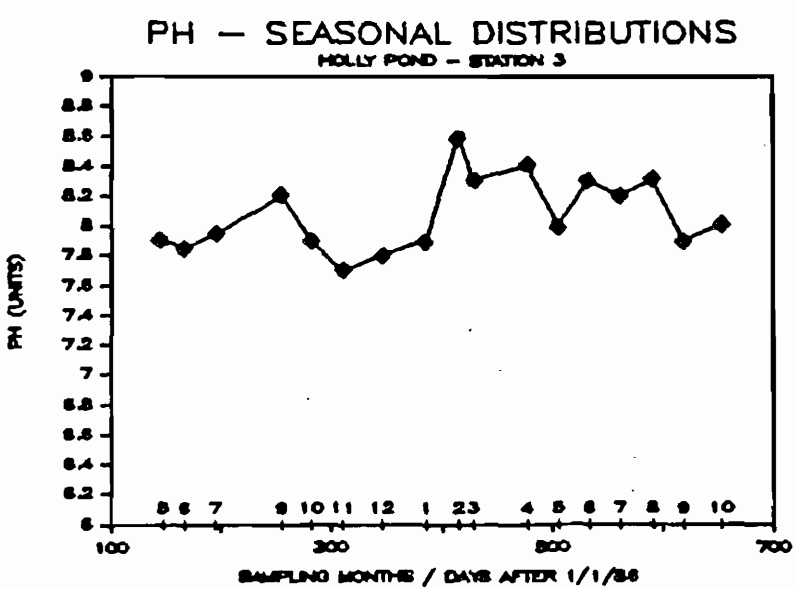
Figure 4. Seasonal pH distributions for Stations 1-6. Since the sampling date varied from month to month, time is plotted as the number of days following January 1, 1986. The months are also indicated.


PH — SEASONAL DISTRIBUTIONS
HOLLY POND — STATION 1
PH (UNITS)
9
8.8
8.6
8.4
8.2
8
7.8
7.6
7.4
7.2
7
6.8
6.6
6.4
6.2
6
5 6 7 9 10 11 12 1 2 3 4 5 6 7 8 9 10
100
300
500
700
SAMPLING MONTHS / DAYS AFTER 1/1/86

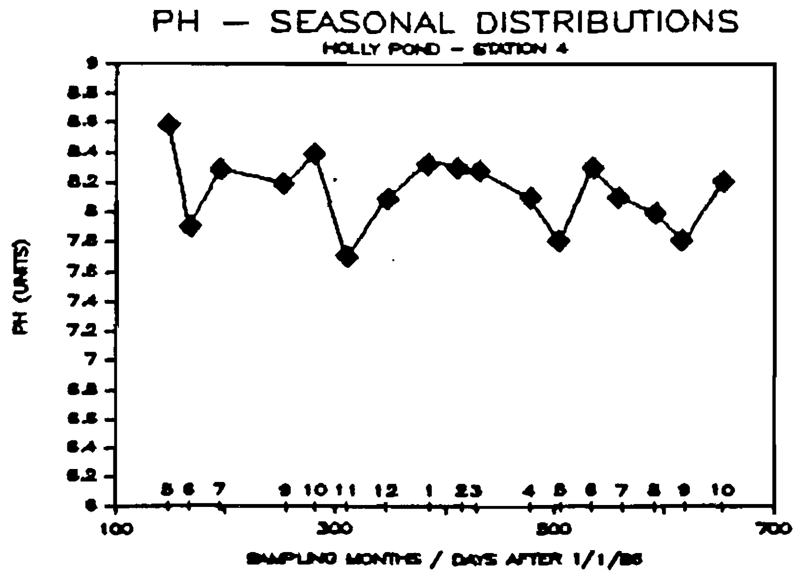
1


PH — SEASONAL DISTRIBUTIONS
HOLLY POND — STATION 2
PH (UNITS)
9
8.8
8.6
8.4
8.2
8
7.8
7.6
7.4
7.2
7
6.8
6.6
6.4
6.2
6
5 6 7 9 10 11 12 1 2 3 4 5 6 7 8 9 10
100
300
500
700
SAMPLING MONTHS / DAYS AFTER 1/1/86

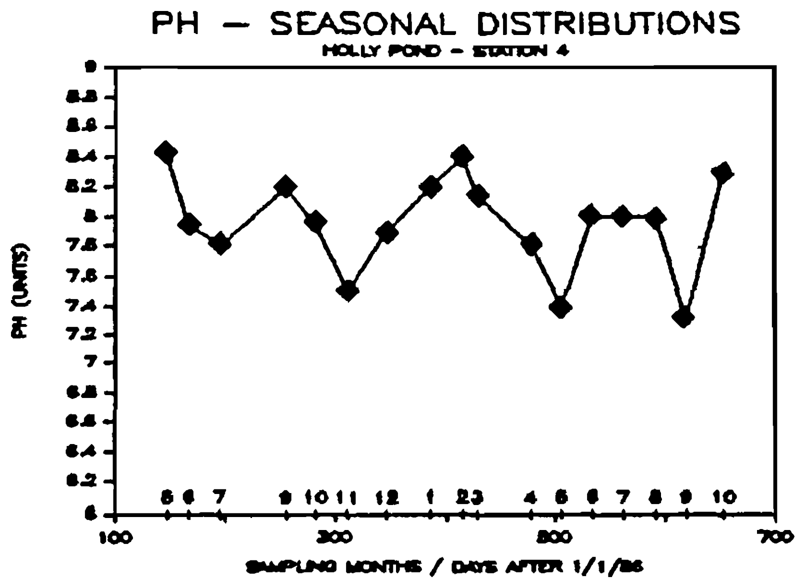
2


PH — SEASONAL DISTRIBUTIONS
HOLLY POND — STATION 3
PH (UNITS)
9
8.8
8.6
8.4
8.2
8
7.8
7.6
7.4
7.2
7
6.8
6.6
6.4
6.2
6
5 6 7 9 10 11 12 1 2 3 4 5 6 7 8 9 10
100
300
500
700
SAMPLING MONTHS / DAYS AFTER 1/1/86

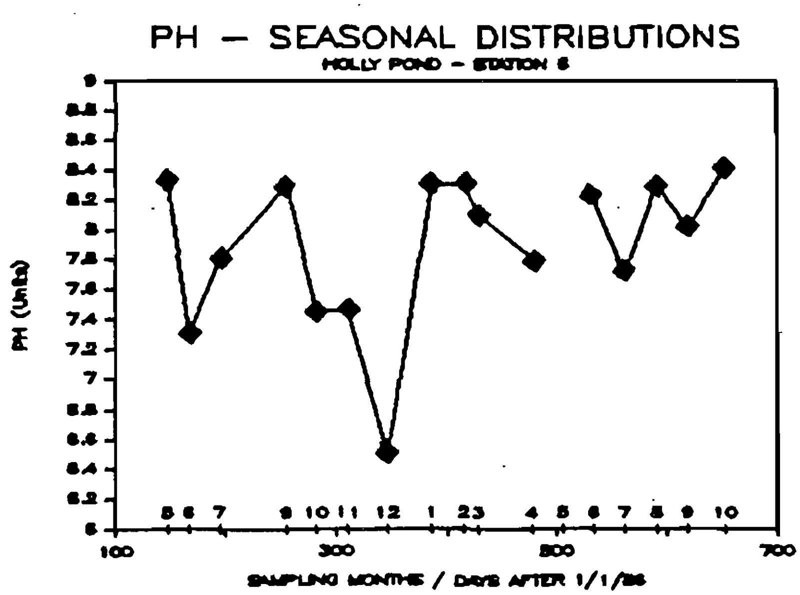
3


PH — SEASONAL DISTRIBUTIONS
HOLLY POND — STATION 4
PH (UNITS)
SAMPLING MONTHS / DAYS AFTER 1/1/86

4

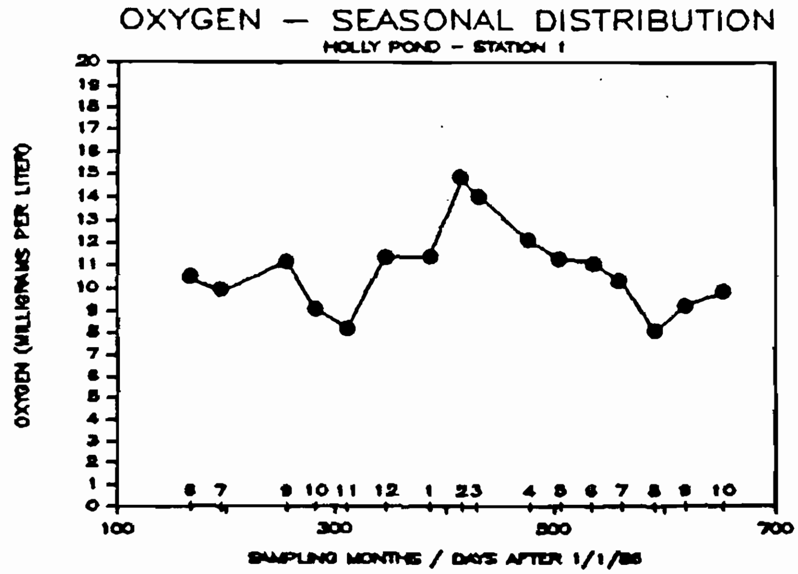

PH — SEASONAL DISTRIBUTIONS
HOLLY POND — STATION 4
PH (UNITS)
SAMPLING MONTHS / DAYS AFTER 1/1/86

5

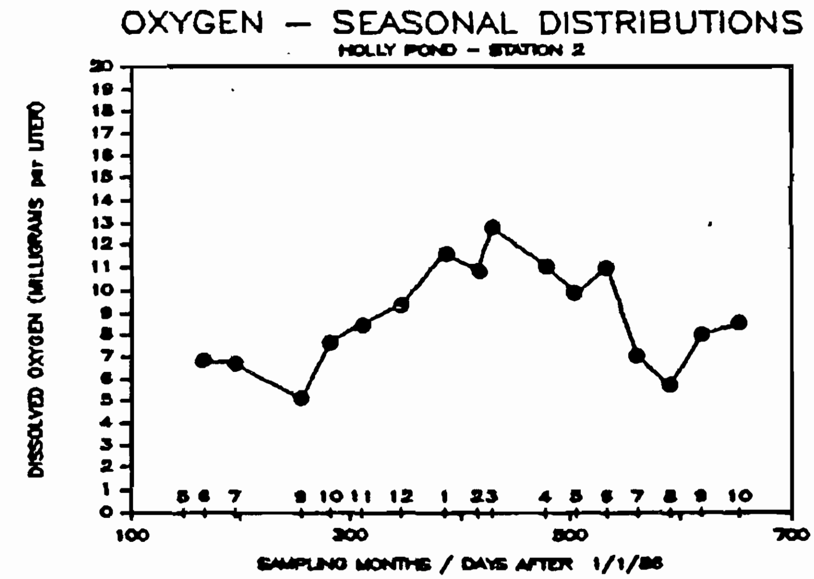

PH — SEASONAL DISTRIBUTIONS
HOLLY POND — STATION 6
PH (Units)
SAMPLING MONTHS / DAYS AFTER 1/1/86

6

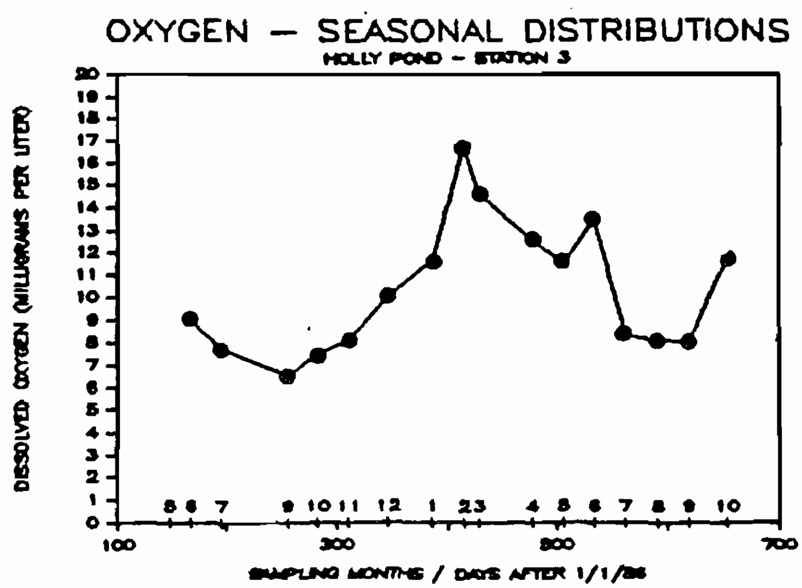
Figure 5. Seasonal dissolved oxygen distributions for Stations 1-6. Since the sampling date varied from month to month, time is plotted as the number of days following January 1, 1986. The months are also indicated.


OXYGEN — SEASONAL DISTRIBUTION
HOLLY POND — STATION 1
OXYGEN (MILLIGRAMS PER LITER)
SAMPLING MONTHS / DAYS AFTER 1/1/86

1

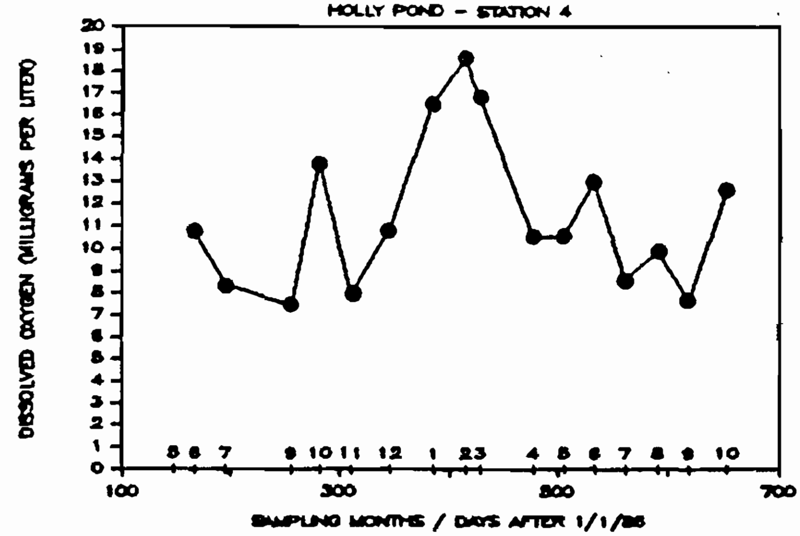

OXYGEN — SEASONAL DISTRIBUTIONS
HOLLY POND — STATION 2
DISSOLVED OXYGEN (MILLIGRAMS per LITER)
SAMPLING MONTHS / DAYS AFTER 1/1/86

2


OXYGEN — SEASONAL DISTRIBUTIONS
HOLLY POND — STATION 3
DISSOLVED OXYGEN (MILLIGRAMS PER LITER)
SAMPLING MONTHS / DAYS AFTER 1/1/86

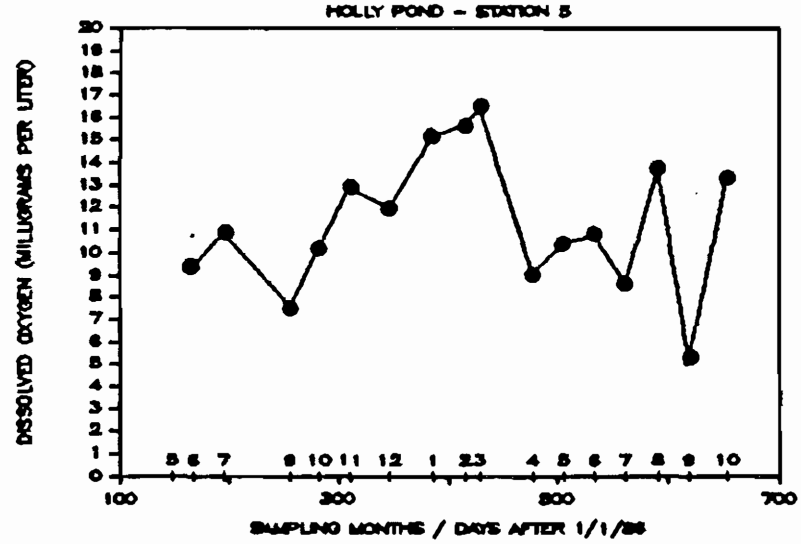
3

OXYGEN — SEASONAL DISTRIBUTION
HOLLY POND — STATION 4



4

OXYGEN — SEASONAL DISTRIBUTIONS
HOLLY POND — STATION 5



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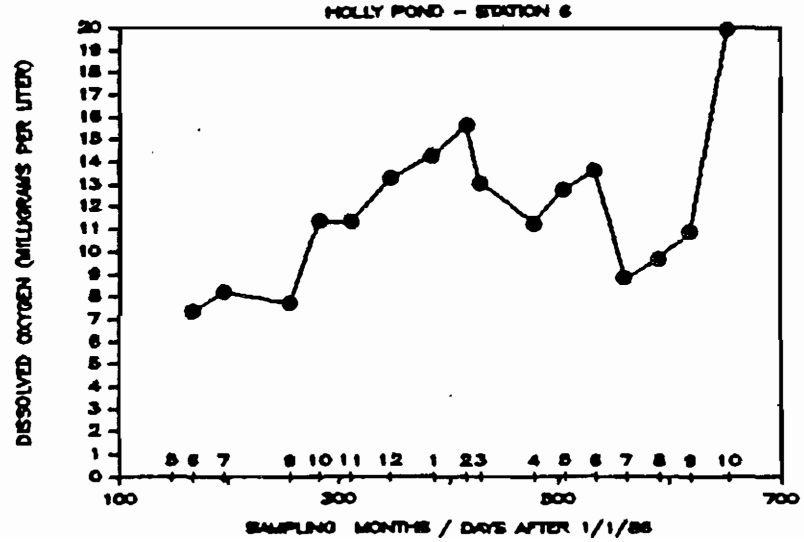
OXYGEN — SEASONAL DISTRIBUTIONS
HOLLY POND — STATION 6



6

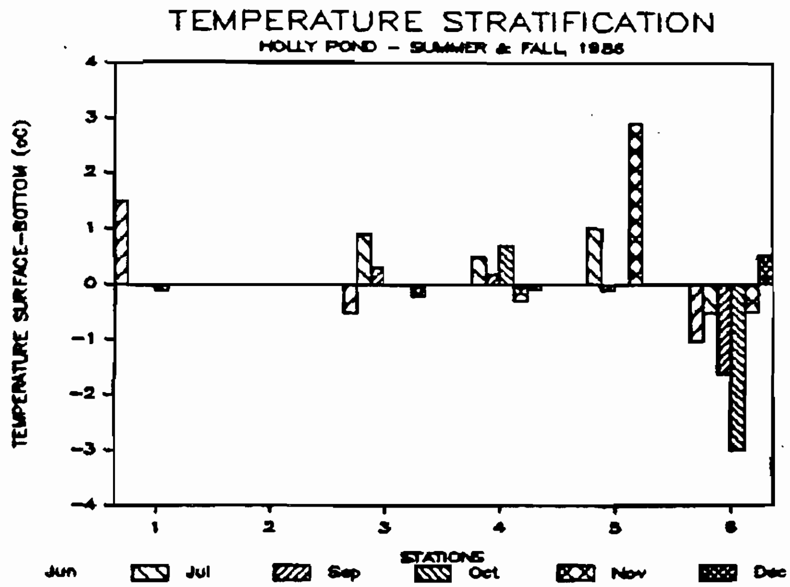
winter months. Although the shape of the seasonal distribution curve at Station 2 is generally similar to the curve for the Sound, oxygen levels were consistently lower beneath the dam (Figure 5). This was the result of respiration by extensive beds of blue mussels in that area. In the Pond, the winter oxygen peak was strongest at Station 4. Photosynthesis by macrophytic growths of benthic diatoms probably caused these exceptionally high winter oxygen levels (Baillie, 1987).

Stratification Patterns

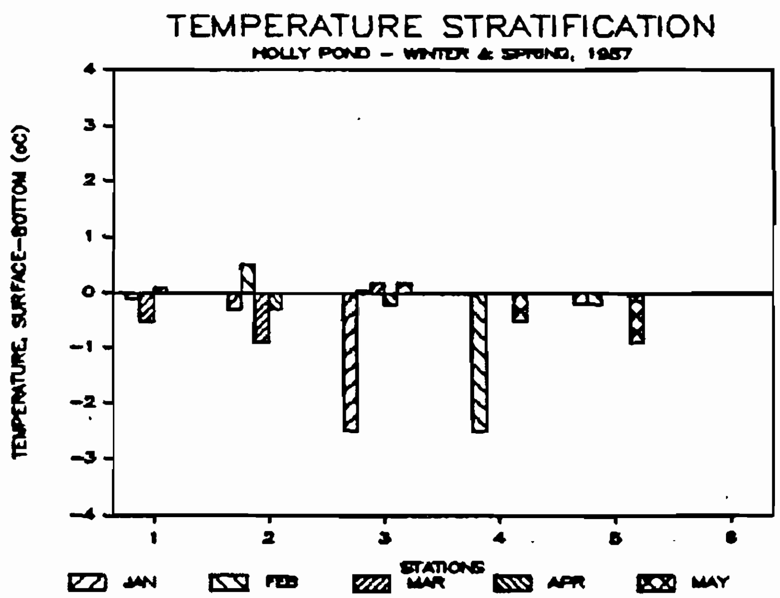
Because of the anoxia problems in the past, it was important to determine whether or not the Pond became thermally or chemically stratified in summer. The difference between surface and bottom measurements throughout the study gave an indication of vertical gradients in the various parameters.

In the summer and fall, temperatures within the Pond were generally higher near the surface due to warming by the sun and lack of mixing (Figure 6). However, fresh water coming down the river was cooler than the saline water beneath it, resulting in negative values at Station 6. This trend was apparent in the summer and fall of both 1986 and 1987. In winter, most areas of the Pond showed warmer waters near the bottom. This condition probably resulted from the extensive respiration occurring in the sediments.

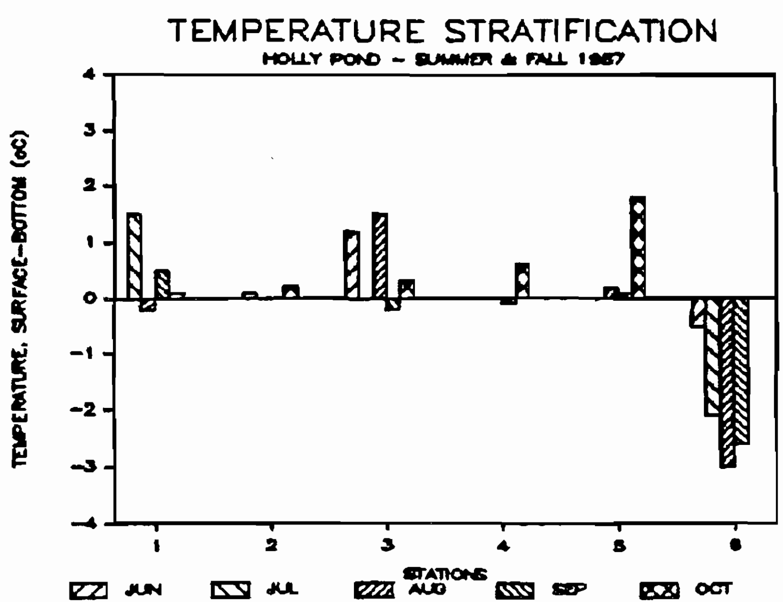
Figure 6. Seasonal temperature stratification patterns (Stations 1 through 6). For each variable, values for the bottom samples were substracted from surface values. Therefore positive values (bars above the zero line) indicate higher levels near the surface and negative values indicate higher levels near the bottom. The length of the bar indicates the degree of stratification. The data were pooled to plot summer-fall 1986 (SF), winter-spring 1987 (WS) and summer-fall 1987 (SF).


TEMPERATURE STRATIFICATION
HOLLY POND – SUMMER & FALL, 1986
TEMPERATURE SURFACE-BOTTOM (oC)
4
3
2
1
0
-1
-2
-3
-4
1
2
3
4
5
6
STATIONS
Jun
Jul
Sep
Oct
Nov
Dec

SF


TEMPERATURE STRATIFICATION
HOLLY POND – WINTER & SPRING, 1987
TEMPERATURE, SURFACE-BOTTOM (oC)
4
3
2
1
0
-1
-2
-3
-4
1
2
3
4
5
6
STATIONS
JAN
FEB
MAR
APR
MAY

WS

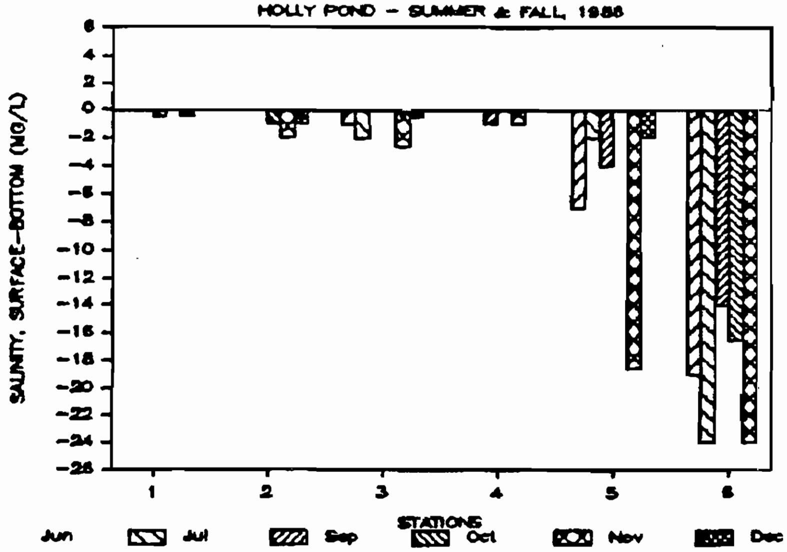

TEMPERATURE STRATIFICATION
HOLLY POND – SUMMER & FALL 1987
TEMPERATURE, SURFACE-BOTTOM (oC)
4
3
2
1
0
-1
-2
-3
-4
1
2
3
4
5
6
STATIONS
JUN
JUL
AUG
SEP
OCT

SF

Figure 7. Seasonal salinity stratification patterns (Stations 1 through 6). For each variable, values for the bottom samples were substracted from surface values. Therefore positive values (bars above the zero line) indicate higher levels near the surface and negative values indicate higher levels near the bottom. The length of the bar indicates the degree of stratification. The data were pooled to plot summer-fall 1986 (SF), winter-spring 1987 (WS) and summer-fall 1987 (SF).

SALINITY STRATIFICATION

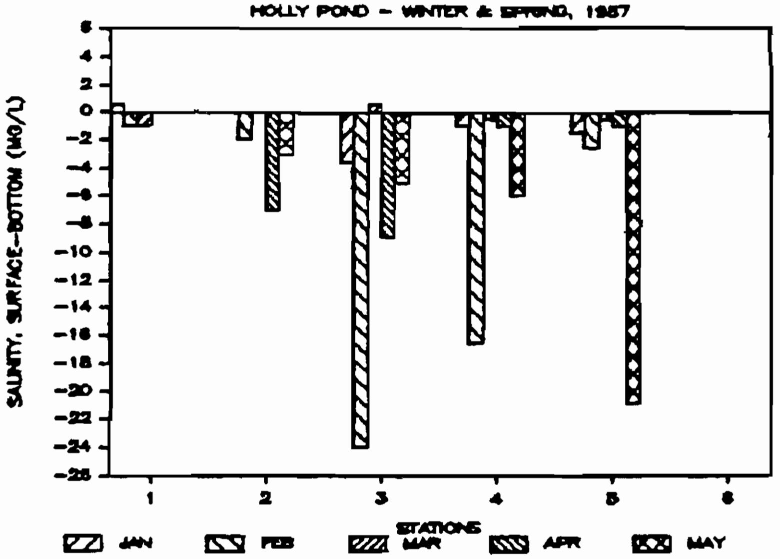
HOLLY POND – SUMMER & FALL, 1986



SF

SALINITY STRATIFICATION

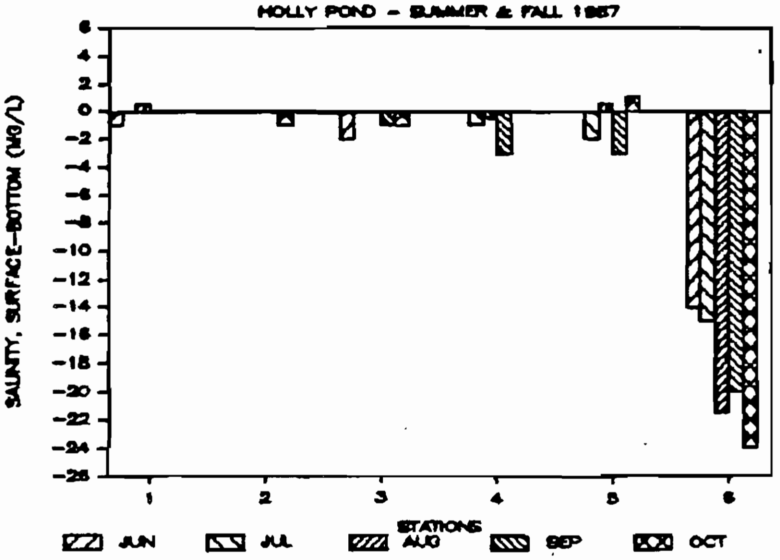
HOLLY POND – WINTER & SPRING, 1987



WS

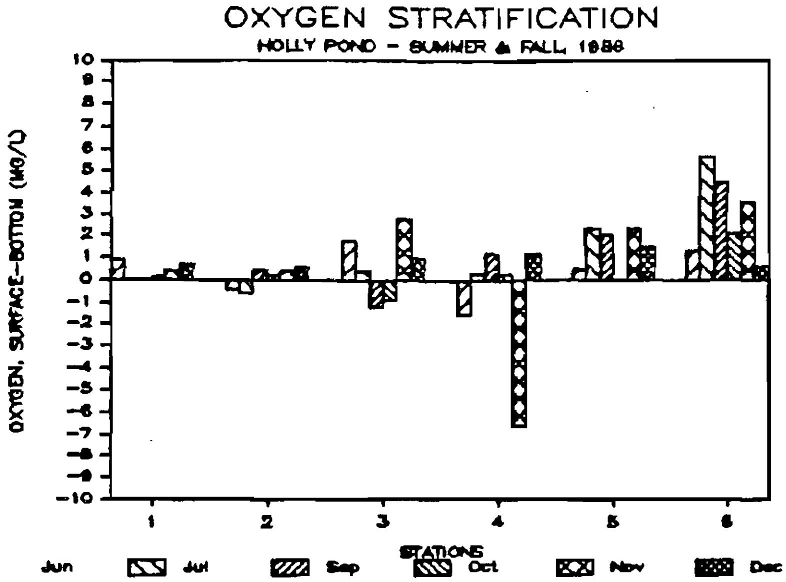
SALINITY STRATIFICATION

HOLLY POND – SUMMER & FALL 1987

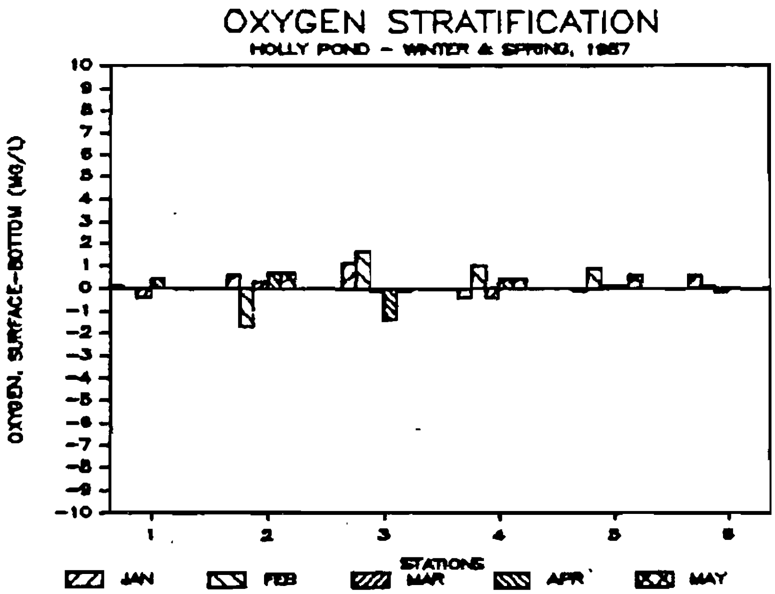


SF

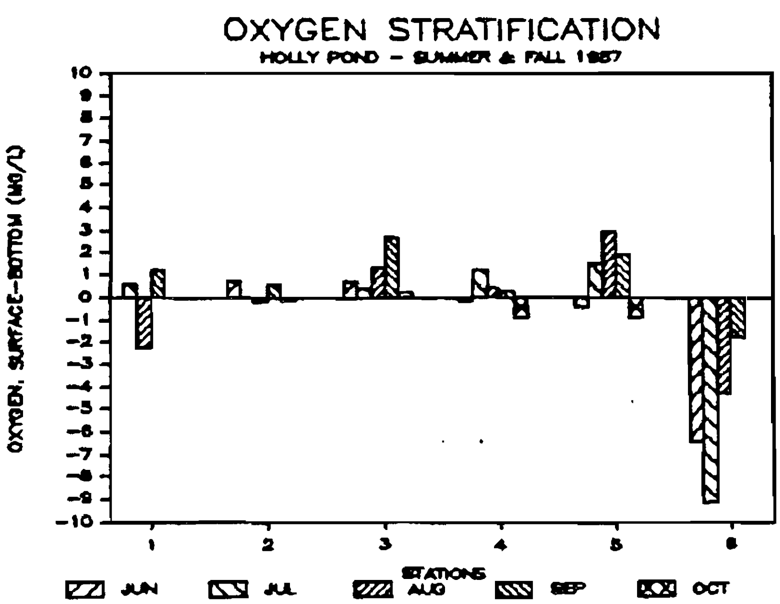
Figure 8. Seasonal dissolved oxygen stratification patterns (Stations 1 through 6). For each variable, values for the bottom samples were substracted from surface values. Therefore positive values (bars above the zero line) indicate higher levels near the surface and negative values indicate higher levels near the bottom. The length of the bar indicates the degree of stratification. The data were pooled to plot summer-fall 1986 (SF), winter-spring 1987 (WS) and summer-fall 1987 (SF).


OXYGEN STRATIFICATION
HOLLY POND - SUMMER & FALL 1986
OXYGEN, SURFACE-BOTTOM (MG/L)
STATIONS
Jun
Jul
Sep
Oct
Nov
Dec

SF


OXYGEN STRATIFICATION
HOLLY POND - WINTER & SPRING, 1987
OXYGEN, SURFACE-BOTTOM (MG/L)
STATIONS
JAN
FEB
MAR
APR
MAY

WS


OXYGEN STRATIFICATION
HOLLY POND - SUMMER & FALL 1987
OXYGEN, SURFACE-BOTTOM (MG/L)
STATIONS
JUN
JUL
AUG
SEP
OCT

SF

Salinity stratification during the summer and fall was most pronounced at the freshwater end of Holly Pond, as river water flowed in over the more saline water underneath (Figure 7). However, during the winter and spring, salinity stratification was present throughout the Pond. Ice cover on the Pond during the winter of 1986 was over 8 in deep (40 cm). It may be that the freshwater flowing into the Pond during winter was distributed more evenly under the ice cover. Melt water from the ice probably also decreased surface salinities.

Oxygen stratification showed a similar trend (Figure 8). Stratification increased toward the freshwater end of the system in summer and fall. There was little difference between surface and bottom oxygen levels in winter. However, there was a change in the oxygen stratification pattern at Station 6 during the summer of 1987. Levels of oxygen on the bottom in the river ran as high as 18 to 20 mg/l in June and July, indicating extensive benthic algal photosynthesis. Macroalgae data showed that there was a threefold increase in the biomass of Enteromorpha intestinalis at Station 6 during this period (see Part II of this report). Apparently, the change in the tidal regime had stimulated the growth of this alga.

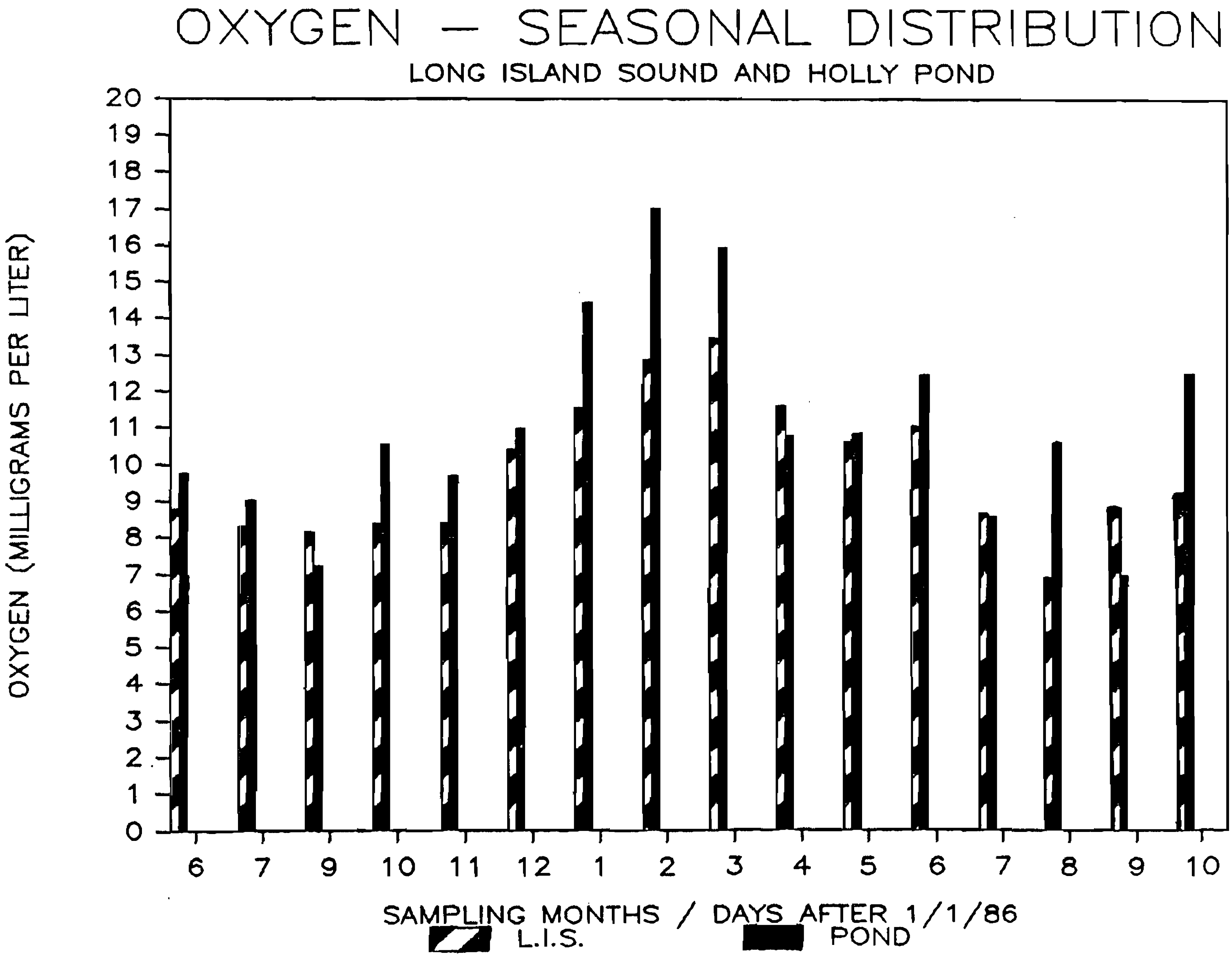
The data indicated that oxygen levels inside the Pond were consistently higher than in Long Island Sound (Figure 9). It must be noted, however, that all sampling was done during the day on a falling tide as photosynthesis increased and the volume of the Pond decreased. Photosynthesis by benthic diatoms in winter and by macroalgae in the spring and summer elevated oxygen concentrations in this shallow system. It can be assumed that oxygen levels decreased substantially at night, especially during the summer when macroalgae dominated the system.

Plant Nutrients

Aquatic ecosystems enriched with an abundance of the nutrients nitrogen and phosphorus often become burdened with an excessive growth of plants and algae. It has been well established in the scientific literature that a surplus of phosphorus is naturally present in coastal ecosystems (Ryther and Dunstan, 1971). Therefore, the growth of plants and algae in marine systems is generally limited by the availability of the scarcer nutrient nitrogen (Lapointe and Ryther, 1979, Lapointe and Tenore, 1981, Lapointe and Duke, 1984).

Nitrogen is a key component of protein, and is thus an essential element for all living organisms. It occurs in the environment in five forms - free gaseous nitrogen, organic

Figure 9. Seasonal dissolved oxygen distributions in Long Island Sound and Holly Pond. Sampling began June, 1986 and continued through October, 1987.



OXYGEN — SEASONAL DISTRIBUTION
LONG ISLAND SOUND AND HOLLY POND
OXYGEN (MILLIGRAMS PER LITER)
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
6 7 9 10 11 12 1 2 3 4 5 6 7 8 9 10
SAMPLING MONTHS / DAYS AFTER 1/1/86
L.I.S.
POND

nitrogen (i.e. amino acids and other complex nitrogenous molecules), ammonia, nitrate and nitrite. The nitrogen cycle is complex, involving constant chemical and bacterial transformations from one form of nitrogen to another. For example, nitrite is usually present in very small quantities in the environment because it is quickly transformed into nitrate. The forms of nitrogen most readily available to plants and algae are nitrate and ammonia. These forms were therefore selected for study in Holly Pond.

Surface and bottom concentrations of ammonia and nitrate-nitrogen were measured at each station on three occasions (Table 2). Mean levels of ammonia were higher in surface waters than in bottom waters at all stations except Station 2 (Figure 10). At this station, the large mussel bed at the base of the dam substantially increased the concentration of ammonia near the bottom. Ammonia levels at this location were highest in the summer and fall and declined during the winter when the mussels were less active. The cause of the winter peak of ammonia at Station 4 is less clear. There is a large *Ulva* population in this area of the Pond. Ammonia from senescent or decomposing seaweeds may have elevated ammonia concentrations at this location (Welsh, 1980). Fine highly organic sediments at this station may also have released large concentrations of ammonia to

Table 2. Ammonia-nitrogen and nitrate-nitrogen for surface and bottom at Stations 1-6.

HOLLY POND
STAMFORD, CT

AMMONIA (Micromoles/liter)

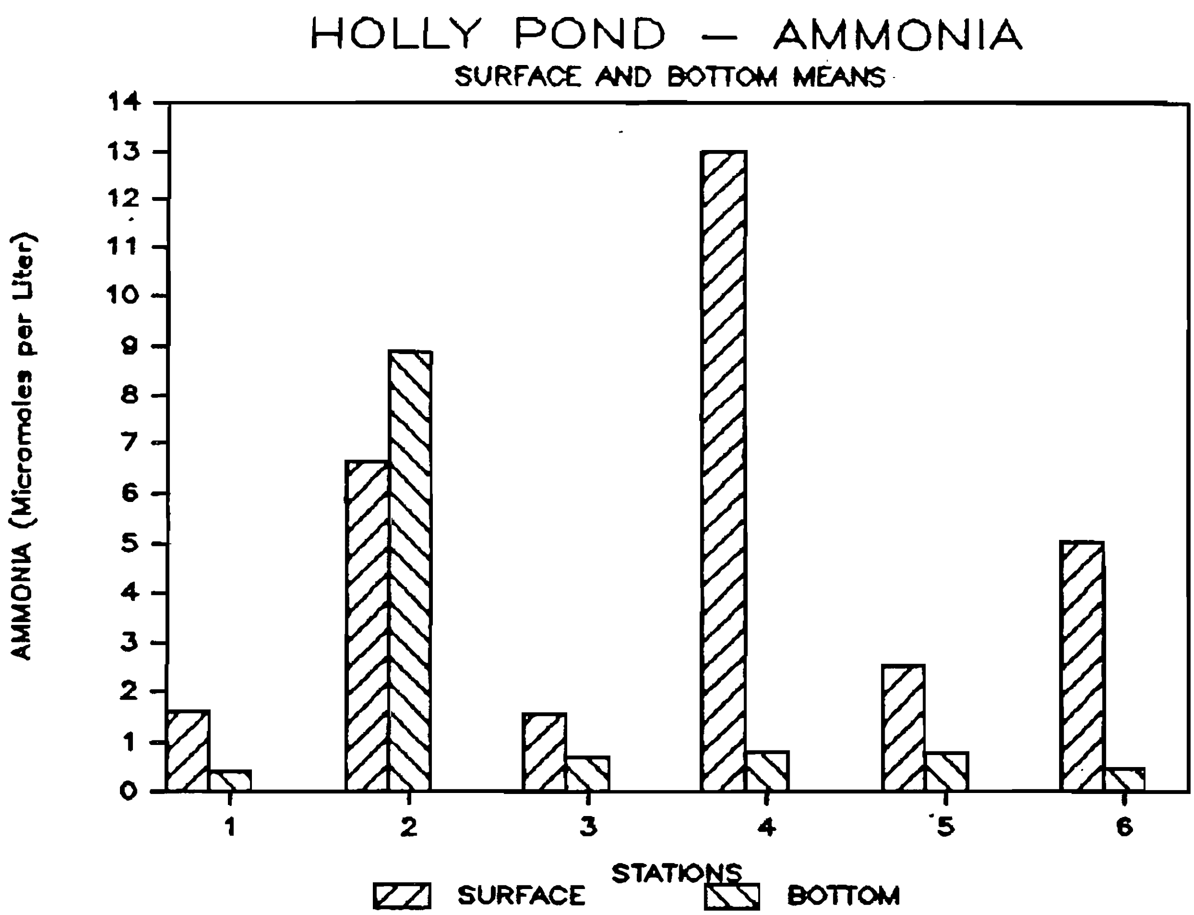
LOCATION	STA.		7/16/86	9/12/86	2/6/87	MEAN
L.I.SOUND	1	S	0.94	0.36	3.52	1.61
		B	1.74	0.40	2.04	1.39
BELOW DAM	2	S	10.08	7.58	2.24	6.63
(MUSSEL BED)		B	9.50	8.89	3.62	7.34
ABOVE DAM	3	S	1.34	1.13	2.22	1.56
		B	1.41	0.69	2.06	1.39
WEED AVE	4	S	3.28	1.74	33.95	12.99
(ULVA)		B	3.78	0.80	5.94	3.51
WEED AVE	5	S	4.31	0.91	2.37	2.53
(BIRDS)		B	2.65	0.77	2.40	1.94
NOROTON RIVER	6	S	9.71	3.00	2.32	5.01
		B	9.48	0.46	0.96	3.63

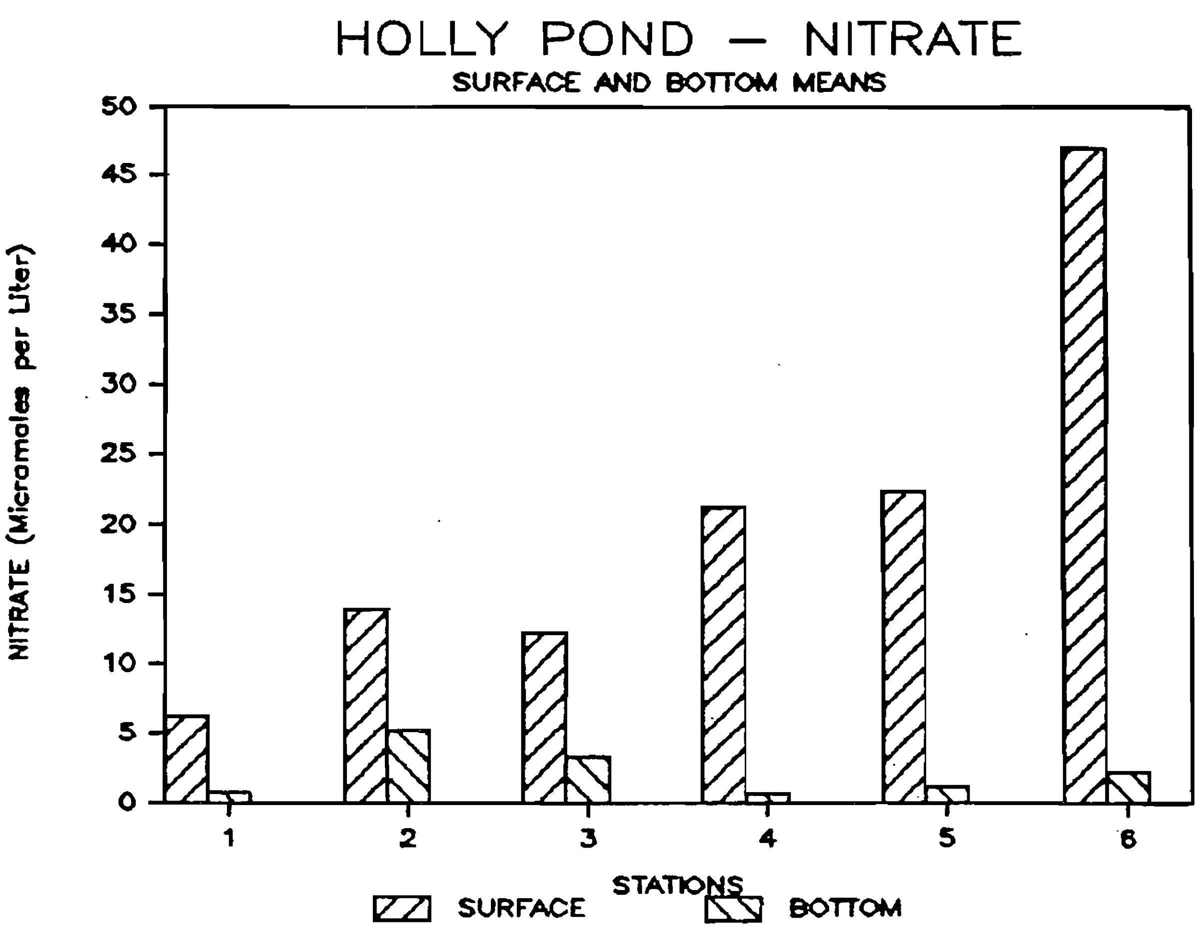
HOLLY POND
STAMFORD, CT

NITRATE (Micromoles perLiter)

LOCATION	STA.		7/16/86	9/12/86	2/6/87	MEAN
L.I.SOUND	1	S	0.20	0.75	17.70	6.22
		B	0.44	0.82	24.32	8.53
BELOW DAM	2	S	2.60	4.94	34.17	13.90
(MUSSEL BED)		B	2.34	5.20	24.54	10.69
ABOVE DAM	3	S	2.04	3.22	31.42	12.23
		B	0.97	3.24	29.92	11.38
WEED AVE	4	S	0.54	0.94	62.20	21.23
(ULVA)		B	1.02	0.71	25.10	8.94
WEED AVE	5	S	6.36	7.71	52.88	22.32
(BIRDS)		B	0.92	1.12	29.05	10.36
NOROTON RIVER	6	S	40.76	36.96	62.86	46.86
		B	2.86	2.26	62.86	22.66

Figure 10. Mean surface and bottom ammonia-nitrogen and nitrate nitrogen at Stations 1-6.


HOLLY POND — AMMONIA
SURFACE AND BOTTOM MEANS
AMMONIA (Micromoles per Liter)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
1
2
3
4
5
6
STATIONS
SURFACE
BOTTOM


HOLLY POND — NITRATE
SURFACE AND BOTTOM MEANS
NITRATE (Micromoles per Liter)
0
5
10
15
20
25
30
35
40
45
50
1
2
3
4
5
6
STATIONS
SURFACE
BOTTOM

the overlying water (Nowicki & Nixon, 1985 A).

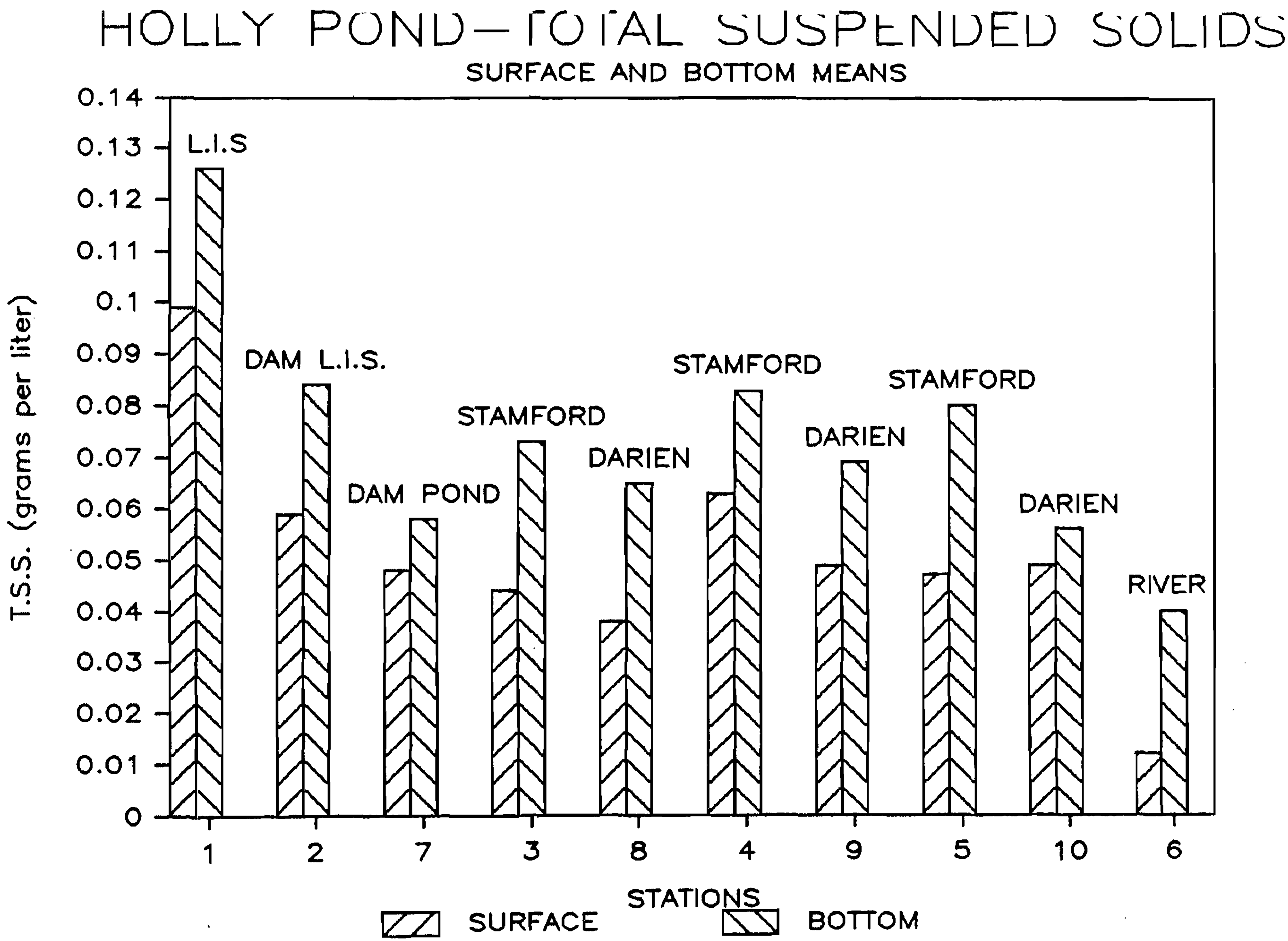
Highest levels of nitrate-nitrogen occurred at all stations during the winter. However, high nitrate-nitrogen was found in the surface waters at Station 6 during all three seasons. A declining gradient in mean nitrate-nitrogen levels along the north-south axis of the Pond showed that the Noroton River was the major source of nitrate-nitrogen to the estuary (Figure 10). The immediate area around Holly Pond is sewered, but the heavily developed urban watershed upstream may be releasing high levels of nitrate-nitrogen to the Pond (Lee and Olsen, 1985). High nitrate-nitrogen levels in the surface waters of Stations 4, 5 and 6 may indicate that the large bird population which congregates along the western shoreline of the Pond is also an important source. Ganning and Wulff (1969) found that the decomposition of bird guano in seawater was followed by a 50% increase in ammonia in 4 days. Nitrification of ammonia usually results in a rapid increase of nitrite and finally nitrate in well oxygenated waters. It is likely, therefore, that the bird population was having a significant effect on nitrogen species in certain areas of the Pond.

Suspended Solids

The waters of Holly Pond were quite turbid as is typical of shallow marine systems (Baillie and Welsh, 1980). Total suspended solids were measured over a 13 month period from April 1986 to April 1987. The data were highly variable on each sampling occasion (Appendix B). However clear trends were evident in the means for each station (Figure 11).

On the average, highest levels of particulates were found in Long Island Sound and lowest levels were found in the Noroton River. Station 1, representing Long Island Sound, was located on a large subtidal sandflat. This station was generally sampled near low tide when the water was less than a meter deep and was quite turbid with resuspended sediments. The rest of the stations were sampled during the outgoing tide in the Pond. Surface and bottom waters on the Stamford side of the system carried more sediments than on the Darien side (Figure 11). The data from this study seem to indicate that Long Island Sound was the primary source of sediments to the system and that the river water was relatively free of suspended materials. However, the literature indicates that freshwater discharge introduces both particulate and dissolved materials to estuaries

Figure 11. Surface and bottom mean total suspended solids at Stations 1-10.


HOLLY POND—TOTAL SUSPENDED SOLIDS
SURFACE AND BOTTOM MEANS
T.S.S. (grams per liter)
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
L.I.S
DAM L.I.S.
DAM POND
STAMFORD
DARIEN
STAMFORD
DARIEN
STAMFORD
DARIEN
RIVER
1
2
7
3
8
4
9
5
10
6
STATIONS
SURFACE
BOTTOM

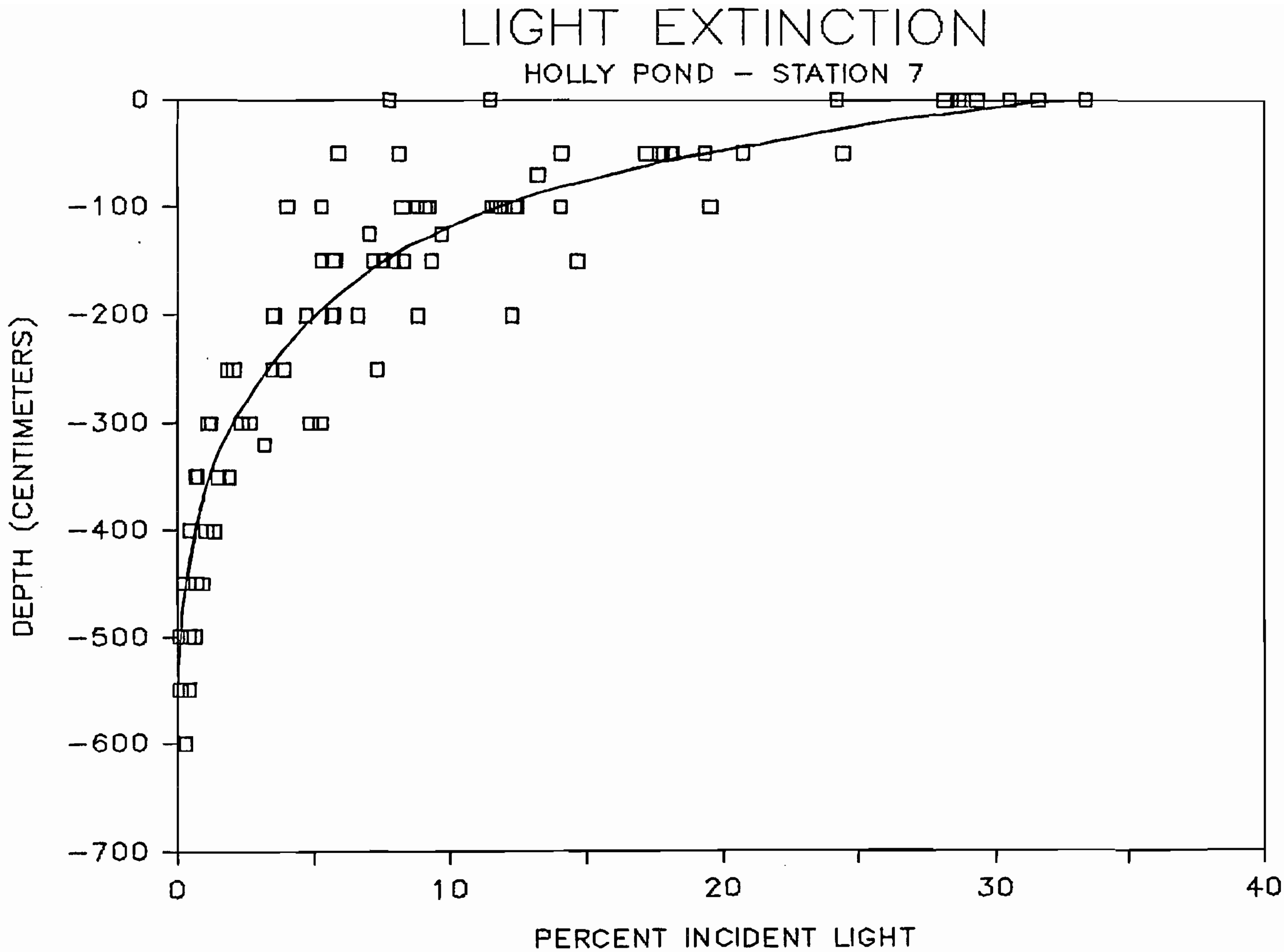
(Smetacek, 1985). Much of this sediment arrives in pulses from the watershed during heavy rains (Jordon, et al., 1986) and is then deposited on the extensive sand and mud flats at Station 6 in the Noroton river.

Bottom waters carried a substantially larger sediment load than did surface waters at all stations. Since sampling was carried out on the ebb tide, this may indicate that sediments were resuspended in the Pond as the water became increasingly shallow during the latter part of the tidal cycle (Baillie and Welsh, 1980). Such resuspension of sediments would be mainly wind driven since tidal currents in salt ponds are weak (Smith, 1983).

Light Penetration

Light penetration in Holly Pond was measured from surface to bottom at Station 7 in the deepest area of the Pond. Light intensity at various depths was expressed as the percentage of light intensity at the surface (percent incident light). Light penetration is affected by numerous factors: time of day, degree of cloudiness, turbulence at the surface, turbidity, color, etc. Therefore, the data tended to be highly variable, especially near the surface (Appendix A, Figure 12).

Figure 12. Light extinction at Station 7.


LIGHT EXTINCTION
HOLLY POND - STATION 7
DEPTH (CENTIMETERS)
0
-100
-200
-300
-400
-500
-600
-700
0
10
20
30
40
PERCENT INCIDENT LIGHT

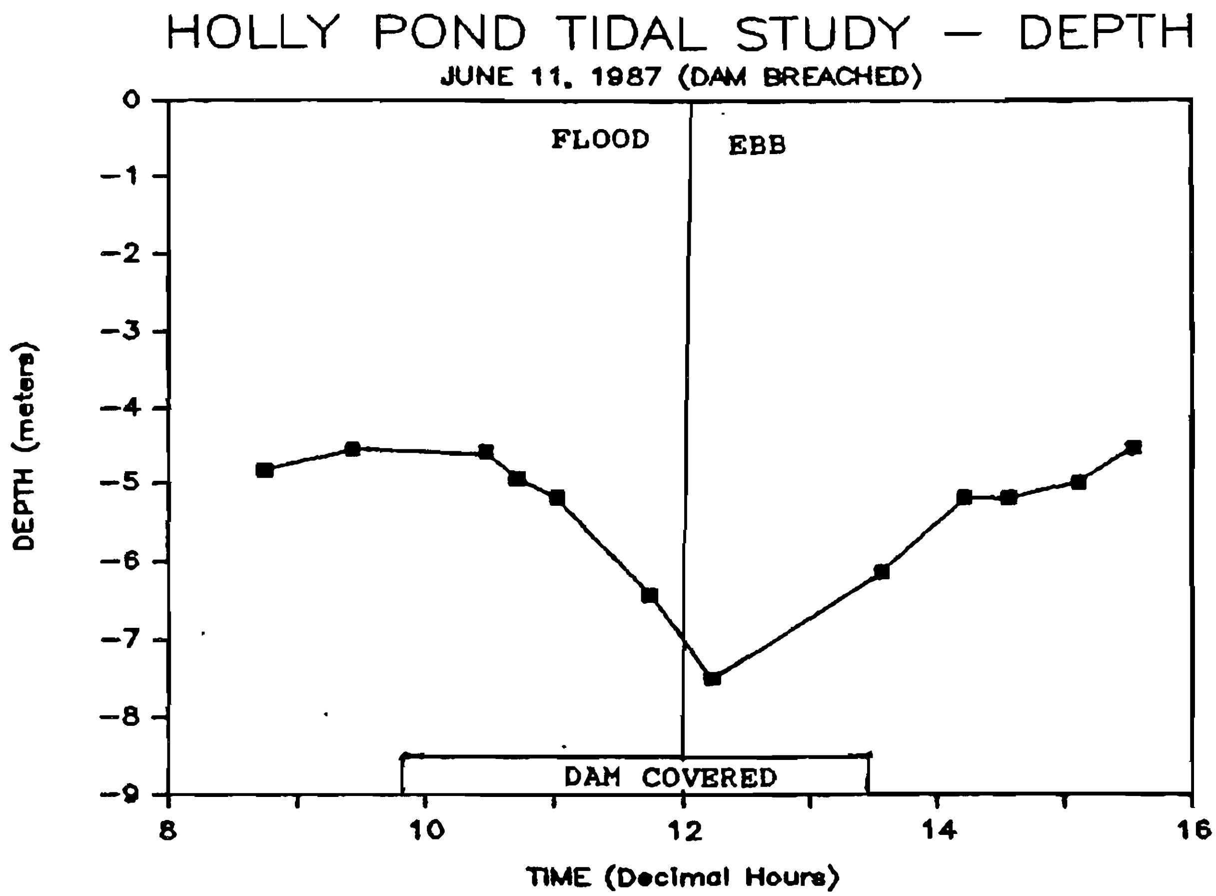
Light penetration in various ecosystems can be compared by calculating a factor known as the extinction coefficient. The extinction coefficient for Holly Pond ranged from $-0.98\ m^{-1}$ to $-2.89\ m^{-1}$ with a mean value of $-1.57\ m^{-1}$. These values were comparable to extinction coefficients published for a salt pond in Rhode Island which ranged from $-0.40\ m^{-1}$ to $-2.10\ m^{-1}$, with a mean of $-1.20\ m^{-1}$ (Nowicki & Nixon, 1985 B). The depth of the 1% light level (below which the algae cannot grow) was 3.5 meters. This meant that light was sufficient for algal growth in all parts of the Pond except in the deep hole at the dam.

High Tide Studies

Typically, a salt pond impounded by a dam experiences a long gradual ebb tide followed by a rapid flood. As the tide falls, water is retained in the Pond except for a small amount leaking under or through the dam. Water continues to flow very slowly out of the Pond until the rising tide in the Sound reaches the top of the dam. At this point in the tidal cycle a turbulent line of foam appears along the full length of the dam surface. Then, with the full force of the Sound behind it, water overtops the dam and surges into the Pond. When the tide turns, after a very short high slack period, water again flows rapidly out of the pond on the ebb until the surface reaches the top of the dam and the characteristic foam line appears. As the tide recedes in the Sound, the Pond begins its long ebb tide phase. With the tide gate in place, all of these events occur in Holly Pond as described above. With the tide gate out, the flood of water into the Pond is accelerated until the dam is covered (a total period of approximately 3.5 hours).

A series of four experiments were carried out at Station 7 just north of the dam to document changes occurring during this dynamic period of the tidal cycle. The first experiment was conducted in August 1986 while the tide gate was still in place, the second in June 1987 when the dam was breached, and the third and fourth in August and September 1987, respectively, after the tide gate had been repaired. On each occasion, a boat was anchored north of the dam and samples were collected at short intervals over a three to six hour period. During the first experiment, the boat was located slightly north of Station 7. For the other three experiments, the boat was located over a deep hole close to the dam. During each experiment, depth readings were made in quick succession together with surface and bottom measurements of temperature, salinity, oxygen, pH and light (Appendix C). Data for the second and third experiments (before and after repair of the tide gate) are shown in Figures 13 through 17. The time during which the dam was covered was

Figure 13. Tidal studies while dam was breached and after dam was repaired. Change in depth with time at late flood tide through early ebb tide.


HOLLY POND TIDAL STUDY — DEPTH
JUNE 11, 1987 (DAM BREACHED)
FLOOD
EBB
DAM COVERED
DEPTH (meters)
TIME (Decimal Hours)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
8
10
12
14
16

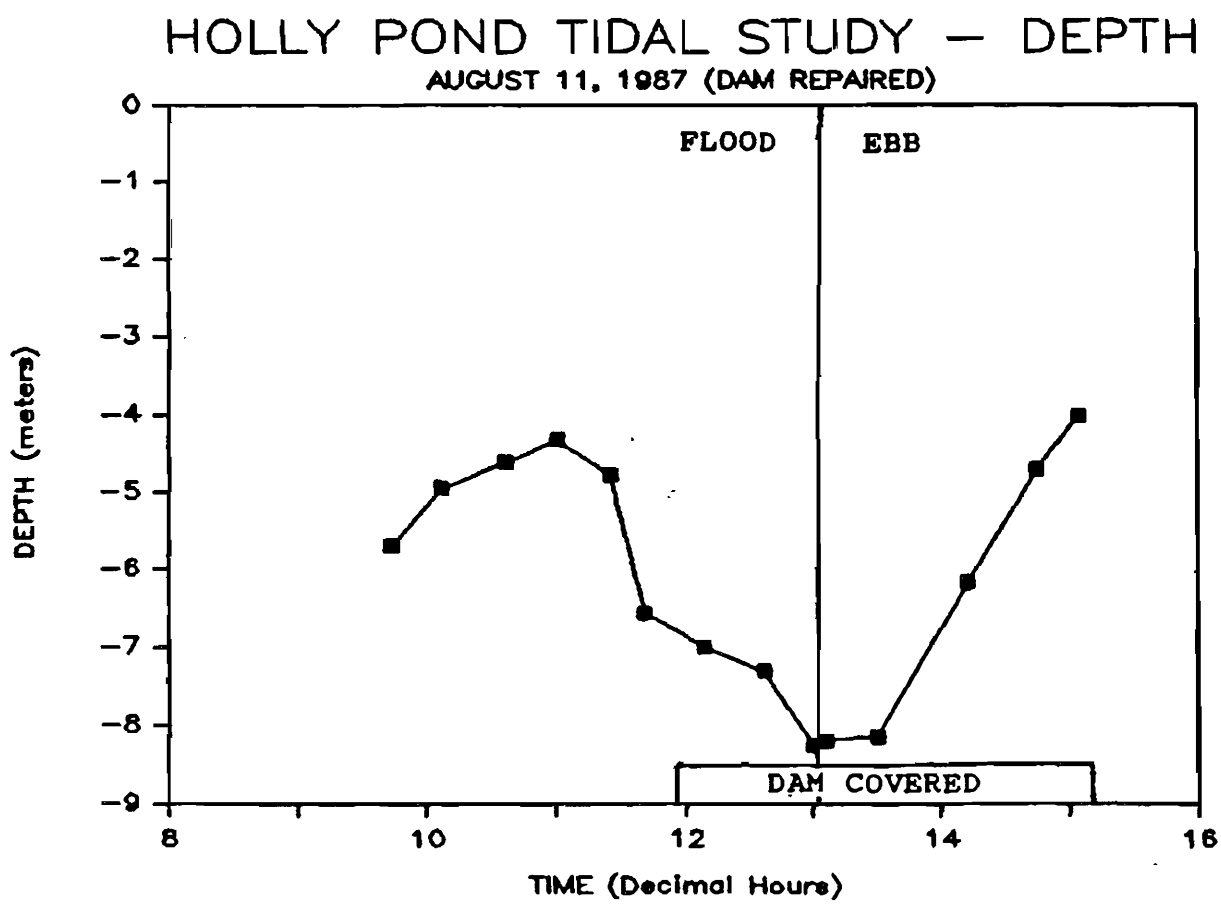
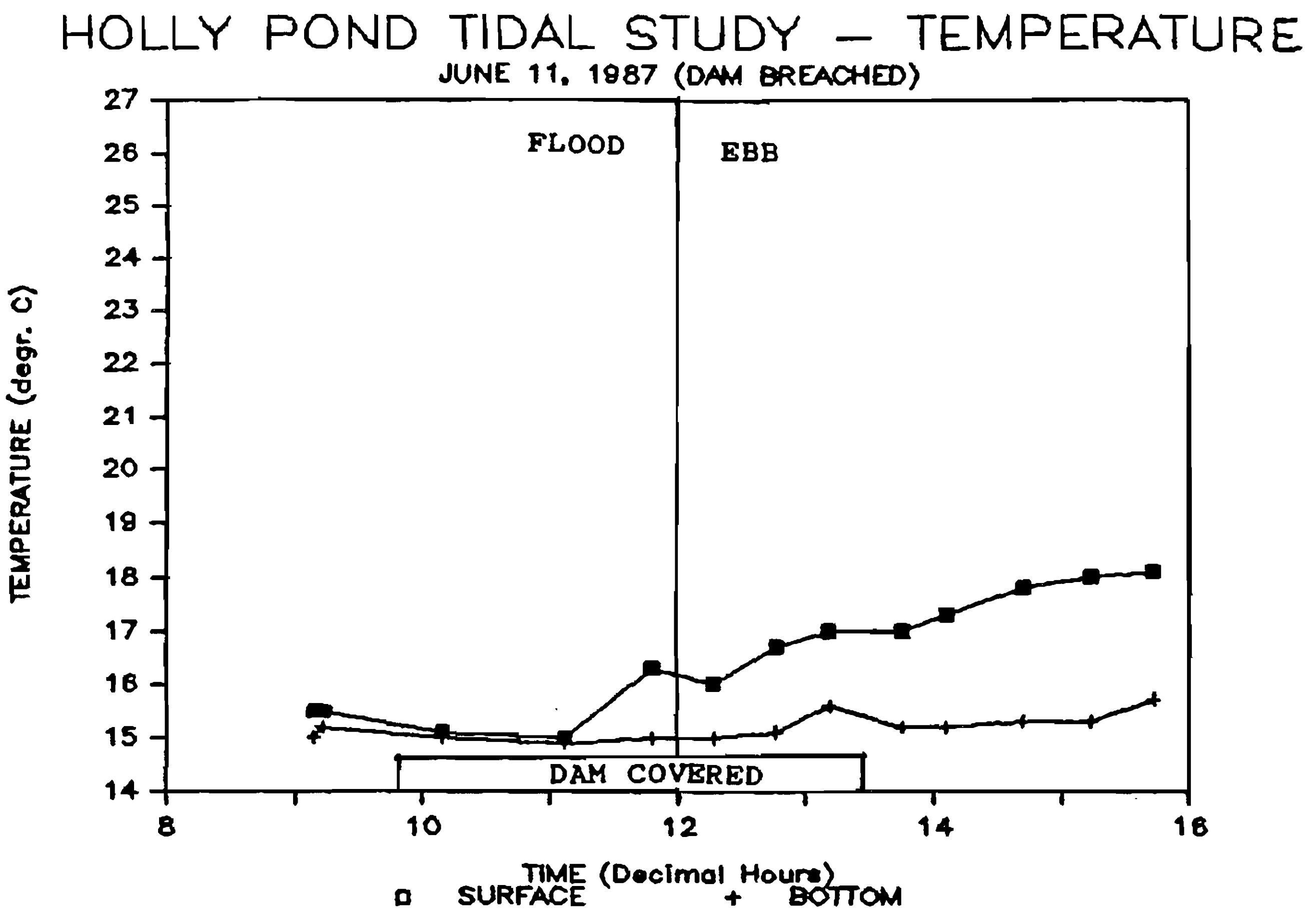

HOLLY POND TIDAL STUDY — DEPTH
AUGUST 11, 1987 (DAM REPAIRED)
FLOOD
EBB
DAM COVERED
DEPTH (meters)
TIME (Decimal Hours)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
8
10
12
14
16

Figure 14. Tidal studies while dam was breached and after dam was repaired. Change in temperature with time at late flood tide through early ebb tide.


HOLLY POND TIDAL STUDY – TEMPERATURE
JUNE 11, 1987 (DAM BREACHED)
FLOOD
EBB
DAM COVERED
TEMPERATURE (degr. C)
TIME (Decimal Hours)
SURFACE
BOTTOM

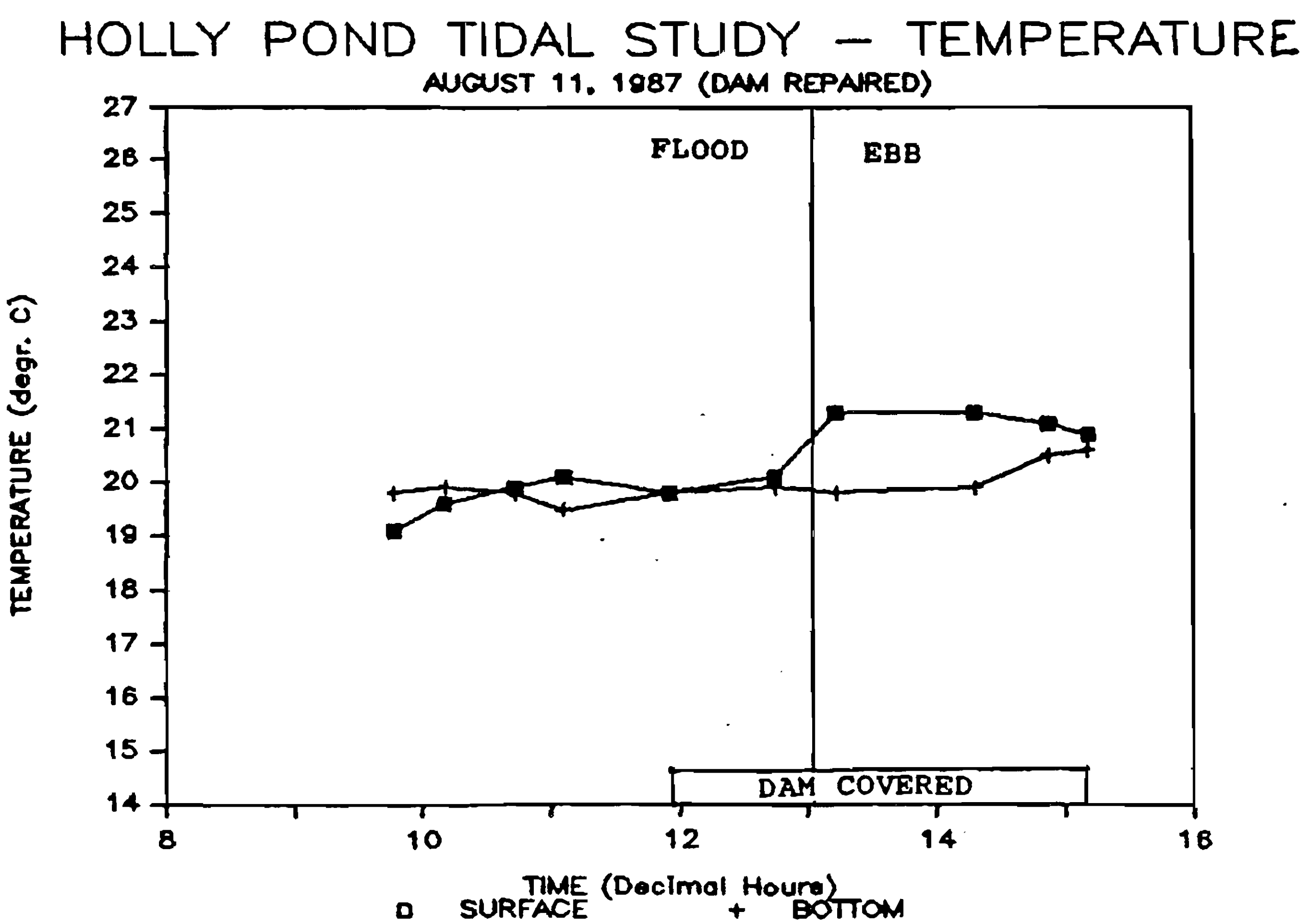
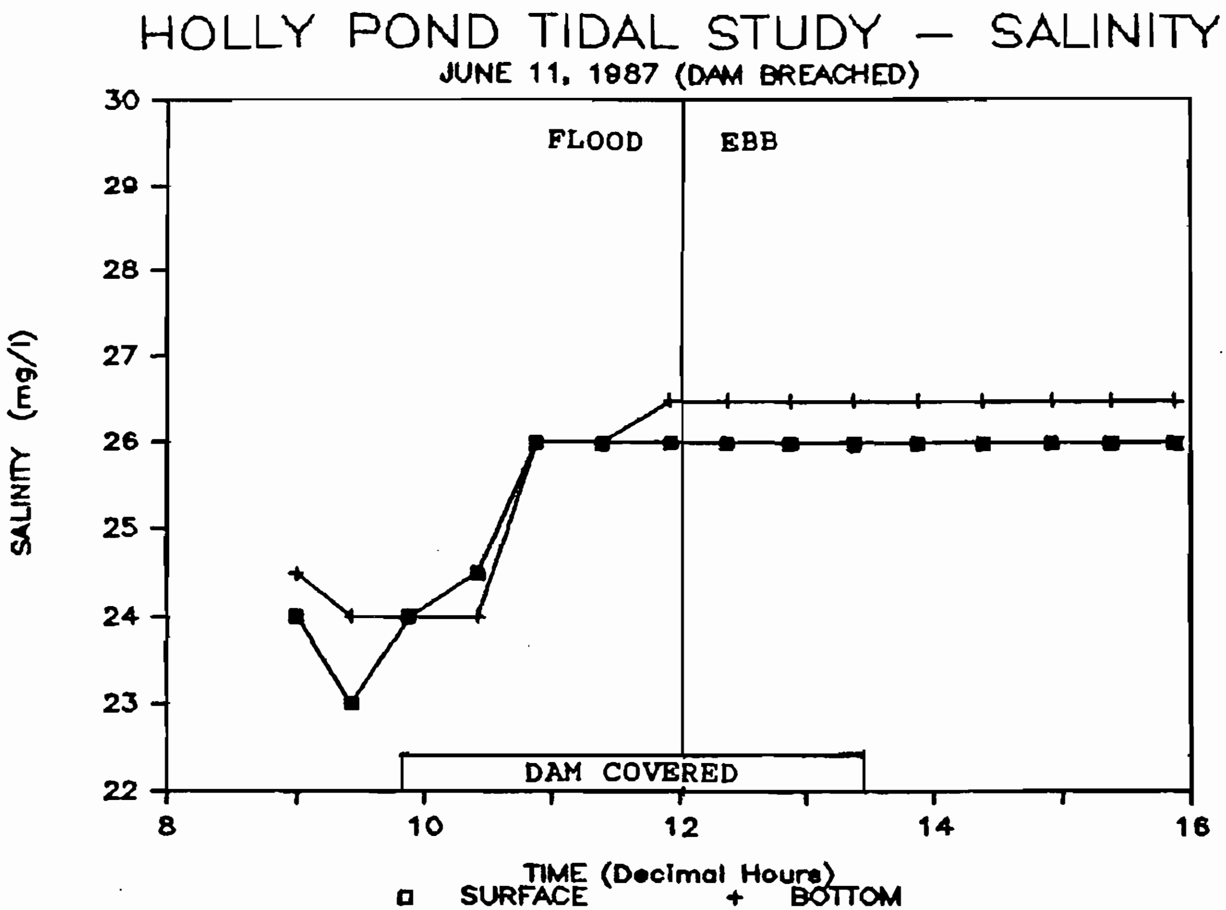

HOLLY POND TIDAL STUDY – TEMPERATURE
AUGUST 11, 1987 (DAM REPAIRED)
FLOOD
EBB
DAM COVERED
TEMPERATURE (degr. C)
TIME (Decimal Hours)
SURFACE
BOTTOM

Figure 15. Tidal studies while dam was breached and after dam was repaired. Change in salinity with time at late flood tide through early ebb tide.


HOLLY POND TIDAL STUDY — SALINITY
JUNE 11, 1987 (DAM BREACHED)
FLOOD
EBB
DAM COVERED
SALINITY (mg/l)
TIME (Decimal Hours)
SURFACE
BOTTOM

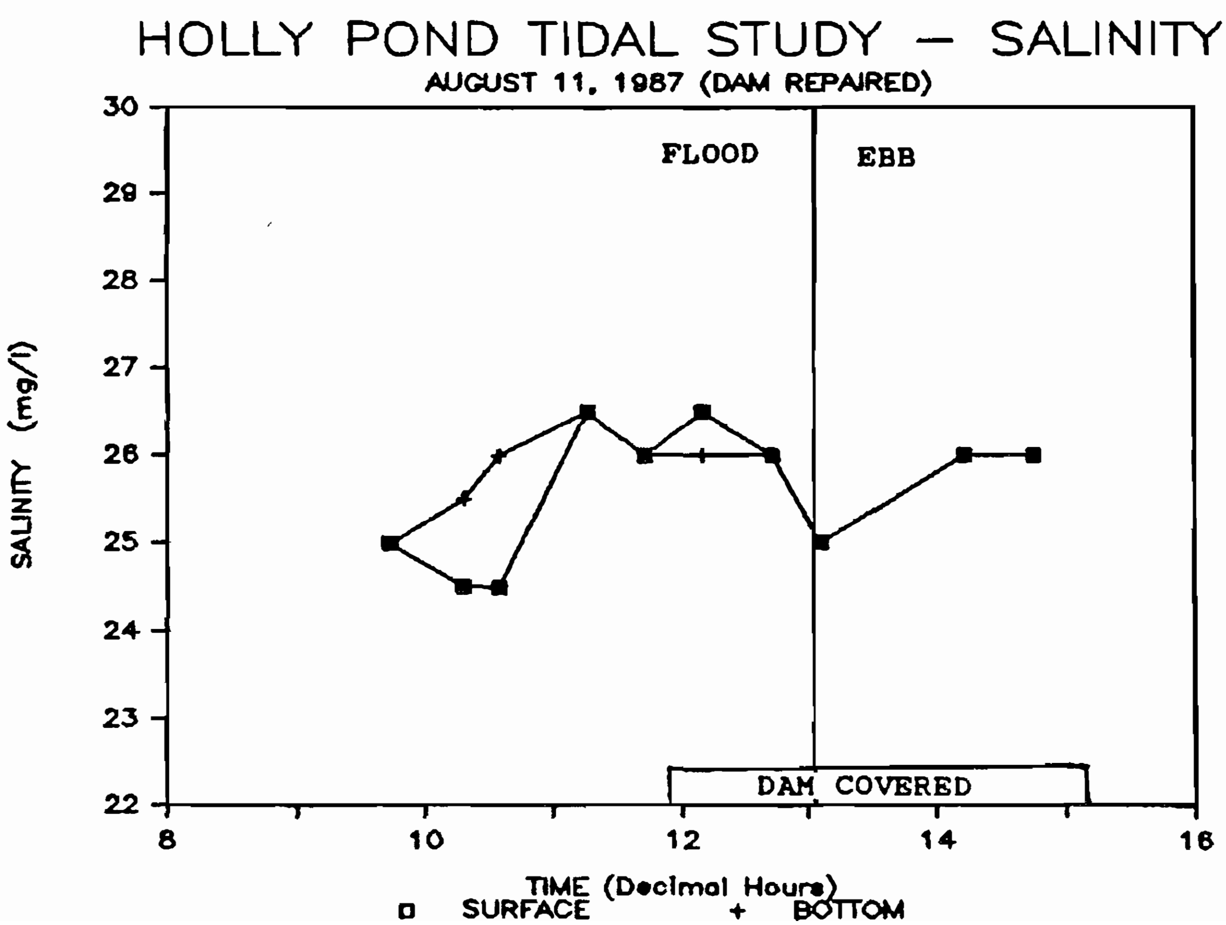
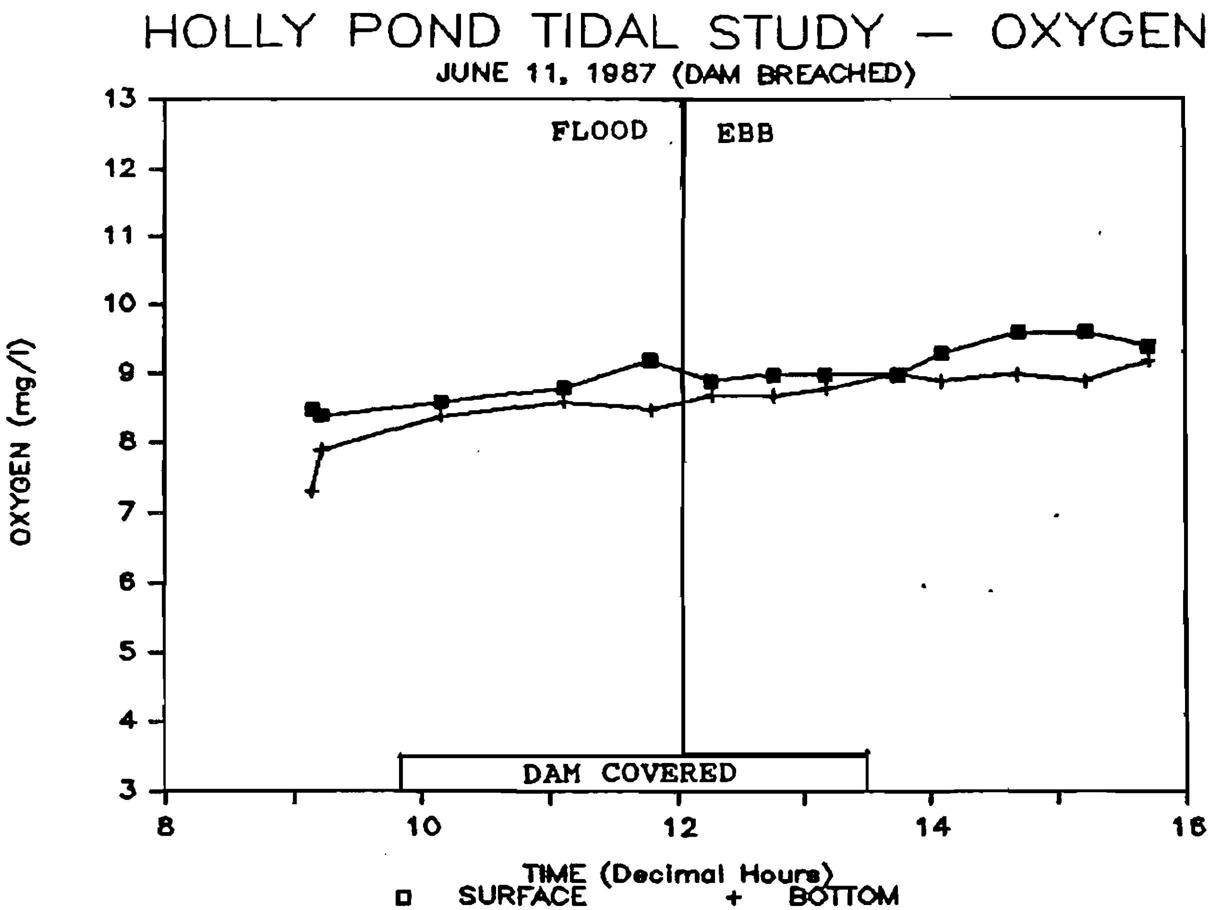

HOLLY POND TIDAL STUDY — SALINITY
AUGUST 11, 1987 (DAM REPAIRED)
FLOOD
EBB
DAM COVERED
SALINITY (mg/l)
TIME (Decimal Hours)
SURFACE
BOTTOM

Figure 16. Tidal studies while dam was breached and after dam was repaired. Change in oxygen with time at late flood tide through early ebb tide.


HOLLY POND TIDAL STUDY — OXYGEN
JUNE 11, 1987 (DAM BREACHED)
FLOOD
EBB
DAM COVERED
OXYGEN (mg/l)
TIME (Decimal Hours)
SURFACE
BOTTOM
13
12
11
10
9
8
7
6
5
4
3
8
10
12
14
16

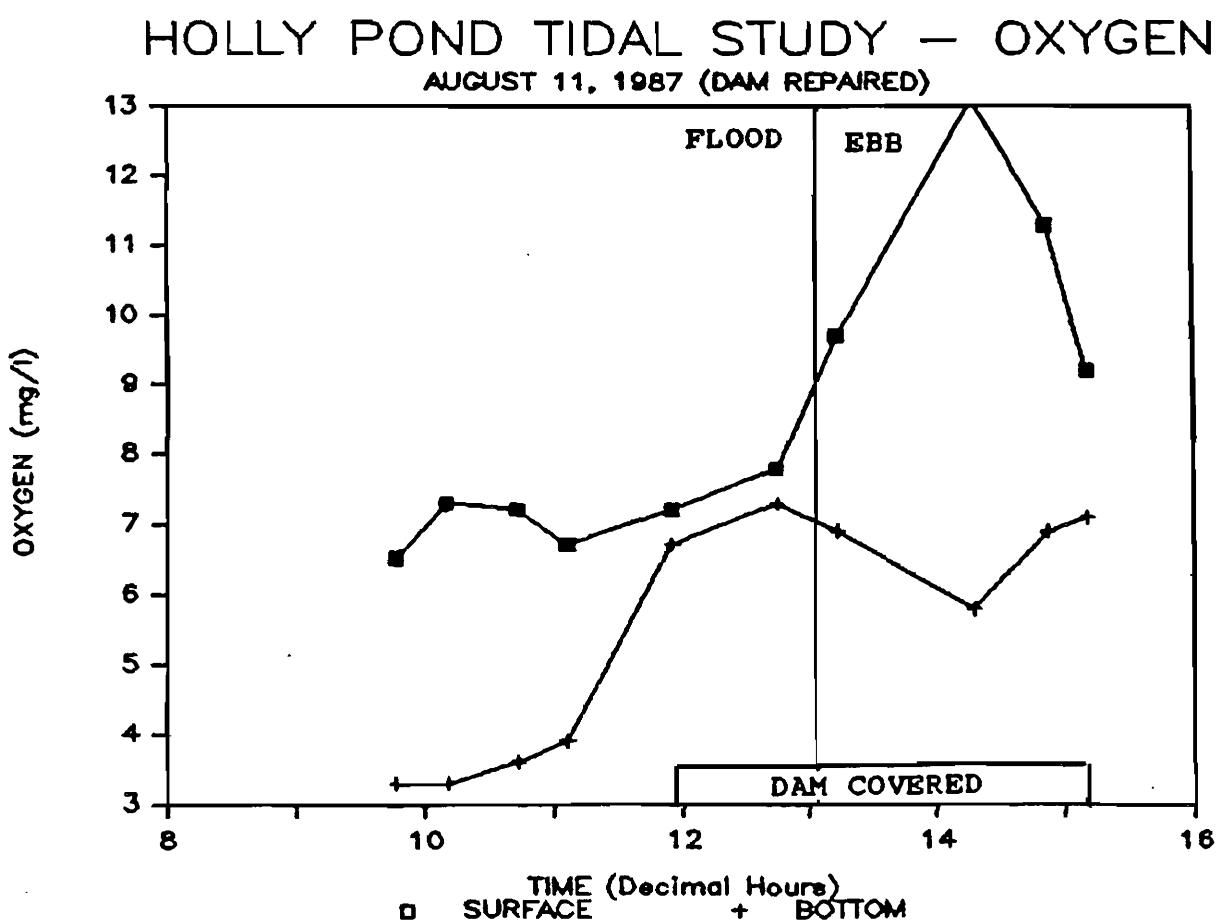
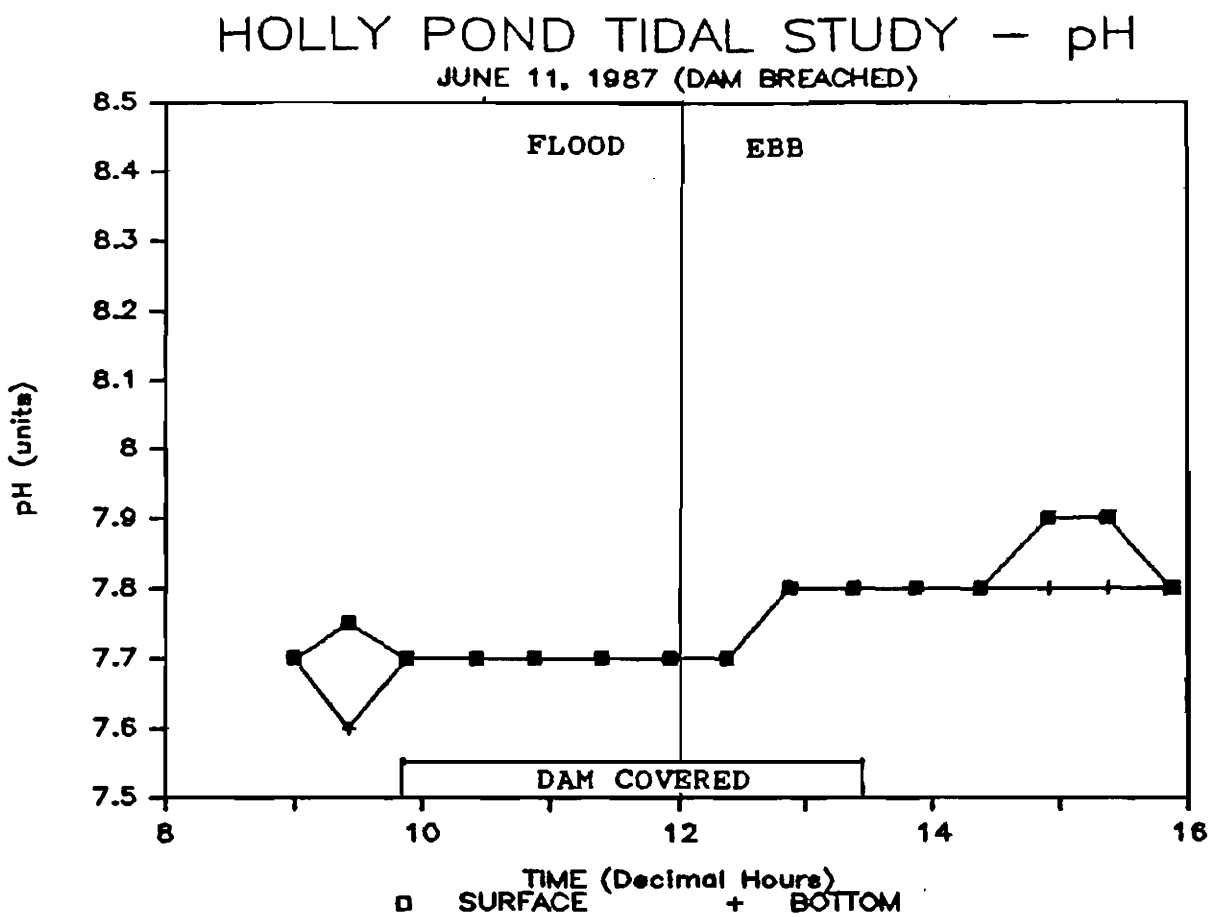
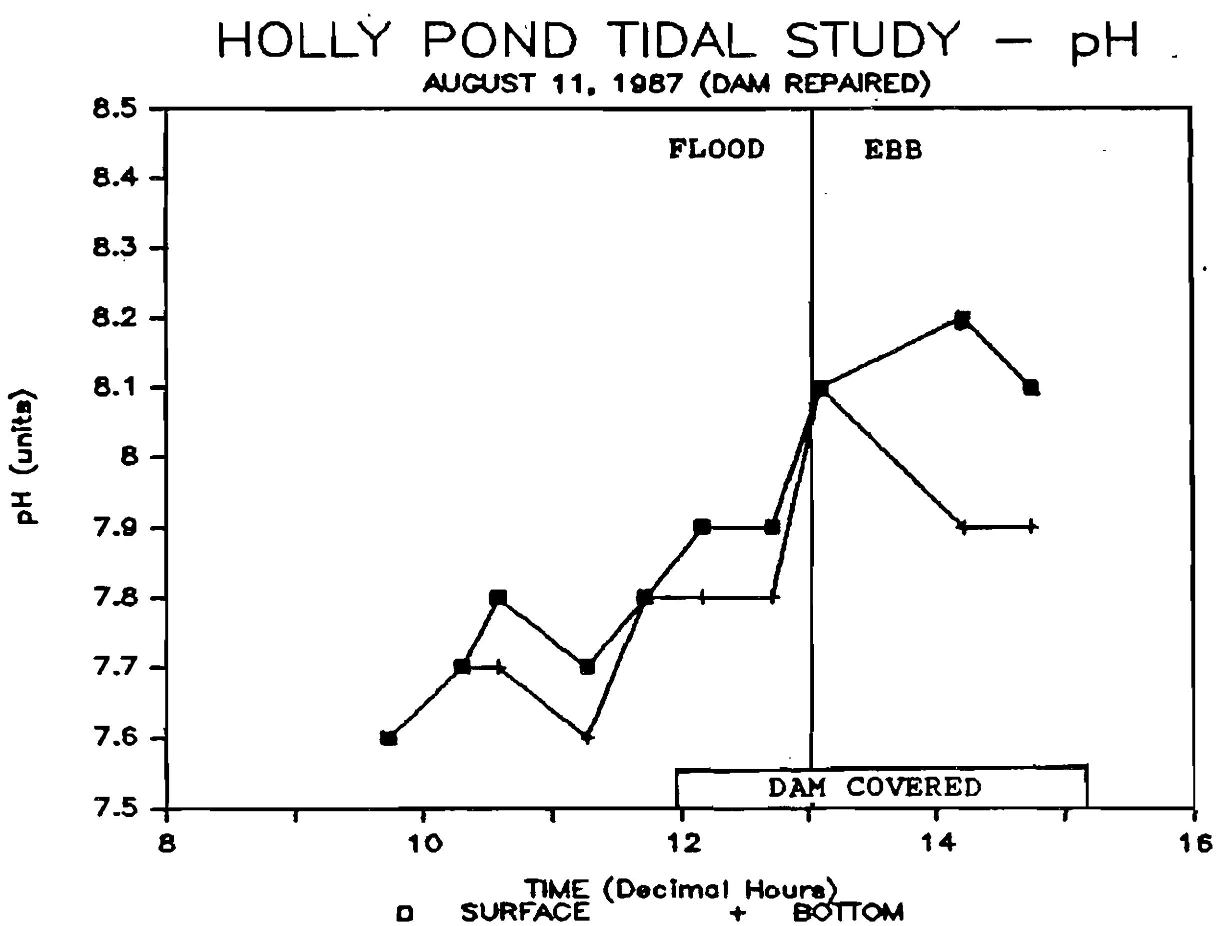

HOLLY POND TIDAL STUDY — OXYGEN
AUGUST 11, 1987 (DAM REPAIRED)
FLOOD
EBB
DAM COVERED
OXYGEN (mg/l)
TIME (Decimal Hours)
SURFACE
BOTTOM
13
12
11
10
9
8
7
6
5
4
3
8
10
12
14
16

Figure 17. Tidal studies while dam was breached and after dam was repaired. Change in pH with time at late flood tide through early ebb tide.



HOLLY POND TIDAL STUDY – pH
JUNE 11, 1987 (DAM BREACHED)
FLOOD
EBB
DAM COVERED
pH (units)
8.5
8.4
8.3
8.2
8.1
8
7.9
7.8
7.7
7.6
7.5
8
10
12
14
16
TIME (Decimal Hours)
□ SURFACE
+ BOTTOM



HOLLY POND TIDAL STUDY – pH
AUGUST 11, 1987 (DAM REPAIRED)
FLOOD
EBB
DAM COVERED
pH (units)
8.5
8.4
8.3
8.2
8.1
8
7.9
7.8
7.7
7.6
7.5
8
10
12
14
16
TIME (Decimal Hours)
□ SURFACE
+ BOTTOM

established by noting the appearance of the foam lines. The turn of the tide was also noted in the field and indicated on the graphs.

The breach of the dam did not have any significant affect on either temperature or salinity. Temperature near the bottom of the Pond was quite stable throughout all the experiments regardless of the tide. During the morning, there was no significant difference between surface and bottom temperatures. In the afternoon, surface waters were warmed by the sun and the Pond became temporarily stratified (Figure 14).

In general, deep waters were more saline than surface waters during these studies (Figure 15 , Appendix C)). As water from Long Island Sound began to flood over the dam, however, salinity levels rose in the Pond. For a short time surface and bottom salinities were similar as mixing occurred. On the ebb, the salinity gradient became reestablished with lower salinity in the surface waters and higher salinity below.

Oxygen and pH levels were significantly affected by the breach in the dam (Figure 16 and 17). In June when the tide gate was open, there was very little difference in pH or oxygen levels between surface and bottom. With the dam repaired, however, the bottom of the Pond had become almost anoxic during the latter part of the ebb tide. For a short time while oxygen rich Sound water over-topped the dam and mixing took place, surface and bottom oxygen levels were more similar. Almost immediately after the tide turned and thermal stratification began to develop, oxygen declined again near the bottom and photosynthesis in the surface waters increased the gradient. These trends in oxygen concentrations were also reflected in the distributions of pH.

Summary

The most important effect of the dam on the physical and chemical characteristics of Holly Pond is the maintenance of an asymmetrical tidal cycle. A short dynamic flood tide briefly mixes the Pond from top to bottom, especially near the dam. A long slow ebb tide follows during which the shallow Pond becomes increasingly influenced by the river, the sediments and the macroalgal community. Distributions of temperature, salinity and pH were highly variable near the freshwater inflow, creating a stressful environment at the upper end of the system. In contrast, conditions near the dam were much less patchy because of tidal mixing.

In the central area of the Pond, the long ebb tide allowed physical and chemical gradients to develop from surface to bottom. Water temperatures differed vertically because of surface warming in summer and sediment respiration in winter. Relatively cool surface water flowing into the Pond from the River reversed the temperature gradient at the upper end of the system, with surface waters cooler than the underlying layer. Salinity stratification was most noticeable at the freshwater end but was manifest throughout the pond in winter. Oxygen levels also differed from surface to bottom, resulting from photosynthetic release of oxygen in the photic zone and respiratory uptake by the sediments. When the dam was breached, extensive growth of green algae on the newly exposed tidal flats reversed the stratification pattern, causing increased oxygen concentrations near the bottom. Light attenuation in the Pond was rapid and intensified by increased suspended sediments near the bottom. Even ammonia and nitgrate-nitrogen levels appeared to be stratified with highest values near the surface. Again, the stability of the long slow ebb tide contributed to the formation and maintenance of these vertical gradients which were a major characteristic of the system.

The data developed by this study covered a wide range of conditions and reflected the natural variability encountered in tidal ecosystems. The dam was intact during both the 1986 and 1987 summer sampling periods and was breached during the fall, winter and spring. Therefore, any subtle changes in physical and chemical characteristics of the pond caused by the 20 cm drop in the low tide level were masked by more robust seasonal effects. However, only one tidal gate was open. If the dam were repaired so that three gates could be opened, physical and chemical conditions in the pond would probably change significantly. Vertical gradients would be less apparent and the effect of the River on the upper end of the system would be diminished.

Experimental changes in the tidal regime of Holly Pond should be approached with caution. Large areas of sediments will be transformed suddenly and temporarily from subtidal to intertidal systems. The stressful effects on life cycles of the resident organisms may be extensive. Part II of this report discusses at length the impact of the accidental breach of the dam on the resident macroalgal community.

PART II: BIOLOGICAL STUDIES

MATERIAL AND METHODS

Description of Study Sites

Six sites for benthic macrophyte sampling were established along the Stamford side of the Noroton River Estuary. Site selection reflected areas that were not only environmentally sensitive but socially important to the area residents (Fig. 1). Site 1 was located at the mouth of the Noroton River Estuary at the eastern end of East Beach on Cove Island. Site 2 was established below the tidal gates on the Stamford side and borders the existing salt marsh community. Site 3 was located above the dam behind the former offices of the Stamford Parks Department. Site 4 was established in an area across from the residence at 25 Weed Avenue. Site 5 was situated in area near the Gus Edson Lookout (an overlook opposite the residence at 175 Weed Avenue). Finally, site 6 was located near the Route 1 overpass separating the Town of Darien and the City of Stamford. The physical-chemical characteristics of each of these sites have been presented in section I of this report.

Biomass Sampling and Processing

Monthly sampling included qualitative measures of the benthic macrophytes (i.e. seaweeds) in the subtidal (i.e. sublittoral) and the intertidal (i.e. eulittoral) zones from May, 1986 through October, 1987. A taxonomic listing and the seasonal occurrence of the macrophytes appear in Tables 1-2. The taxonomy of the listing basically follows that of South & Tittley (1986) and Schneider et al. (1979). This list was compiled from 108 plant collections at the 6 stations. At least 6 field collections at each station were taken between May, 1986 and May, 1988 to assess percent cover and biomass.

At each station quadrats were placed according to a random stratified sampling design. The strata were the subtidal and intertidal zones. Three randomly situated 0.25 m^2 quadrats were measured within each zone at each station. Visible percent cover of seaweed genera, animal genera and bare substrate (rock, shell, stones, gravel, sand, peat or mud) was estimated within each quadrat. Then the seaweeds in the quadrat were collected by hand for measurements of biomass. All samples were stored in plastic bags during field collections and held at 4 ^{o}C until processing was completed. Each sample was sorted by species and wet weight for the dominant taxa was determined to the nearest 0.1 g. Approximate conversions from wet to dry weights are as follows: Ulva lactuca - 0.150; Fucus spiralis - 0.166; Enteromorpha intestinalis - 0.191; E. linza - 0.188; E. prolifera - 0.227; E. clathrata-0.090; Fucus spiralis-0.166; Petalonia fascia - 0.196; Scytosiphon lomentaria - 0.167; Laminaria saccharina - 0.143; Ectocarpus siliculosus - 0.241; Agardhiella subulata - 0.192; Gracilaria tikvahiae - 0.139; Chondrus crispus - 0.193; and Polysiphonia harveyi - 0.140.

Voucher specimens were and are available for inspection in Professor Yarish's herbarium at the University of Connecticut at Stamford.

Trace Element Analysis

Samples of Chondrus crispus, a perennial red alga in Holly Pond (Station 3), were collected on July 15, 1986. They were thoroughly rinsed and freeze-dried for shipment to Dr. James Craigie at the Atlantic Regional Laboratories of the National Research Council of Canada. Dr. Craigie consented to do trace element analyses on these samples (i.e. for Zn, Ca, P, Mg, Cu, Fe, Bo, Co, and Mn). He digested the samples for trace element analyses using concentrated nitric acid and then employed standard atomic absorption techniques.

Frost Tolerance of Ulva spp.

In an attempt to determine the frost tolerance of Ulva species in Holly Pond, an independent study project by Mr. Ray Foley, an advanced biology student, was undertaken using 100 Ulva plants which were collected on 7 May, 1987. Plants, upon arrival to the lab, were cut to a standard length of size 3.5 cm and placed individually in small Petri dishes with 10.0 ml of enriched seawater medium. Each plant was slowly acclimated, in 5 ^{o}C increments, for a period of two weeks down to -11 ^{o}C. After the final acclimation period, the plants were then placed in aluminium containers. Half of them were were placed in seawater and the other half were air dried, and then covered by aluminium foil. Replicate groups of 8 plants (4 submersed and 4 air-dried) were then placed in the -11 ^{o}C incubator for exposure periods including 1, 2, 4, 8, 16, 32, 64, 128, 256, and 512 hours. A group of 20 plants (10 submersed and 10 air-dried) were exposed to -11 ^{o}C for 1024 hours. All plants were slowly re-acclimated in 5 ^{o}C increments as before until they reached the ambient temperature at the time of collection. To ascertain if plants survived, the re-acclimated plants were exposed to an irradiance (i.e. photon fluence rate) of 150 uE m^{-2} s^{-1} in the 10 ^{o}C incubator for 28 days. Survival was determined by microscopic examination of cells after the experimental period. Specimens were vouchered in Professor Yarish's herbarium.

RESULTS

Distribution of Dominant Species

A total of 61 taxa were identified during the study (Tables 1a-1c); 22 species were numerically dominant and accounted for 99.0% of the total biomass or percent cover (Tables 2,3-8). The mean biomass of the remaining 39 taxa was less than 1 gram or the mean percent cover was less than 1%.

The distribution of the dominant species varied significantly along the estuarine gradient from Stations 1 to 6 (Tables 1a-1c; Fig. 1a). A reduction in species number in the estuary was evident from Station 1 at the mouth to Station 6 at the head of the estuary (Fig. 1a) - i.e. 41 were found at Station 1 while only 6 were collected at Station 6. Peak biomass and percent cover of seaweeds were found in the Pond with maximum values at Stations 4 and 5 and minimum values at Station 6. Most of the biomass at Station 1 was comprised of brown algae (mostly species of *Fucus*). Green and red algae dominated the Pond (Stations 3-5). Pond species of green algae included *Ulva* and *Enteromorpha* spp., and species of red algae included *Agardhiella subulata*, *Chondrus crispus* and *Gracilaria tikvahiae*. At Station 6, the most common green algae were *Blidingia minima*, *Enteromorpha intestinalis* and *Gayralia* {=*Ulvaria*} *oxyspermum*.

Table 1. Seasonal occurrence and distribution of macroalgae.

Table 1a

SEASONAL OCCURRENCE AND DISTRIBUTION OF MACROALGAE

NOROTON RIVER ESTUARY 1986 - 1987

Species	May 1986	Jun 1986	Jul 1986	Aug 1986	Sep 1986	Oct 1986
RED ALGAE						
Goniotrichum alsidii						1
Bangia atropurpurea	2	1,2	2	2	2	2
Porphyra umbilicalis	2	1	1			1
Audouinella secundata						
Agardhiella subulata			1,2,3,4,5	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5
Chondrus crispus	1,3,4	1,3,4	1,3,4	1,3,4	1,3,4	1,3,4
Gracilaria tikvahiae	1,4,5	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5	1,3,5
Hildenbrandia rubra	1	1	1	1	1	1
Lomentaria baileyana					3	3
Antithamnion cruciatum						
Callithamnion tetragonum						
Ceramium deslongchampii v hooperi						
Ceramium diaphanum			3	3	3	3
Ceramium rubrum	1	1	1	1	1	1
Grinnellia americana					3	3
Dasya baillouviana			3	3	3	3
Bostrychia radicans			4	4	4	4
Polysiphonia denudata						
Polysiphonia harveyi	2,3,4,5	2,3,5	3,4,5	3,4,5	3,4,5	3,4,5
Polysiphonia urceolata	3	3	3	3	3	3
Polysiphonia nigrescens	1					
BROWN ALGAE						
Ectocarpus siliculosis						
Pilayella littoralis						
Ralfsia verrucosa	1	1	1	1	1	1
Elachista fucicola						
Leathesia difformis	1	1				
Petalonia fascia	1,2,3,4,5	1				
Scytosiphon lomentaria	1,2,3,4	1				
Desmarestia viridis						
Sphacelaria cirrosa	1					
Laminaria saccharina	1,2	1	1			
Ascophyllum nodosum						
Fucus spiralis	1,2	1,2	1,2	1,2	1,2	1,2
Fucus vesiculosus	2,4	1,2,4	1,2,4	1,2,4	2,4	2,4
GREEN ALGAE						
Ulothrix flacca	1,2,4	1,2,4	1,2,4	1,2,4	1,2,4	1,2,4,5
Urospora penicilliformis						
Epicladia testarum			3	3		

SEASONAL OCCURRENCE AND DISTRIBUTION OF MACROALGAE

NOROTON RIVER ESTUARY 1986 - 1987

Species	May 1986	Jun 1986	Jul 1986	Aug 1986	Sep 1986	Oct 1986
Acrochaete viridis	3	3	3	3	3	3
Ochlochaete hystrix	4	4	4	4	4	4
Phaeophila dendroides	4	4	4	4	4	4
Pseudendoclonium submarinum	1	1	1	1	1	1
Monostroma grevillei						
Spongomorpha arcta	1					
Capsosiphon fulvescens	5	5	5	5	5	5
Blidingia minima	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6
Enteromorpha clathrata	2,5	5	5	5	5	5
Enteromorpha flexuosa	1	1	1	1	1	1
Enteromorpha intestinalis	2,3,4,5,6	2,3,4,5,6	2,3,4,5,6	2,3,4,5,6	2,3,4,5,6	2,3,4,5,6
Enteromorpha linza	1,2	1,2	1,2	1,2	1,2,3	1,2
Enteromorpha prolifera	3	3	3	3	3	3
Ulva lactuca	1,2,3,4,5	1,2,3,4,5	1,3,4	1,3,4	1,2,3,4	1,2,3,4,5
Ulva rigida	1,2	2	1,2	1,2	2	2
Ulva rotundata	4,5	4	4	4	4	4
Ulva pseudocurvata	4,5	3,4,5	5	5	5	5
Ulvaria oxysperma	4,5	4,5	4,5	4,5	4,5	4,5
Percursaria percursa	6	6	6	6	6	6
Cladophora sericea	4,5					
Rhizoclonium riparium		2,5,6	2,4,5	2,4,5	2,4,5	2,4,5
Bryopsis plumosa					3	1,3
Codium fragile		3	3	3	3	3
Microspora spp.						

GOLDEN ALGAE

Species	May 1986	Jun 1986	Jul 1986	Aug 1986	Sep 1986	Oct 1986
Vaucheria compacta	6	6	5,6	5,6	5,6	5,6

Table 1b

SEASONAL OCCURRENCE AND DISTRIBUTION OF MACROALGAE

NOROTON RIVER ESTUARY

Species	Nov 1986	Dec 1986	Jan 1987	Feb 1987	Mar 1987	Apr 1987
RED ALGAE						
Goniotrichum alsidii						
Bangia atropurpurea	1,2,3	1,2,4	1,2,4	1,2	1,2	1,2,4
Porphyra umbilicalis	1,2,3	1,2,3	1,4	1	1,3	1
Audouinella secundata		1	1	1	1	1
Agardhiella subulata	1,2,3,4	1,2,4	1,4	4	1,4	1,4
Chondrus crispus	1,2,3	1,2,3	1,3	1,3	1,3	1,3
Gracilaria tikvahiae						
Hildenbrandia rubra	1,2	1,2	1	1	1	1
Lomentaria baileyana						
Antithamnion cruciatum					1	1
Callithamnion tetragonum		1	1	1	1	1
Ceramium deslongchampii v hooperi	1,2	2				
Ceramium diaphanum	3					
Ceramium rubrum	1,3	1,3	1.3	1,3	1,3	1,3
Grinnellia americana	1	2				
Dasya baillouviana	3	1,2,3				
Bostrychia radicans	2,4,5	4,5	4			
Polysiphonia denudata						
Polysiphonia harveyi						
Polysiphonia urceolata	1			1	1	1
Polysiphonia nigrescens		1	1	1	1	1
BROWN ALGAE						
Ectocarpus siliculosis		2,3,5	2,3,5	2,3,5	2,3,5	
Pilayella littoralis		2				
Ralfsia verrucosa	1	1	1	1	1	1
Elachista fucicola						
Leathesia difformis						
Petalonia fascia	1	1,2	1	1	1,2	1,3
Scytosiphon lomentaria			1	1	1,2	1,3
Desmarestia viridis					1	1
Sphacelaria cirrosa	1	1,2		1	1	1
Laminaria saccharina		1	1	1	1	1
Ascophyllum nodosum	1,2	1	1	1	1	1
Fucus spiralis	1,2,3	1,2	1,2	1,2	1,2	1,2
Fucus vesiculosus	1,2,4,5	1,2,4	1,2,4	1,2,4	1,2,4	1,2,4
GREEN ALGAE						
Ulothrix flacca	1,2,3,4,5,6	1,2,3,4	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5
Urospora penicilliformis		1,2,4	1	1,3	1,3	1,3,4

SEASONAL OCCURRENCE AND DISTRIBUTION OF MACROALGAE

NOROTON RIVER ESTUARY

Species	Nov 1986	Dec 1986	Jan 1987	Feb 1987	Mar 1987	Apr 1987
Epicladia testarum						
Acrochaete viridis	3	2,3	3	3	3	3
Ochlochaete hystrix	4	4	4	4	4	4
Phaeophila dendroides	4	4	4	4	4	4
Pseudendoclonium submarinum	1	1	1	1	1	1
Monostroma grevillei				3	3	
Spongomorpha arcta						
Capsosiphon fulvescens	5	5	5	5	5	5
Blidingia minima	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6
Enteromorpha clathrata						
Enteromorpha flexuosa	1	1	1	1	1	1
Enteromorpha intestinalis	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,4
Enteromorpha linza	1,2	1,2,3	1,2	1,2	1,2,3	1
Enteromorpha prolifera						
Ulva lactuca	1,2,3,4	1,2,3,4	1,5	1,2,3	1,2,3	1,5
Ulva rigida	2,3	1,2				
Ulva rotundata						
Ulva pseudocurvata	1,3	1,3,4,5	4,5	4,5	4,5	4,5
Ulvaria oxysperma	2,3,4,5,6	1,2,3'5	4,6	4	4	4
Percursaria percursa	6	6	6	6	6	6
Cladophora sericea						
Rhizoclonium riparium	1	2,4			5	4,5
Bryopsis plumosa	1,3					
Codium fragile	1,3	3	1,3	3	3	3
Microspora spp.					6	

GOLDEN ALGAE

Vaucheria compacta	2,3,4,5,6					

Table 1c

SEASONAL OCCURRENCE AND DISTRIBUTION OF MACROALGAE

NOROTON RIVER ESTUARY

Species	May 1987	Jun 1987	Jul 1987	Aug 1987	Sep 1987	Oct 1987
RED ALGAE						
Goniotrichum alsidii						
Bangia atropurpurea	1,2	1,2				
Porphyra umbilicalis	1					1,4
Audouinella secundata	1	1	1	1		1
Agardhiella subulata	1,4		1	1	4	4
Chondrus crispus	1,3	1,3	1,3	1,3	1,3	1,3
Gracilaria tikvahiae						
Hildenbrandia rubra	1	1	1	1	1	1,3
Lomentaria baileyana						
Antithamnion cruciatum					1	1
Callithamnion tetragonum	1	1				1
Ceramium deslongchampii v hooperi						
Ceramium diaphanum						
Ceramium rubrum	1	1	1	1	1	1
Grinnellia americana						
Dasya baillouviana					3	3
Bostrychia radicans	4	4	4	4	4	
Polysiphonia denudata						1 ←
Polysiphonia harveyi	1,4				3,4	3,4
Polysiphonia urceolata	1					
Polysiphonia nigrescens						
BROWN ALGAE						
Ectocarpus siliculosis						
Pilayella littoralis						
Ralfsia verrucosa	1	1	1	1	1	1
Elachista fucicola						
Leathesia difformis						
Petalonia fascia	1,3,5					
Scytosiphon lomentaria	1,3,5					
Desmarestia viridis						
Sphacelaria cirrosa	1					
Laminaria saccharina						
Ascophyllum nodosum	1					
Fucus spiralis	1,2	1,2	1,2	1,2	1,2	1,2
Fucus vesiculosus	2,4	2,4	2,4	2,4	2,4	2,4
GREEN ALGAE						
Ulothrix flacca	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5

SEASONAL OCCURRENCE AND DISTRIBUTION OF MACROALGAE

NOROTON RIVER ESTUARY

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Species	May 1987	Jun 1987	Jul 1987	Aug 1987	Sep 1987	Oct 1987
Urospora penicilliformis	1,3					
Epicladia testarum						
Acrochaete viridis	3	3	3	3	3	3
Ochlochaete hystrix	4	4	4	4	4	4
Phaeophila dendroides	4	4	4	4	4	4
Pseudendoclonium submarinum	1	1	1	1	1	1
Monostroma grevillei						
Spongomorpha arcta						
Capsosiphon fulvescens	5	5	5	5	5	5
Blidingia minima	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6
Enteromorpha clathrata						
Enteromorpha flexuosa	1	1	1	1	1	1
Enteromorpha intestinalis	4,6	4,6	6	3		6
Enteromorpha linza	1		3			
Enteromorpha prolifera						
Ulva lactuca	1,5	4,5	3,4,5	3,4,5		4
Ulva rigida						
Ulva rotundata						
Ulva pseudocurvata	4,5	4,5	4,5	4,5		
Ulvaria oxysperma	4,5	4,5	4,5	4,5	4,5	4,5,6
Percursaria percursa	6	6	6	6	6	6
Cladophora sericea		4	4	4	4	4
Rhizoclonium riparium	2,4,5	4,5	4,5	4,5	4,5	4,5
Bryopsis plumosa			3	3	3	3
Codium fragile						
Microspora spp.						

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GOLDEN ALGAE

Vaucheria compacta	6	6				6

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Tables 2. Macroalgal longevity and distribution type along the Noroton River Estuary.

MACROALGAL LONGEVITY AND DISTRIBUTION TYPE

NOROTON RIVER ESTUARY

Species	Longevity	Dist. Type
RED ALGAE		
Goniotrichum alsidii	Ann.	Cos.
Bangia atropurpurea	Ann.	Est.
Porphyra umbilicalis	Ann.	Cos.
Audouinella secundata	Per.	Cos.
Agardhiella subulata	Pseudo.	Est.
Chondrus crispus	Pseudo.	Est.
Gracilaria tikvahiae	Pseudo.	Est.
Hildenbrandia rubra	Per.	Cos.
Lomentaria baileyana	Pseudo.	Cos.
Antithamnion cruciatum	Ann.	Cos.
Callithamnion tetragonum	Ann.	Cos.
Ceramium deslongchampii	Ann.	Cos.
Ceramium diaphanum	Ann.	Cos.
Ceramium rubrum	Per.	Cos.
Grinnellia americana	Pseudo.	Cos.
Dasya baillouviana	Ann.	Cos.
Bostrychia radicans	Pseudo.	Est.
Polysiphonia denudata	Ann.	Cos.
Polysiphonia harveyi	Pseudo.	Est.
Polysiphonia urceolata	Per.	Cos.
Polysiphonia nigrescens	Ann.	Cos.
BROWN ALGAE		
Ectocarpus siliculosis	Ann.	Est.
Pilayella littoralis	Ann.	Cos.
Ralfsia verrucosa	Per.	Cos.
Leathesia difformis	Ann.	Cos.
Petalonia fascia	Ann.	Est.
Scytosiphon lomentaria	Ann.	Est.
Desmarestia viridis	Ann.	Cos.
Sphacelaria cirrosa	Ann.	Cos.
Laminaria saccharina	Ann.	Cos.
Ascophyllum nodosum	Per.	Cos.
Fucus spiralis	Per.	Cos.
Fucus vesiculosus	Per.	Est.

GREEN ALGAE

Ulothrix flacca	Per.	Est.
Urospora penicilliformis	Ann.	Est.
Epicladia testarum	Ann.	Cos.
Acrochaete viridis	Per.	Cos.
Ochlochaete hystrix	Per.	Est.
Phaeophila dendroides	Per.	Est.
Pseudendoclonium submarinum	Per.	Cos.
Monostroma grevillei	Ann.	Cos.
Spongomorpha arcta	Ann.	Cos.
Capsosiphon fulvescens	Per.	Est.
Blidingia minima	Per.	Est.
Enteromorpha clathrata	Per.	Est.
Enteromorpha flexuosa	Per.	Cos.
Enteromorpha intestinalis	Per.	Est.
Enteromorpha linza	Per.	Cos.
Enteromorpha prolifera	Per.	Cos.
Ulva lactuca	Per.	Est.
Ulva rigida	Ann.	Cos.
Ulva rotundata	Ann.	Est.
Ulva curvata	Per.	Est.
Gayralia oxysperma	Per.	Est.
Percursaria percursa	Per.	Est.
Cladophora sericea	Ann.	Est.
Rhizoclonium riparium	Per.	Est.
Bryopsis plumosa	Ann.	Cos.
Codium fragile	Per.	Cos.
Microspora spp.	Ann.	F.W.

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GOLDEN ALGAE

Vaucheria compacta	Per.	Est.

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Ann. = Annual
Per. = Perennial
Pseudo. = Pseudoperennial
Cos. = Cosmopolitan
Est. = Estuarine
F.W. = Freshwater

Table 3. Total macoalgal biomass (g 0.25 m^{-2}) on May 28, 1986.

HOLLY POND

TOTAL MACROALGAL BIOMASS
(g/0.25m2)

MAY 28, 1986

GROUP	STA.1 1 S	1 I	STA.2 2 S	2 I	STA.3 3 S	3 I	STA.4 4 S	4 I	STA.5 5 S	5 I	STA.6 6 S	6 I
BROWN ALGAE	41.8	28.7	83.6	1.7	2.2	2.8	3.7	0.0	7.3	0.0	0.0	0.0
Petalonia	30.5	13.7	4.2	0.0	2.1	2.1	3.7	0.0	7.3	0.0	0.0	0.0
Scytosiphon	10.9	14.1	76.4	1.7	0.1	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Laminaria	0.4	0.4	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fucus	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RED ALGAE	6.9	8.5	0.0	0.0	35.8	221.5	77.4	0.0	26.7	0.0	0.0	0.0
Chondrus	6.2	8.0	0.0	0.0	35.8	204.9	0.0	0.0	0.0	0.0	0.0	0.0
Polysiphonia nigr.	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polysiphonia harveyii	0.0	0.0	0.0	0.0	0.0	16.6	2.9	0.0	23.4	0.0	0.0	0.0
Gracilaria	0.2	0.0	0.0	0.0	0.0	0.0	74.5	0.0	3.3	0.0	0.0	0.0
GREEN ALGAE	1.3	72.0	50.0	26.9	2.8	112.3	522.5	0.0	603.6	0.0	11.1	0.0
Enteromorpha	1.3	23.8	0.3	11.4	0.3	1.6	0.1	0.0	5.3	0.0	10.8	0.0
Ulva	0.0	47.8	49.7	15.5	2.5	110.7	522.1	0.0	598.3	0.0	0.0	0.0
Cladophora	0.0	0.1	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Spongomorpha	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0

Zones: S = Subtidal, I = Intertidal

Table 4. Total macoalgal biomass (g 0.25 m^{-2}) on September 13, 1986.

HOLLY POND

TOTAL MACROALGAL BIOMASS
(g/0.25 m2)

SEPT. 13, 1986

GROUP ZONE:	STA.1 1 S	1 I	STA.2 2 S	2 I	STA.3 3 S	3 I	STA.4 4 S	4 I	STA.5 5 S	5 I	STA.6 6 S	6 I
BROWN ALGAE	0.0	29.7	0.0	22.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fucus	0.0	29.7	0.0	22.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RED ALGAE	2.5	0.0	1.4	0.0	109.5	8.1	1008.3	4.6	473.3	0.0	0.0	0.0
Chondrus	1.2	0.0	0.1	0.0	108.9	6.4	0.0	0.0	0.0	0.0	0.0	0.0
Polysiphonia harveyii	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Gracilaria	0.0	0.0	0.0	0.0	0.0	0.5	9.3	0.9	0.0	0.0	0.0	0.0
Ceramium	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agardhiella	0.9	0.0	1.3	0.0	0.2	1.1	999.0	3.7	473.3	0.0	0.0	0.0
GREEN ALGAE	5.9	2.3	8.8	20.1	0.3	29.5	4.4	94.8	0.4	0.0	0.0	0.0
Enteromorpha	0.0	2.3	0.0	10.5	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0
Ulva	5.9	0.0	8.8	2.2	0.3	27.9	4.4	93.8	0.4	0.0	0.0	0.0
Blidingia	0.0	0.0	0.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Codium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0

Zones: S = Subtidal, I = Intertidal

Table 5. Total macoalgal biomass (g 0.25 m^{-2}) on March 6, 1987.

HOLLY POND

TOTAL MACROALGAL BIOMASS
(g/0.25 m2)

MARCH 6, 1987

GROUP SPECIES ZONE:	STA.1 1 S	1 I	STA.2 2 S	2 I	STA.3 3 S	3 I	STA.4 4 S	4 I	STA.5 5 S	5 I	STA.6 6 S	6 I
BROWN ALGAE	2.3	1400.3	17.3	92.7	0.3	0.3	0.1	35.0	0.0	0.3	0.0	0.3
Petalonia	0.8	0.0	.0	0.0	0.0	.0	0.0	0.0	0.0	0.0	0.0	0.0
Scytosiphon	0.3	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Fucus	0.0	1400.3	0.0	92.7	0.0	0.0	0.0	35.0	0.0	0.0	0.0	0.0
Diatoms	1.2	0.0	17.3	0.0	0.3	0.3	0.1	0.0	0.0	0.3	0.0	0.3
RED ALGAE	2.1	0.0	0.0	0.0	140.8	0.0	781.7	0.0	0.0	0.0	0.0	0.0
Chondrus	2.1	0.0	0.0	0.0	140.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agardhiella	0.0	0.0	0.0	0.0	0.0	0.0	781.7	0.0	0.0	0.0	0.0	0.0
GREEN ALGAE	0.0	0.6	0.0	3.3	0.4	1.1	0.0	4.0	0.0	0.0	0.0	0.6
Enteromorpha	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ulva	0.0	.0	0.0	0.0	.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blidingia/Urospora	0.0	0.6	0.0	3.3	0.0	1.1	0.0	4.0	0.0	0.0	0.0	0.0
Monostroma	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ulothrix	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Microspora	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3

Zones: S = Subtidal, I = Intertidal

Table 6. Total macoalgal biomass (g 0.25 m^{-2}) on June 16, 1987.

HOLLY POND   TOTAL MACROALGAL BIOMASS (g/0.25 m2)

JUNE 16, 1987

GROUP SPECIES ZONE:	STA.1 1 S	1 I	STA.2 2 S	2 I	STA.3 3 S	3 I	STA.4 4 S	4 I	STA.5 5 S	5 I	STA.6 6 S	6 I
BROWN ALGAE	0.4	414.7	0.0	12.1	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0
Fucus	0.4	414.7	0.0	12.1	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0
RED ALGAE	71.2	0.0	5.4	0.0	248.8	0.0	24.9	0.0	2.8	0.0	0.0	0.0
Chondrus	50.1	0.0	0.0	0.0	243.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polysiphonia harveyii	0.0	0.0	0.0	0.0	5.4	0.0	6.3	0.0	0.0	0.0	0.0	0.0
Gracilaria	7.7	0.0	5.4	0.0	0.0	0.0	18.6	0.0	2.8	0.0	0.0	0.0
Agardhiella	13.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GREEN ALGAE	266.1	233.3	150.8	44.1	153.5	55.6	837.7	118.9	101.4	0.0	36.1	0.0
Enteromorpha	0.0	113.3	0.0	44.0	0.0	49.2	0.0	118.9	0.0	0.0	36.1	0.0
Ulva	266.1	0.0	150.8	0.0	153.5	6.4	837.7	0.0	101.4	0.0	0.0	0.0
Blidingia	0.0	120.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Zones: S = Subtidal, I = Intertidal

Table 7. Total macoalgal biomass (g 0.25 m^{-2}) on September 10, 1987.

HOLLY POND

TOTAL MACROALGAL BIOMASS
(g/0.25 m2)

SEPT. 10, 1987

GROUP SPECIES ZONE:	STA.1 1 S	1 I	STA.2 2 S	2 I	STA.3 3 S	3 I	STA.4 4 S	4 I	STA.5 5 S	5 I	STA.6 6 S	6 I
BROWN ALGAE	0.0	120.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fucus	0.0	120.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RED ALGAE	83.4	0.5	26.1	0.0	0.0	54.3	136.1	0.0	38.2	0.0	0.0	0.0
Chondrus	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polysiphonia harveyii	0.0	0.0	0.2	0.0	0.0	54.3	5.6	0.0	2.6	0.0	0.0	0.0
Gracilaria	53.1	0.1	0.7	0.0	0.0	0.0	19.3	0.0	1.4	0.0	0.0	0.0
Agardhiella	24.6	0.4	25.2	0.0	0.0	0.0	111.2	0.0	34.2	0.0	0.0	0.0
GREEN ALGAE	5.0	68.3	25.7	16.7	0.0	76.4	468.4	0.3	24.3	0.0	0.0	0.0
Enteromorpha	0.0	0.3	0.0	0.1	0.0	52.6	462.0	0.3	0.0	0.0	0.0	0.0
Ulva	5.0	4.1	25.4	16.6	0.0	20.2	6.4	0.0	24.3	0.0	0.0	0.0
Blidingia	0.0	64.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Codium	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Zones: S = Subtidal, I = Intertidal

Table 8. Total macoalgal biomass (g 0.25 m^{-2}) on June 6, 1988.

HOLLY POND

TOTAL MACROALGAL BIOMASS
(g/0.25 m2)

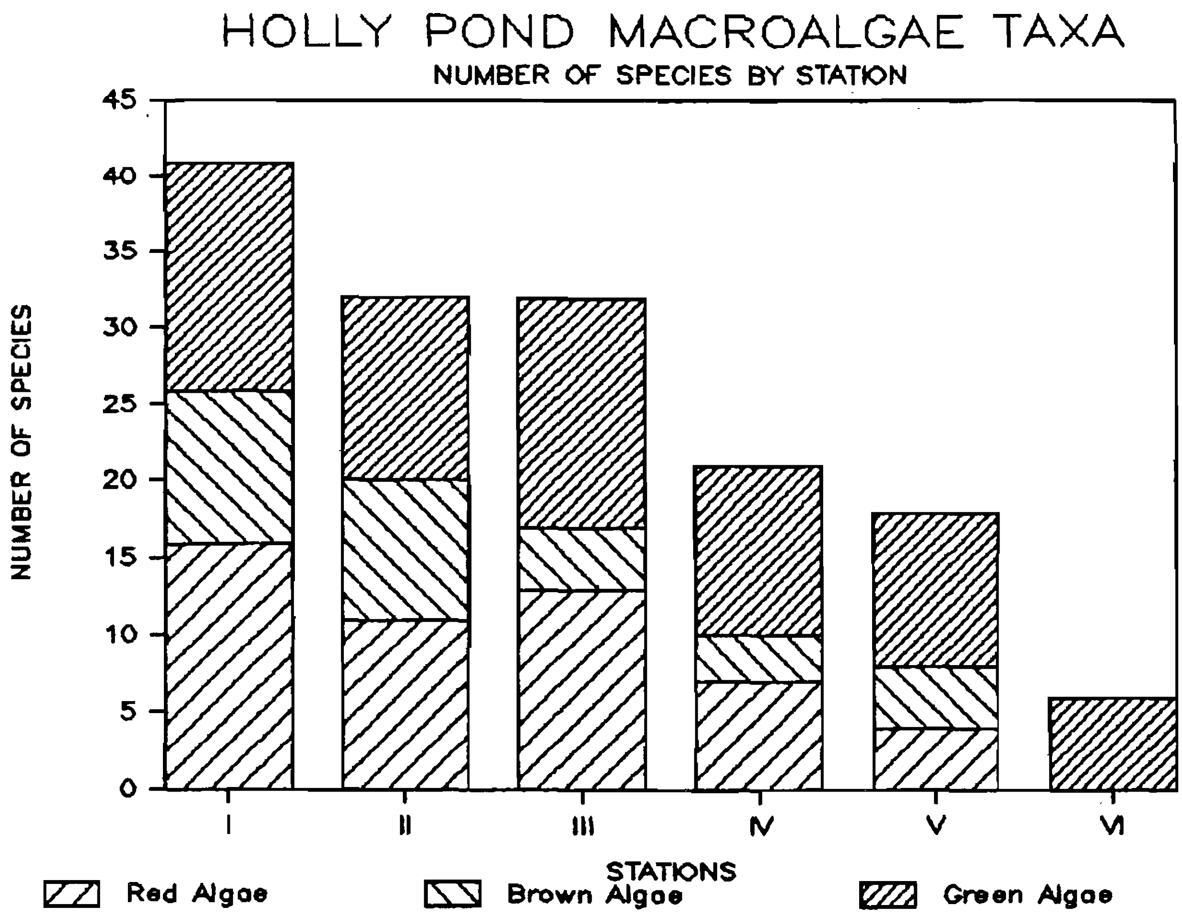
UNE 6, 1988

ROUP SPECIES ZONE:	STA.1 1 S	 1 I	STA.2 2 S	 2 I	STA.3 3 S	 3 I	STA.4 4 S	 4 I	STA.5 5 S	 5 I	STA.6 6 S	 6 I
ROWN ALGAE	339.2	2158.6	315.7	.0	299.9	0.2	17.5	0.0	31.5	0.0	0.0	0.0
Petalonia	324.3	0.0	0.0	0.0	4.0	0.2	17.5	0.0	31.5	0.0	0.0	0.0
Scytosiphon	1.0	3.7	0.5	.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Laminaria	8.3	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fucus	0.0	2154.9	313.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ectocarpus	5.6	0.0	0.0	0.0	295.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ED ALGAE	6.1	0.0	0.0	0.0	295.9	0.0	149.7	0.0	62.1	0.0	0.0	0.0
Chondrus	5.9	0.0	0.0	0.0	295.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polysiphonia harveyii	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agardhiella	0.2	0.0	0.0	0.0	0.0	0.0	144.8	0.0	61.8	0.0	0.0	0.0
Gracilaria	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.0	0.3	0.0	0.0	0.0
REEN ALGAE	8.6	51.3	49.6	34.0	5.9	91.9	172.3	0.8	5.5	26.3	0.0	12.0
Enteromorpha	0.1	40.9	9.4	21.4	0.0	91.9	0.6	0.6	0.0	11.2	0.0	12.0
Ulva	8.5	0.0	40.2	11.6	5.9	0.0	171.7	0.0	5.5	15.1	0.0	0.0
Blidingia	0.0	10.4	0.0	1.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0

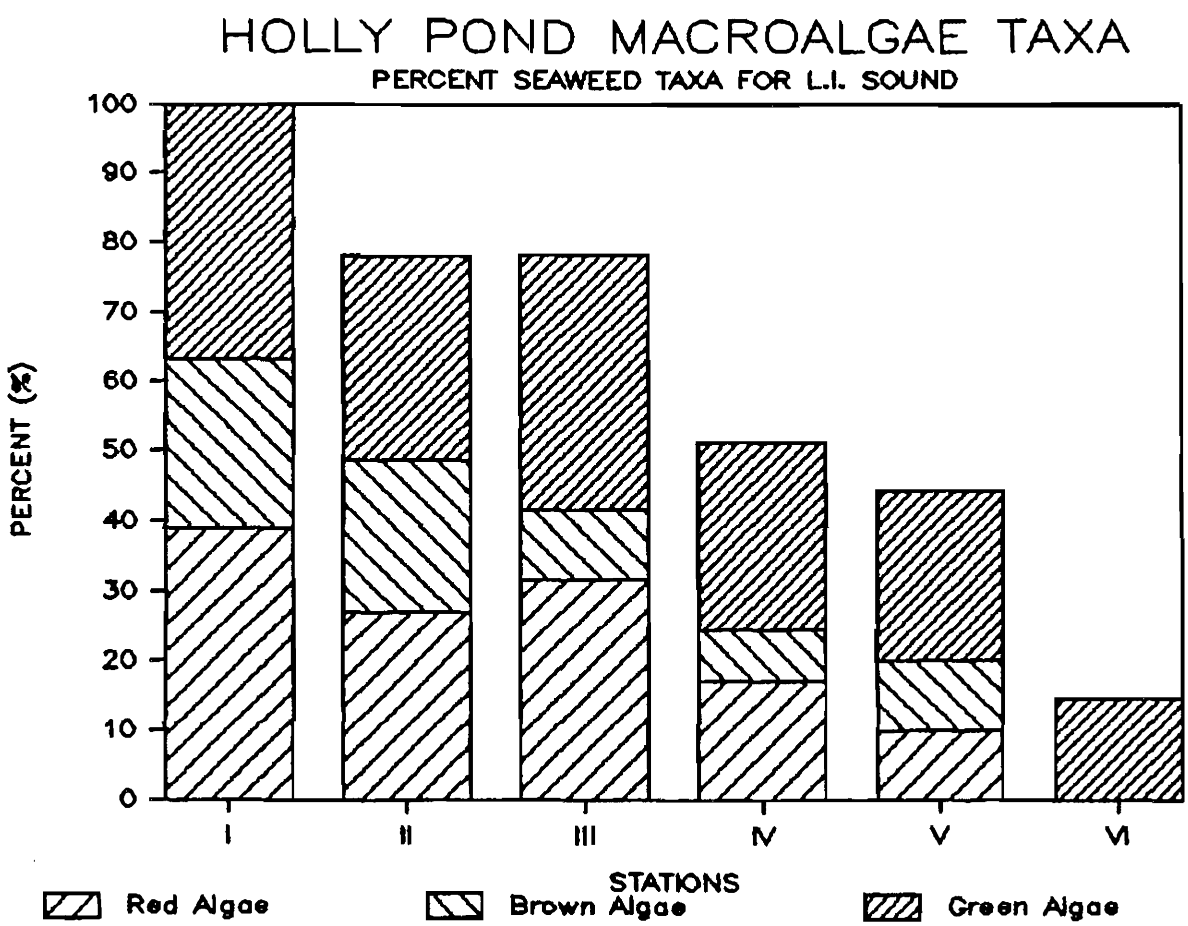
ones: S = Subtidal, I = Intertidal

Fig. 1a (top). Number of macroalgal species at each station.

1b (bottom). Percent of seaweed taxa from Long Island Sound (Station 1) at different stations.



HOLLY POND MACROALGAE TAXA
NUMBER OF SPECIES BY STATION
NUMBER OF SPECIES
45
40
35
30
25
20
15
10
5
0
I
II
III
IV
V
VI
STATIONS
Red Algae
Brown Algae
Green Algae



HOLLY POND MACROALGAE TAXA
PERCENT SEAWEED TAXA FOR L.I. SOUND
PERCENT (%)
100
90
80
70
60
50
40
30
20
10
0
I
II
III
IV
V
VI
STATIONS
Red Algae
Brown Algae
Green Algae

Figure 1b shows the percent of Station 1 seaweed taxa from occurring various locations. Peak numbers were found at Stations 2 and and 3, with a steady decline at Station 6 which is strongly influenced by the Noroton River. A total of 61 taxa were collected at the 6 stations including 21 Rhodophyceae (i.e. red algae), 14 Phaeophyceae/Xanthophyceae (i.e. brown/golden algae), and 26 Chlorophyceae (i.e. green algae). Approximately 68.3% (41 taxa) of the total flora were found at Station 1. Fifty-six percent of the flora (34 taxa) are cosmopolitan in occurrence (Tables 2a-b), i.e. occur throughout Long Island Sound and at Stations 1-3. Approximately 44% (27 taxa) were found in the estuarine waters of the Pond and are clearly estuarine species in our region (Tables 2a-b). Some of the estuarine species are winter or spring annuals (*Ectocarpus siliculosus*, *Petalonia fascia*, *Scytosiphon lomentaria*, and *Microspsora* spp.) or summer annuals (*Ulva rotundata*, and *Bostrychia radicans*). However, the dominant taxa are perennials or pseudoperennials (*Agardhiella subulata*, *Gracilaria tikvahiae*, *Chondrus crispus*, *Polysiphonia harveyi*, *Fucus vesiculosus*, *Ulothrix flacca*, *Enteromorpha clathrata*, *Enteromorpha intestinalis*, *Gayralia* {=*Ulvaria*} *oxyspermum*, *Ulva lactuca* and *Ulva curvata*).

The seaweeds in the Noroton River Estuary have a distinct seasonal distribution. In the spring, (Tables 1a-1c; 3-8 and Appendix Tables D-I) at the mouth of the Noroton River Estuary (Sites 1 and 2 below the dam) the dominant seaweeds were the brown algae (e.g. Fucus spiralis in the eulittoral (i.e. intertidal) zone, Petalonia fascia and Scytosiphon lomentaria in the low eulittoral and extending into the shallow sublittoral zone). Immediately above the dam (Site 3), the red algae predominate in the sublittoral zone (e.g. Chondrus crispus). The eulittoral zone is very restrictive, usually covered with spp. of Enteromorpha. Moving up into the estuary, to Sites 4 and 5, there was an increasing abundance of green algae in the shallow sublittoral zone (e.g. species of Ulva and Enteromorpha). Towards the end of spring, these organisms were very common in the eulittoral and shallow subtidal zones. By the end of the summer, the mouth of the Noroton River Estuary (Station 1) was dominated by the green algae (e.g. Ulva spp) in the subtidal zone and brown algae in the eulittoral zone (e.g. Fucus spiralis).

Biomass fluctuations in Holly Pond

In the summer months, most of Holly Pond was strongly dominated in percent cover and biomass by one red alga, i.e. Agardhiella subulata (3.096 kg m^{-2} at Station 4 and 1.893 kg m^{-2}

at Station 5) until the dam was breached (Tables 3-8 and Appendix Tables D-I). It formed an extensive carpet over the bottom of the entire Pond. It was also thrust up onto the exposed mudflats towards the head of the estuary. The decay of the unusually large biomasses of this red alga, after it was exposed to high summer temperatures and bright light, ultimately contributed to the decomposition processes which were responsible for the odor experienced in September, 1986 by the residents living near the Pond. Figures 2,3,4 show the enormous biomass which developed at Stations 4 and 5 during the late spring and summer of 1986, and 1987. At Station 4, (the station most representative of the subtidal Holly Pond community), the red and green seaweed biomass and percent cover were inversely related (Figure 5).

Influence of the Breaching of the Dam on the Flora

After the dam was breached early in September, 1986, the dominant seaweed community of the Pond shifted the following summer (Fig. 4). The <u>Agardhiella subulata</u> dominated community decreased by almost an order of magnitude to a biomass of 0.444 kg m^{-2} and 0.136 kg m^{-2} at Stations 4 and 5, respectively. The companion red alga <u>Gracilaria tikvahiae</u> showed a slight increase in biomass at Station 4 (i.e. 0.037 kg m^{-2} in September, 1986 versus 0.077 kg m^{-2} in September, 1987). The new dominant community in the Pond at Station 4 consisted of a mixture of <u>Enteromorpha</u> spp. by late summer. <u>Enteromorpha</u> biomass increased by several orders of magnitude from a negligible value of < 0.1 g m^{-2} in September, 1986 to 1.848 kg m^{-2} in September, 1987. The

Figure 2. Mean macroalgal biomass (in freshweight g 0.25 m^{-2}) for intertidal and subtidal zones at each station for the entire study period (May, 1986 - June, 1988).

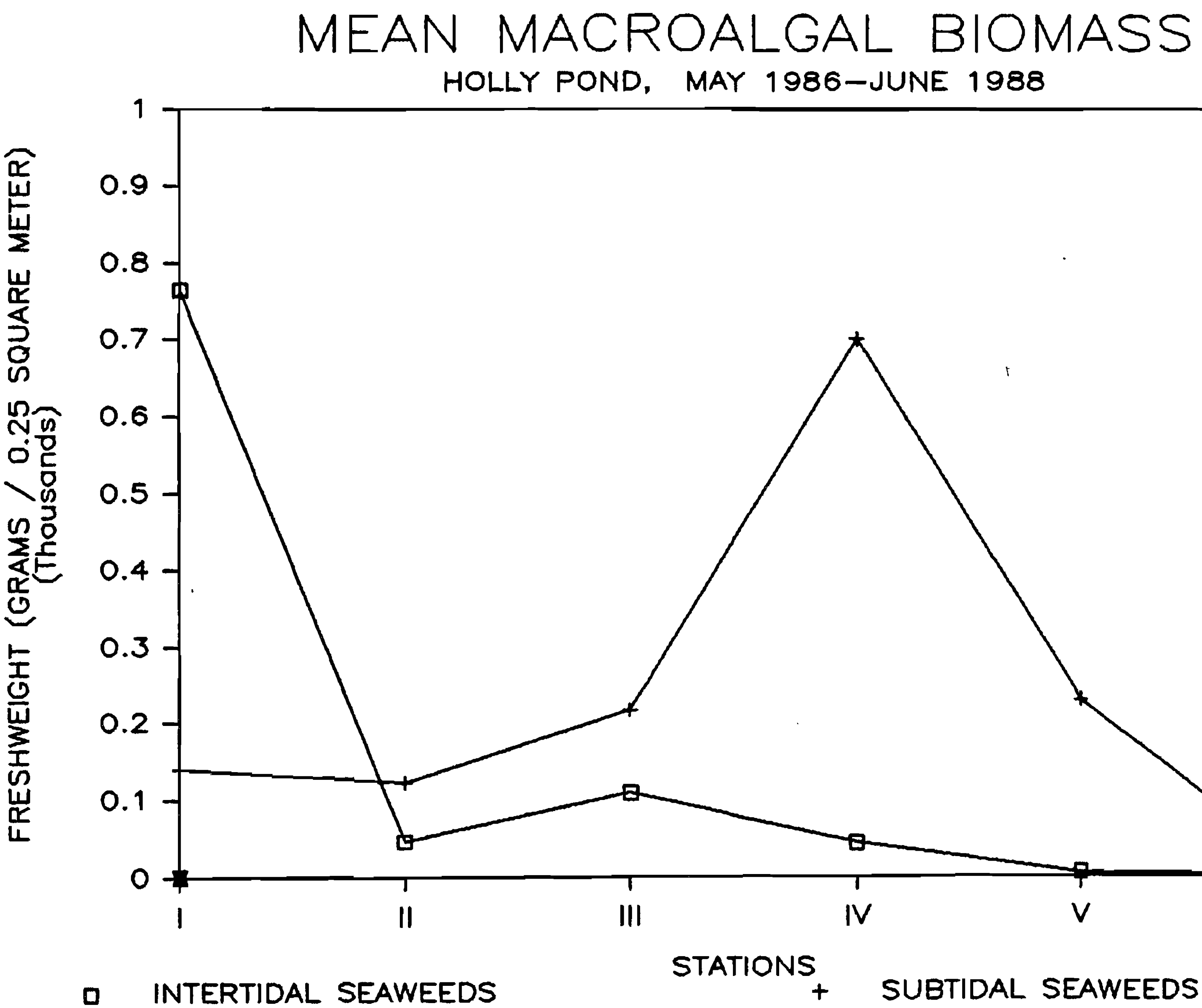
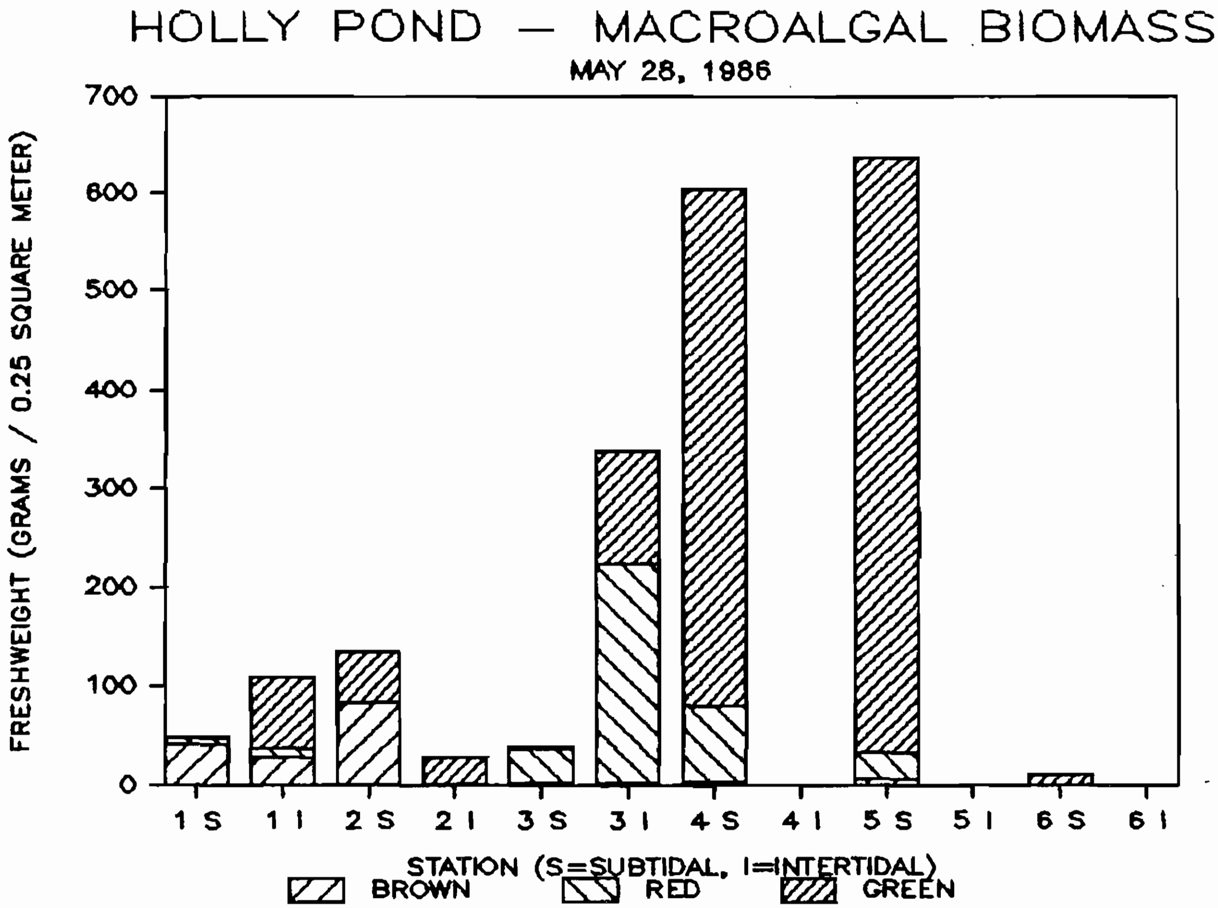

MEAN MACROALGAL BIOMASS
HOLLY POND, MAY 1986–JUNE 1988
FRESHWEIGHT (GRAMS / 0.25 SQUARE METER)
(Thousands)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
I
II
III
IV
V
VI
STATIONS
INTERTIDAL SEAWEEDS
SUBTIDAL SEAWEEDS

Figure 3. Macroalgal biomass (in freshweight g 0.25 m^{-2}) at each station in late spring.


HOLLY POND — MACROALGAL BIOMASS
MAY 28, 1986
FRESHWEIGHT (GRAMS / 0.25 SQUARE METER)
0
100
200
300
400
500
600
700
1 S
1 I
2 S
2 I
3 S
3 I
4 S
4 I
5 S
5 I
6 S
6 I
STATION (S=SUBTIDAL, I=INTERTIDAL)
BROWN
RED
GREEN

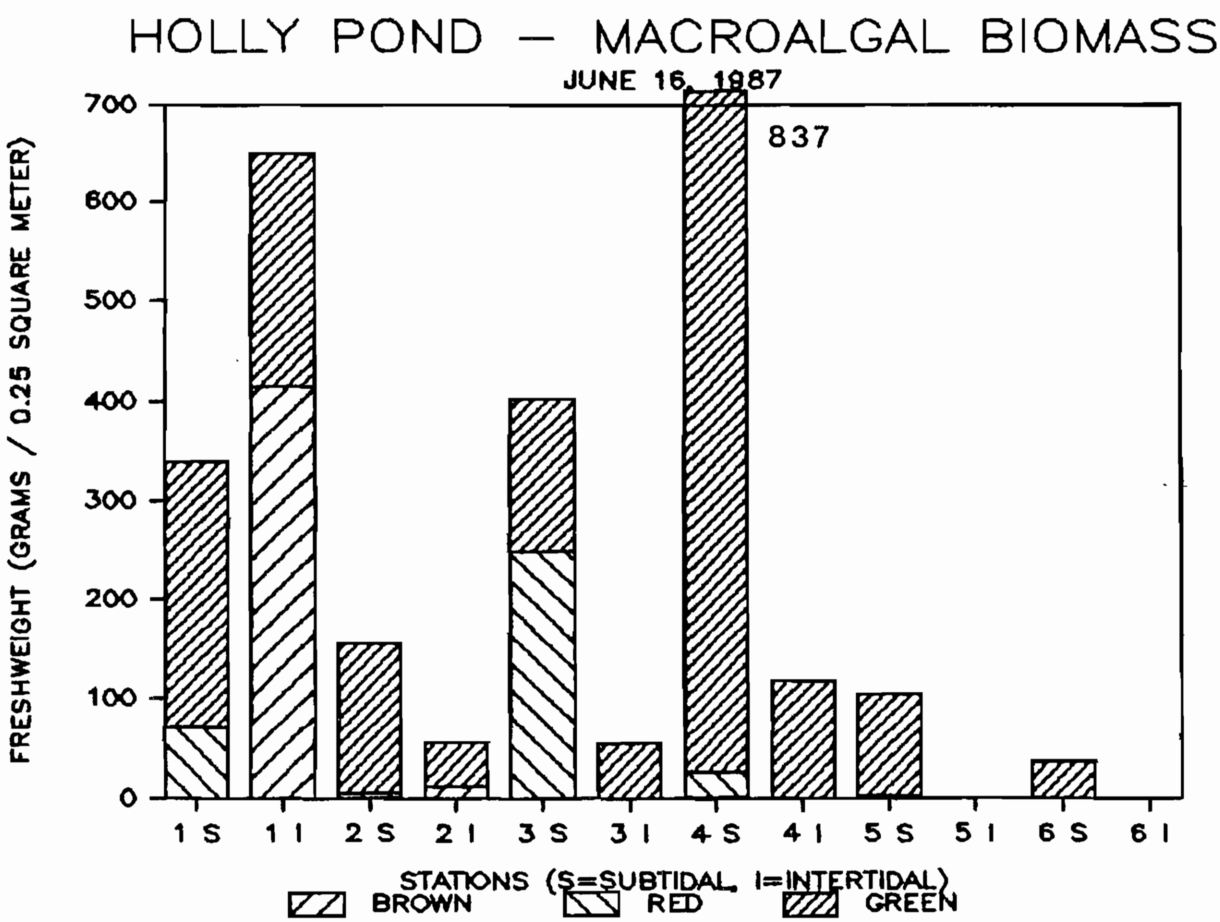
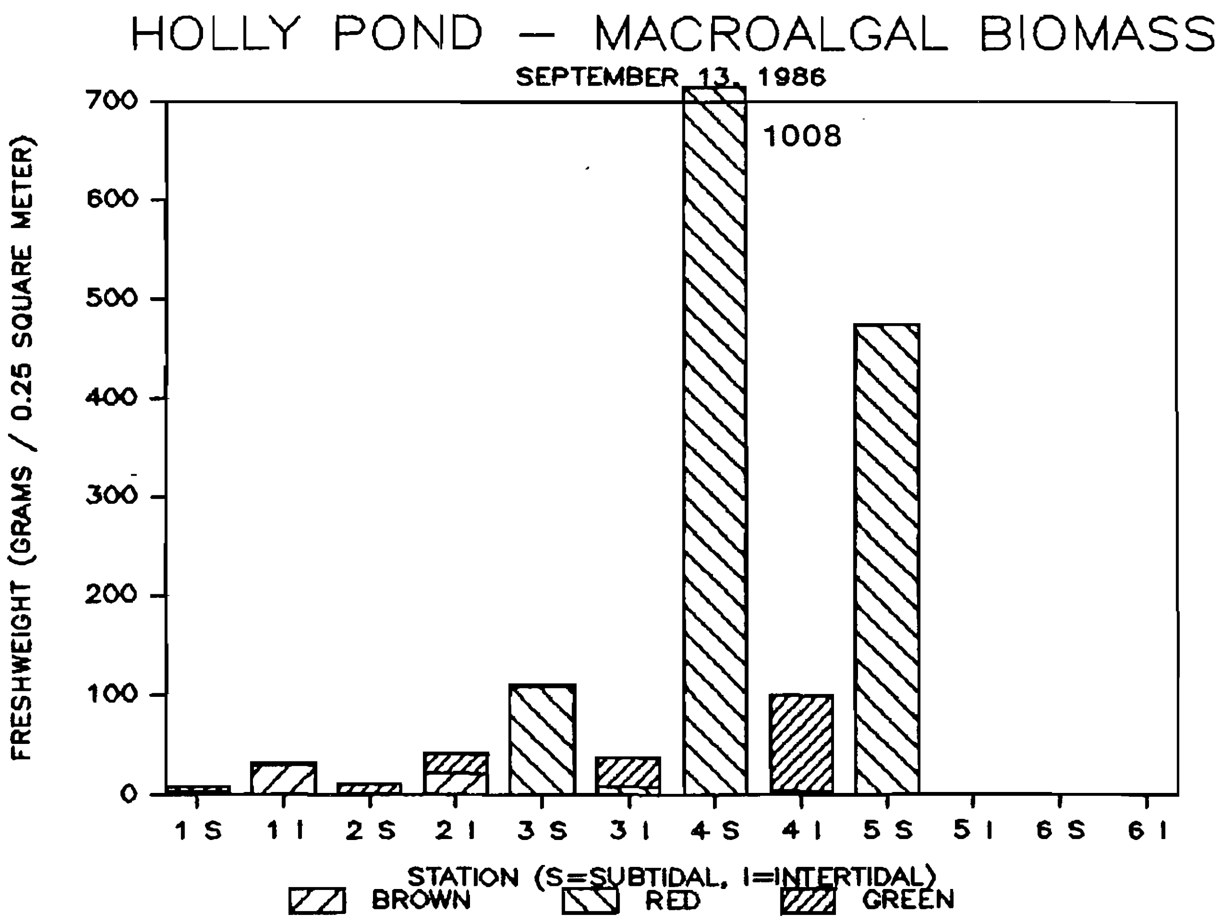

HOLLY POND — MACROALGAL BIOMASS
JUNE 16, 1987
FRESHWEIGHT (GRAMS / 0.25 SQUARE METER)
0
100
200
300
400
500
600
700
837
1 S
1 I
2 S
2 I
3 S
3 I
4 S
4 I
5 S
5 I
6 S
6 I
STATIONS (S=SUBTIDAL, I=INTERTIDAL)
BROWN
RED
GREEN

Figure 4. Macroalgal biomass (in freshweight g 0.25 m^{-2}) at each station in late summer.


HOLLY POND — MACROALGAL BIOMASS
SEPTEMBER 13, 1986
1008
FRESHWEIGHT (GRAMS / 0.25 SQUARE METER)
0
100
200
300
400
500
600
700
1 S
1 I
2 S
2 I
3 S
3 I
4 S
4 I
5 S
5 I
6 S
6 I
STATION (S=SUBTIDAL, I=INTERTIDAL)
BROWN
RED
GREEN

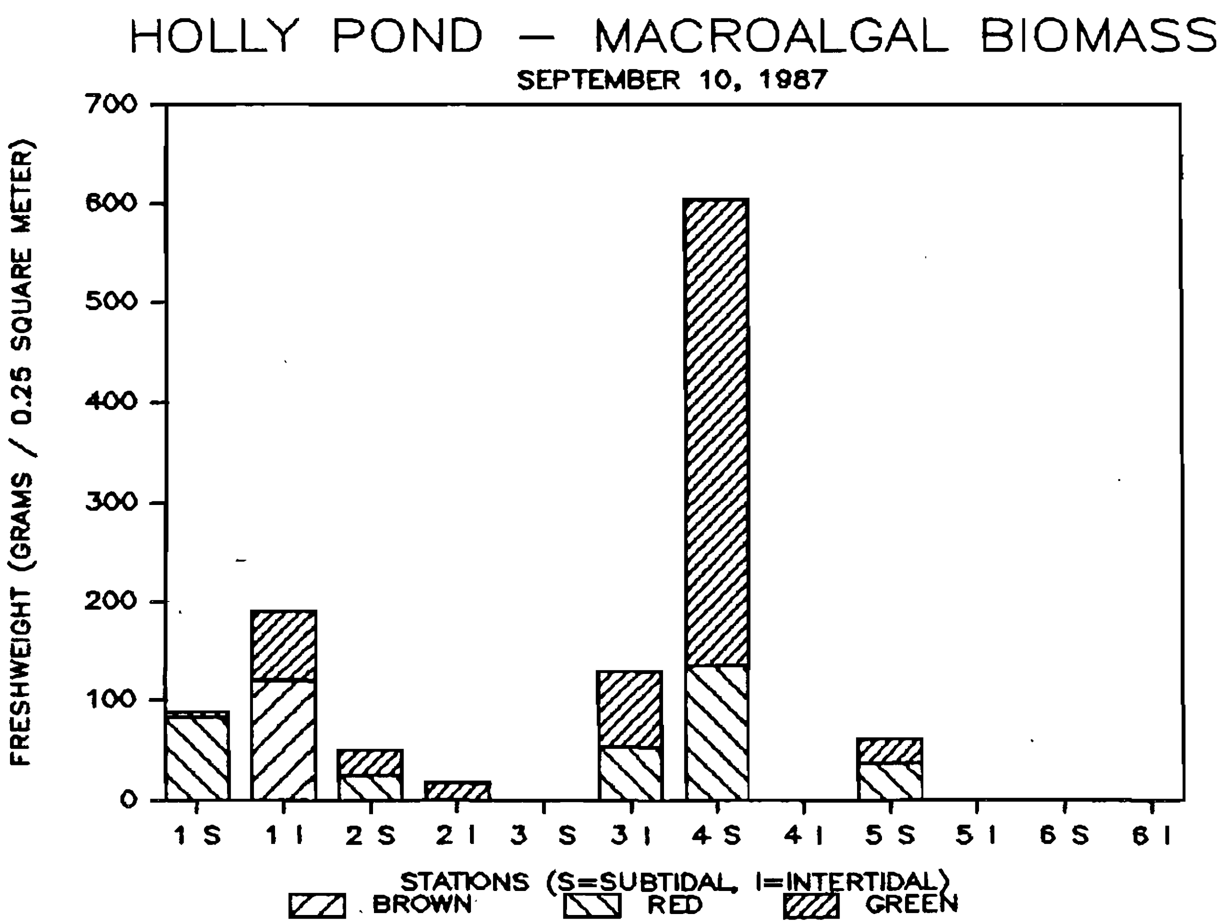
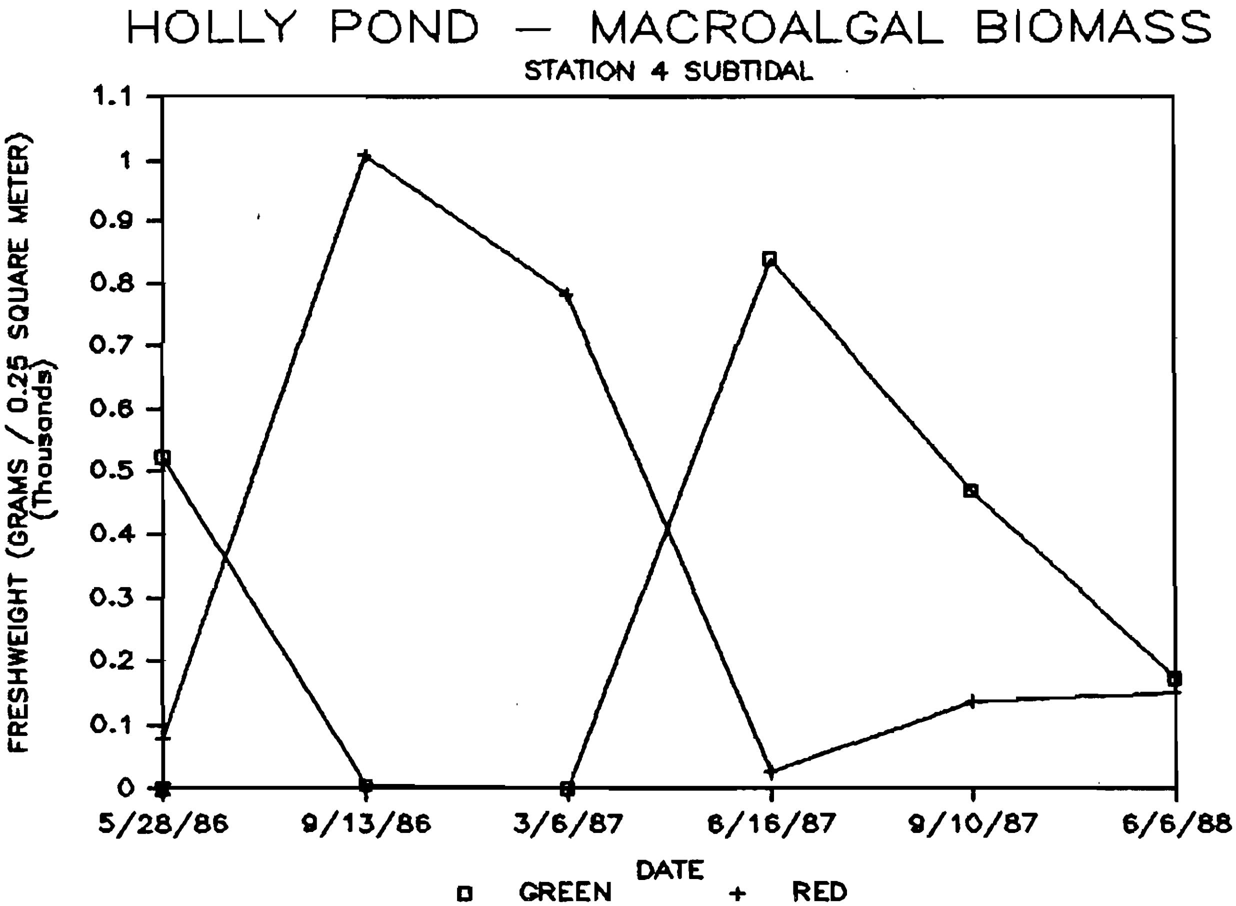
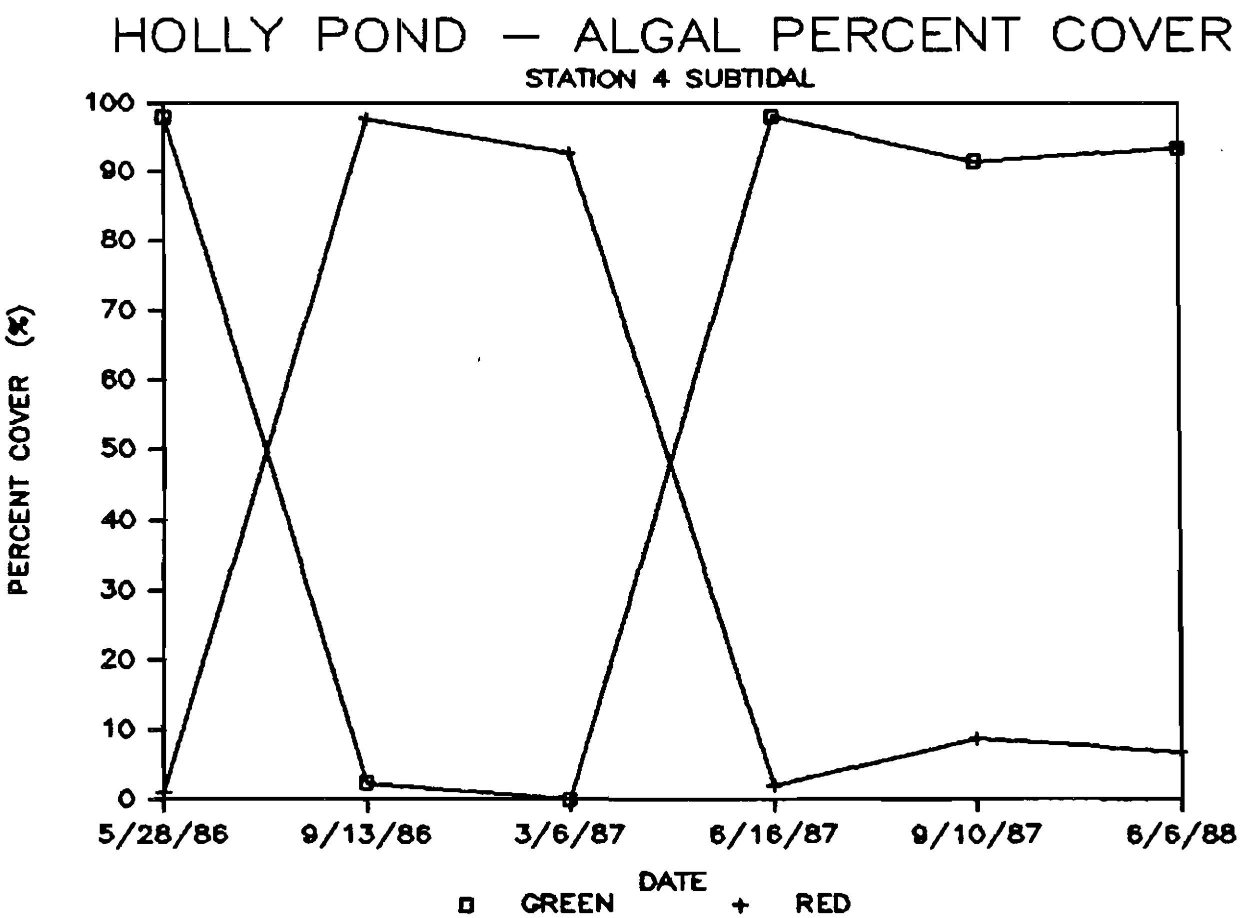

HOLLY POND — MACROALGAL BIOMASS
SEPTEMBER 10, 1987
FRESHWEIGHT (GRAMS / 0.25 SQUARE METER)
0
100
200
300
400
500
600
700
1 S
1 I
2 S
2 I
3 S
3 I
4 S
4 I
5 S
5 I
6 S
6 I
STATIONS (S=SUBTIDAL, I=INTERTIDAL)
BROWN
RED
GREEN

Figure 5. Red and green subtidal macroalgal biomass and percent cover at Station 4.


HOLLY POND — MACROALGAL BIOMASS
STATION 4 SUBTIDAL
FRESHWEIGHT (GRAMS / 0.25 SQUARE METER)
(Thousands)
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5/28/86
9/13/86
3/6/87
6/16/87
9/10/87
6/6/88
DATE
GREEN
RED


HOLLY POND — ALGAL PERCENT COVER
STATION 4 SUBTIDAL
PERCENT COVER (%)
100
90
80
70
60
50
40
30
20
10
0
5/28/86
9/13/86
3/6/87
6/16/87
9/10/87
6/6/88
DATE
GREEN
RED

Ulva spp. also experienced a decline in biomass during the fall from 0.375 kg m^{-2} (September, 1986) to a value of 0.025 kg m^{-2} (September, 1987). However, its dominance at Station 4 in the spring increased from 2.088 kg m^{-2} in late May, 1986, to 3.350 kg m^{-2} in early June, 1987. At Station 5, the stand of *Ulva* spp. decreased from 2.393 kg m^{-2} to 0.405 kg m^{-2}. The dramatic changes in the biomass were also reflected in the percent cover of the dominants in the community at each of these Stations (Appendix Tables J-O).

In addition, the stand of the perennial red alga *Chondrus crispus* was negatively impacted by the increase in light levels and subsequent exposure to air at Station 3. The intertidal population disappeared with its 0.143 kg m^{-2} standing crop. However, the subtidal population remained stable, actually experiencing a slight increase (0.820 kg m^{-2} in late May, 1986 versus 0.974 kg m^{-2} the following June, 1987). After the repair of the dam (July, 1987) the system appears to have rebounded by the following summer sampling period, June 1988. *Agardhiella subulata* was well on its way in re-establishing its dominance in the Pond (0.579 kg m^{-2}) during the summer of 1988, and there was a significant decline in the dominant green algal community. At Station 4 in June, 1988, *Ulva* had a standing crop of 0.687 k g m^{-2} and *Enteromorpha* 0.367 kg m^{-2}. The standing crop of *Ulva* at Station 5 was 0.082 kg m^{-2} and for *Enteromorpha* 0.045 kg m^{-2}. The latter values are significantly below the previous year's standing crop.

Trace Element Analyses

On July 15, 1986 the perennial red alga, Chondrus crispus, was harvested from the sublittoral zone at Station 3 for trace element analyses. The following is a list of the trace elements (ppm or mg/g dry weight) which were assayed:

Element	Sample A	Sample B
Calcium	3.41 mg/g	3.40 mg/g
Phosphorous	2.34 "	2.33 "
Magnesium	6.19 "	6.20 "
Zinc	58.4 ppm	59.6 ppm
Copper	17.9 "	18.3 "
Iron	667.0 "	712.0 "
Boron	160.0 "	113.0 "
Cobalt	4.29 "	4.05 "
Manganese	2041.0 "	2072.0 "

Levels of most of these elements are within reported ranges according to Dr. J. Craigie who has assayed Chondrus populations from all over the world. Internal levels of copper, iron, cobalt, and manganese are much higher for the Holly Pond population of *Chondrus* than from other populations along its latitudinal range. Copper levels are 5-7 times higher, iron levels are 3-4 times higher, cobalt levels are 4-5 times higher and manganese levels are 51 times higher than populations from comparable estuarine regions. The levels of manganese are the highest concentrations Dr. Craigie has ever measured!

Frost Tolerance of Ulva spp.

The frost tolerance (i.e. frost hardiness) of *Ulva* spp. from Holly Pond was quite variable (Table 9). Plants acclimated to -11 ^{o}C in an air dried state, and plants that were immersed in seawater were quite tolerant to the test temperature. *Ulva* plants that were air dried, appeared to be more tolerant to -11 ^{o}C than plants immersed in seawater over the four week test period. The former plants had a survival rate of 30% even after 1024 hours at the test temperature. However, plants that were kept in -11 ^{o}C seawater for 512 hours, did have a 75% survival rate. The 512 hour test condition had an unusual interaction in that all plants that were air dried expired, yet the plants frozen in seawater had at least a 50% survival rate.

Table 9. Freezing tolerance, after 4 weeks to -11 ^{o}C, of Ulva spp. for exposures up to 1024 hours. Plants which were alive were denoted by a "+" and ones which were dead were denoted by a "-".

--TABLE 9--

Experimental Results of Freezing *Ulva* sp

at -11 °C for various time intervals

+ = ALIVE

- = DEAD

EXPOSURE TIME	WEEK 1 DRY	WEEK 1 S.W.	WEEK 2 DRY	WEEK 2 S.W.	WEEK 3 DRY	WEEK 3 S.W.	WEEK 4 DRY	WEEK 4 S.W.
1 HOUR	+++-	++++	+++-	++++	+++-	++++	++++	++++
2 HOURS	++--	++++	++--	++++	++--	++++	++--	++++
4 HOURS	+++-	++++	+++-	++++	+++-	++++	++++	++++
8 HOURS	++--	----	++--	----	++--	----	++--	----
16 HOURS	++++	+++-	++++	+++-	++++	+++-	++++	+++-
32 HOURS	+++-	++--	++++	++--	++++	++--	++++	++--
64 HOURS	+++-	++++	+++-	+++-	+++-	+++-	+++-	+++-
128 HOURS	++++	+++-	++++	+++-	++++	+++-	++++	+++-
256 HOURS	++--	++--	++--	++--	++--	++--	++++	++--
512 HOURS	----	++--	----	++--	----	+++-	----	+++-
1024 HOURS	++--- -----	----- -----	++--- -----	----- -----	++--- -----	----- -----	+++-- -----	----- -----

Fauna of Holly Pond and Environs

According to our observations, the nutrient enrichment from the waterfowl has contributed to the poor water quality conditions of the Pond. We have observed during our visits to the Pond a tremendous number of birds (on one occassion a bird count exceeded 223). Species included: mute swans; domestic and wild geese; mallard and buffle head ducks; seagulls; crows; and pigeons. Their actual contribution to the nutrient loading and stimulation of seaweed growth is unknown. However, the seasonally collected nutrient samples suggested they have a significant impact on the seaweed biomass at Stations 4 and 5 (see Part I).

During our many visits to the Pond we have also documented the importance of the Noroton River Estuary to fish and shellfish. Our preliminary observations during the sampling period indicated that Holly Pond provides nursery areas for recreational species of flounder, blue crabs, soft shell clams, the American oysters, and blue mussels. We have also observed striped killifish, sheepshead minnows, silversides, pipefish, eels, juvenile fluke, Atlantic menhaden, and snapper and adult blues in the Pond. In addition, there was a large density of sea squirts growing on *Agardhiella subulata* and *Gracilaria tikvahiae*. A complete listing of the animal species that we have encountered during our studies in Holly Pond is given in Table 10.

Table 10. Common animal species observed in Holly Pond during this study.

HOLLY POND - COMMON ANIMALS 1986 - 1988

Common Name	Scientific Name
American eel	*Anguilla rostrata*
American oyster	*Crassostrea virginica*
Atlantic menhaden	*Brevoortia tyrannus*
Barnacles	*Balanus balanoides*
Blue crab	*Callinectes sapidus*
Blue mussel	*Mytilus edulis*
Bryozoans	Bryozoa
Cunner	*Tautogolabrus adspersus*
Hermit crabs	*Pagurus longicarpus*
Marsh crab	*Sesarma reticulatum*
Mud snail	*Ilyanassa obsoleta*
Oyster drill	*Urosalpinx cinerea*
Periwinkle	*Littorina littorea*
Pipe fish	*Syngnathus fuscus*
Red bearded sponge	*Halichondria* spp.(?)
Ribbed mussel	*Gaukensia demissus*
Sea squirts	*Molgula manhattensis*
Shrimp	*Palaemonetes* spp.
Silversides	*Menidia menidia*
Snapper blues	*Pomatomus saltatrix*
Spider crab	*Labinia* spp.
Striped bass	*Morone saxatilis*
Striped killifish	*Fundulus majalis*
Summer flounder	*Paralicthys dentatus*
Windowpane	*Scophthalmus aquosus*
Winter flounder	*Pseudopleuronectes americanus*

DISCUSSION

Coastal ponds are very productive, shallow bodies of waters of varying degrees of salinity that harbor fluctuating communities of euryhaline or visiting species (Colombo, 1977). These estuarine ecosystems are composed of many trophic levels together forming productive, dynamic and important food webs. At what may be considered the focal point of these systems are the macroalgae or seaweeds, not only because they are generally the dominant primary producers of new carbon material (Littler and Murray, 1974; Brinkhuis, 1977a, 1977b; Wallentinus, 1978, Littler et al., 1979; Littler, 1980), but also for their interactions with most life forms either indigenous or transient through the coastal environment (Teal, 1962; Nixon and Oviatt, 1973; Ragsdale and Thorhaug, 1980). In this respect, seaweeds provide food and shelter for many invertebrate forms (Lubchenco, 1978, 1980; Raffaelli, 1979); algal stands are considered primary spawning grounds for important commercial fishes (Nixon and Oviatt, 1973; Oviatt et al., 1977) and algae supply large amounts of organic materials that is then remineralized through microbial transformation (Woodwell et al., 1972; Reimold et al., 1975). However, large mats of macroalgae may be detrimental to some of the faunal community (especially the polychaete worms) of the underlying sediment (Perkins and Abbott, 1972), yet these mats may act as a source of food for herbivorous ducks and geese (Soulsby et al., 1982).

Data concerning the distribution of seaweed species along estuarine gradients is limited, especially for coastal ponds (McRoy and McMillan, 1977; Den Hartog, 1979; Thorne-Miller et al., 1984; Thorne-Miller and Harlin, 1984). Therefore much of the biological data and supporting physical-chemical data (see summary at end of Part I Results section) obtained for the Noroton River Estuary is an important data base for the State of Connecticut.

Several investigators (Doty and Newhouse, 1954; Widdowson, 1965, Sanders et al., 1965; Day, 1967, Edwards, 1972; Boesch, 1977; Wilkinson, 1973, 1980; Mathieson and Fralick, 1973; Mathieson et al., 1981; Hardwick-Matheison, 1984) have reported the reduction of species numbers along salinity gradients and have emphasized the impact of salinity on seaweed distributions. Salinity is a major factor in controlling the horizontal distribution of species, but temperature, the nature of the substrate, turbidity, light, tidal currents and pollution are also important (Conover, 1958; Kinne, 1970, 1971; Edwards, 1972; Edwards and Kapraun, 1973; Yarish and Edwards, 1982).

The decrease in the species numbers and biomass recorded from Station 1 on Long Island Sound to Station 6 on the Noroton River is primarily related to fluctuating salinity and substate availability. The greatest fluctuations of oxygen and pH conditions (see Part 1 of this report) were also recorded in the upper reaches of this estuary. As one progresses up the estuary, there are increasingly large areas of tidal flats, and little substrate available for the attachment of seaweeds. The combined effects of limited substrate and the varying physical and chemical conditions drastically limits the number of species at Station 6, where only 6 taxa were found. On the whole, the green algae can withstand the greatest extremes of physical conditions, and they often dominate the upper reaches of an estuary, as in the Noroton River Estuary.

However, the most striking characteristic of the Noroton River Estuary, in particular the Holly Pond region, is that much of the macroalgal biomass is comprised of unattached red algae (i.e. Agardhiella subulata and Gracilaria tikvahiae) that drift throughout the Pond with the wind. The dominant macrophytes offer substrate to numerous epiphytic macroalgae (e.g. Polysiphonia harveyi, Ectocarpus siliculosus, Enteromorpha clathrata) and several microalgae (especially the diatoms) during the winter months. Prior to the breaching of the dam and subsequent to its repair, there was a strong seasonal component in flora of the Pond. The green algae dominated the spring to early summer period, the red algae dominated the late summer and fall and the winter was dominated by brown algae and diatoms. When the dam was breached green algae were dominant throughout the year.

In the lower reaches of the Pond (Stations 3 and 4), the average subtidal biomass . ranged over a two year period from 0 g f.w. m^{-2} (September, 1987) at Station 3 to 4.0332 kg f.w. m^{-2} (September, 1986) at Station 4. Green algal biomass was as high as 3.350 kg f.w. m^{-2} for *Ulva* spp., and 1.848 kg f.w. m^{-2} for *Enteromorpha* spp. The dominant red algae were *Agardhiella subulata* (3.996 kg f.w. m^{-2}), *Chondrus crispus* (1.183.6 kg f.w. m^{-2}), *Gracilaria tikvahiae* (0.298 kg f.w. m^{-2}), and *Polysiphonia harveyi* (0.2172 kg f.w. m^{-2}). The brown algae were least important in the Estuary with *Ectocarpus siliculosus* being the dominant with 1.1832 kg m^{-2}. The biomass values for *C. crispus*, *A. subulata* (red algae), *Enteromorpha* and *Ulva* spp. (green algae), and *Ectocarpus siliculosus* (a brown alga) were higher than those reported for other salt or coastal lagoons (Udell et al., 1969; Thorne-Miller and Harlin, 1983, 1984; Virnstein and Carbonara, 1985). The maximum macroalgal biomass was found at Station 4, which also had the highest surface levels of ammonia. The high nitrate levels at Stations 4 and 5 may have also contributed in promoting macroalgal growth in Holly Pond. The high seaweed biomass in the Pond may be a consequence of nutrient input from the Noroton River, from nonpoint source pollution and from the large water fowl community.

The trace element analyses are only preliminary at most. However, the data show that for the perennial red alga, Chondrus crispus, the levels of copper, cobalt, iron and manganese are much higher than other regions of the world. The high concentrations of these metals may have been derived from the local sediments. High levels of copper have been reported in earlier studies for the Oceanic Society (Buckland, 1984) and historically date back to time when the Cerro Copper and Brass Company released wastes directly into the River (Anonymous, 1967). The concentrations of heavy metals within the macroalgae accurately indicated the concentrations found in the surrounding waters (Bryan, 1971; Seeliger and Edwards, 1977; Levine, 1982). Algae are also known to leak out their organic molecules (Khailov and Burlakova, 1969) and thus will act as a gateway for heavy metals to enter higher trophic levels (Seeliger and Edwards, 1979). Chondrus appears to have a high affinity for selective trace elements and can be used for an indicator organism in Holly Pond, if dredging commences. It should also be pointed out that internal levels of manganese are 51 times higher than other comparable estuarine populations of Chondrus. This too may be a reflection of a steady release of manganese from the sediments and subsequent uptake by Chondrus. The implications of this element on the productivity of the macroalga is unknown, as well as for the detritus food chain in the Pond. With the location of the Chondrus population at Station 3, much of its export will be to Long Island Sound.

Impact of breaching of the dam and subsequent drawdown

After the dam had been breached (September, 1986), the water depth in the Pond dropped by 20 cm at low tide. Changes in the physical and chemical characteristics were not significant. However, the macrophyte community changed during the summer of 1987, from one which was dominated by two red algae which extended all the way across the Pond (i.e. Agardhiella subulata and Gracilaria tikvahiae) to one dominated by green algae (especially Enteromorpha and Ulva spp.). The spring biomass of green algae at Station 4 was enhanced by the drawdown, but it significantly decreased at Station 5. We suggest the dramatic decline in green algae biomass at Station 5 was a reflection of the loss of the shallow sublittoral zone and the subsequent harsh winter conditions which caused the Pond to rapidly freeze over. The dramatic decline in the red algal community was a reflection in the decreased availability of their shallow subtidal environment and the concommitant increase in light penetration in the remaining subtidal areas. These algae are sensitive to high irradiation and temperature levels, conditions which followed the drawdown in the Pond (Yarish et al. 1984, 1987).

What are the implications to the community if a coastal pond is dominated by green, red or brown seaweeds? Only a small portion of macrophyte production is grazed by herbivores, so a significant fraction enters the detrital pool (Teal, 1962; Kailov and Burlakova, 1969). Laboratory studies have shown that red algal detritus may lose upto 65% of its original organic content after 150 days (Rice and Tenore, 1981). The red algal detritus continuously loses nitrogen during its decomposition, is more easily decomposed than brown algae and thereby contributes to increased protein content as microbial biomass (Newell, 1965; Fenchel, 1970; Mann, 1972; Rice and Tenore, 1981). Even after releasing soluble materials, algal detritus is easily degraded by microbes (Tenore et al., 1979). Kailov and Burlakova (1969) reported that red algae were more readily consumed by herbivores, than were brown and green algae. Apparently, red algal detritus may be a more valued food resource in the community for herbivores and a better substrate for microbial decomposition.

From the results obtained from the frost tolerance experiments, it is reasonable to assume that Ulva spp. does exhibit a degree of frost hardiness (at least to -11 C). It is evident that the frost resistant and hardened Ulva plants functioned for a significant period of time, surviving severe dehydration caused by extracellular ice produced during the deep freeze. According to Trunova (1987), plants usually start to cold harden at temperatures slightly above zero (i.e. at 2 °C) and one or more weeks are required before a cold hardiness is significantly increased. This will parallel normal conditions if the Pond is drawn down by tidal gate manipulation during the winter months. Ulva spp. in the Noroton River Estuary, especially in the Pond, are well adapted to the harsh conditions of exposure to air. Migata (1966) found that the genus Porphyra (a red alga similar in thallus construction to Ulva) exhibited the highest amount of freezing resistance. If the thallus of this alga has a water content of 20%, it can be held at -20 °C up to one year. Therefore, a drawdown will have little impact in decreasing the overall abundance of Ulva spp. and the closely related taxa of Entromorpha spp. in the Pond. According to laboratory experiments of Mariani (1981), Ulva curvata (a common estuarine species in the Pond) survives but does not grow at temperatures below 11 °C. However, juvenile plants of another very common species in the Noroton River Estuary, Ulva lactuca, grow at temperatures as low as 7 °C. Adult plants stop growing at 11 °C. These experiments suggest that winter drawdown in the Pond, will have minimal impact on Ulva spp. in the Pond. There is little information on the lethal effects of high summer temperatures and exposure to air for Ulva spp. (Luening, 1984).

However, the end result of a drawdown in the summer months would be increased mudflats which would be extremely malodorous for the local residents.

MANAGEMENT AND RESTORATION RECOMMENDATIONS

The results of our monitoring program enables us to discuss some management alternatives for Holly Pond. These management options are: mechanical harvesting; the repair and manipulation of one or more of the tidal gates (preferably at least three); and dredging and containment of sediments. Mechanical harvesting and removal of excessive seaweed growth is an expensive and temporary technique. The use of a harvester which fragments the plants might be unwise choice for Holly Pond because *Agardhiella subulata*, *Gracilaria tikvahiae* and *Polysiphonia harveyi* can be propagated by fragmentation. Disposal of the seaweed may also be a problem because of the high biomass in the Pond during most of the year. The two remaining options, i.e. the repair and manipulation of the tidal gates and the dredging and containment of the sediments, are short term and long term solutions, respectively.

The repair of the tidal gates has two benefits. These are (1) increased flushing and (2) control over the tidal height in the Pond. The breach of the dam in early September, 1986 had permitted increased flushing in the Pond during a period of maximum standing crop of the macrophytes. The decay of the biomass in this stagnant Pond should have increased the biological oxygen demand upon the system. However, from our observations this did not materialize. Was the breached dam in part responsible for any increased mixing? We suggest that it was, at least in the localized region near the Darien shoreline where the dam was open. If the tidal gates were repaired and manipulated to permit future tidal drawdowns in the Pond during fall, winter and early spring, the increase in exposure of the subtidal zone might decrease the standing crop of the most problematic macrophyte, Agardhiella subulata. From Professor Yarish's published laboratory experiments on Agardhiella, this alga has the survival potential to temperatures as low as 0 °C when submerged, however, it is negatively impacted by high light levels. From our rather limited field experience during the unanticipated drawdown, from September, 1986 to July, 1987, we believe Agardhiella doesn't have the same survival tolerance in an exposed condition, or to sustained temperatures below 0 °C. From the known distribution of Agardhiella in northeastern America and from its initial response to the breached dam, we had hypothesized that the overwintering stages of Agardhiella would be killed due to prolonged sub-zero temperatures and simultaneous exposure to high light and air in the intertidal zone. This macroalgal species is adapted to lower light regimes in the subtidal zone. The alternate strategy of a tidal drawdown in the warmest times of the year should also be considered. Since we expect that this subtidal seaweed would be killed by sustained high summer temperatures and light. From Professor Yarish's published (Yarish et al., 1984, 1987) and unpublished laboratory experiments on this alga, temperatures above 33 - 34 ^{o}C (i.e. 92 - 94 ^{o}F) are lethal. Therefore the management strategy of a tidal drawdown, following Labor Day, is another alternative, providing there is a forecasted prolonged hot period above the lethal temperatures of 33 - 34 ^{o}C. However, the exposed mudflats at this time of the year would be extremely malodorous, especially to the neighbors bordering the Pond.

If there were drawdowns (by tidal gate manipulation), what may happen to the exposed tidal surfaces in Holly Pond? Experience in this and other tidal systems in Connecticut has shown that intertidal flats will be dominated by green algal species such as Ulva and Enteromorpha. From our experience with the Holly Pond system, the Enteromorpha spp., which had been restricted to the margins of the shoreline, increased in abundance in the shallow subtidal areas of Holly Pond after its main competitor for space (i.e. Agardhiella) was destroyed by the tidal drawdown from September, 1986 to July, 1987. However, the published literature suggests that red algal tissue is a high quality food for herbivores and its detritus is more effective in promoting microbial decomposition of this organic matter.

Drawdowns may decrease red algal biomass and increase green algal biomass, thus having a profound effect on this estuarine food web.

The long-term solution is the dredging of Holly Pond to increase its recreational value. The disadvantages are that dredging is extremely expensive and the Pond may silt up again. If tidal drawdown can be used to control the seaweeds, the decrease in biomass may slow the siltation process. If dredging is to proceed, we recommend the Pond be dredged to a depth of at least 3.5 m. Our data indicate this is the maximum depth to which photosynthetically active radiation penetrates in this Pond (i.e. the 1 % light level). Below this depth algae would not be able to grow for lack of light and substrate. One must also understand, at least during the period of September, 1986 to July, 1987 drawdown, the physical-chemical properties of the Pond (with the exception of light and possibly temperature) failed to change significantly. Monitoring of physical-chemical parameters should include light, temperature, salinity, nutrients (ammonia-nitrogen and nitrate-nitrite nitrogen) and dissolved oxygen along the north-south estuarine gradient.

We now strongly recommend an integrated management program of tidal gate repair and manipulation coupled with dredging. The former should be a short-term high priority goal, whereas the latter can be postponed until a funding source is secured at some future date. It is absolutely essential that a monitoring program be continued at Stations 3, 4 and 5 because these are the most environmentally sensitive areas and would be most impacted by tidal gate manipulations. The manipulation of the tidal level in Holly Pond will increase the area of exposed mudflats and decrease the subtidal zone. The impact on the biotic community will be a change from the red algal dominated system to one that is dominated by green algae and overall a diminished standing crop of seaweed biomass.

Our specific suggestions for a continued monitoring program in conjunction with tidal gate manipulations include:

(1) Seasonal macrophyte survey and inventory at Stations 3, 4, and 5. This includes an inventory of the seaweeds, and measurements of percent cover and biomass at each study station;

(2) The physical-chemical monitoring program at Stations 1, 3, 4, 5, and 6. The sampling regimen should include temperature, salinity, dissolved oxygen, light and nutrients (ammonia-nitrogen and nitrate-nitrite nitrogen collected seasonally);

(3) Selective heavy metal and trace element analyses (i.e. copper, cobalt, chromium, zinc, iron and manganese) of the perennial red alga _Chondrus crispus_ at Station 3 and associated sediment collected seasonally.

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Appendix Table A. Physical/chemical baseline data.

HOLLY POND

PHYSICAL CHEMICAL DATA

MAY 28, 1986

Weather: Bright sun, cool, light breeze
Low Tide: 0900 e.s.t

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		854							
1 Surf.					26.0	8.1			
1 Bott.									
2 Air		1110					3200		
2 Surf.					26.0	7.9	2772	86.6	21.0
2 Bott.	50						1782	55.7	21.0
3 Air		1230					3200		
3 Surf.					26.0	7.9	2376	74.3	22.0
3 Bott	100						1465	45.8	21.2
4 Air		1315							
4 Surf.					26.0	8.6			
4 Bott.									
5 Air		1355							
5 Surf.					25.0	8.4			
5 Bott.									
6 Air		1430							
6 Surf.					10.0	8.3			
6 Bott.									

JUNE 16, 1986

Weather: Hazy sun, breezy
Low Tide: 1134 e.s.t.

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		1344					2600		
1 Surf.			10.5	24.0	27.0	7.9	845	32.5	23.0
1 Bott.	50		9.6	22.5	27.0	7.9	409	15.7	23.0
2 Air		1300					2300		
2 Surf.			6.8	22.2	26.0	7.7	871	37.9	23.2
2 Bott.	28		7.2	22.2	26.0	7.7	198	8.6	23.0
3 Air		1230					2300		34.0
3 Surf.			9.0	22.0	25.0	7.9	898	39.0	25.0
3 Bott	28		7.2	22.5	26.0	7.8	264	11.5	24.0
4 Air		1145					2300		
4 Surf.			10.8	24.0	24.0	7.9	726	31.6	26.0
4 Bott.	38		12.4	24.0	24.0	8.0	528	23.0	25.5
5 Air		1130					460		

5 Surf.			9.4	(24)	14.0	8.0	172	37.3	26.0
5 Bott.	18		8.9	(24)	21.0	7.9	106	23.0	26.0
6 Air		1100					460		
6 Surf.			7.3	(22)	1.0	7.3	277	60.3	24.0
6 Bott.	28		6.0	(23)	20.0	7.5	158	34.4	25.0
7 Air		1200					3000		
7 Surf.			9.4	22.6	26.0	7.7	726	24.2	25.0
	50		9.2	22.2			422	14.1	24.6
	100		7.2	20.0			264	8.8	23.0
	150		7.0	19.1			158	5.3	22.5
7 Bott.			6.5	19.1	26.0	7.7			

##

JULY 14, 1986 Weather: Clear sky, warm, breezy
Low Tide: 1005 e.s.t.

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		1115					3000		
1 Surf.			9.9	22.0	26.0	8.0	1214	40.5	25.5
1 Bott.	60		9.9	22.0	26.0	8.1	805	26.8	25.3
2 Air		1225					1100		
2 Surf.			6.7	21.1	25.0	7.9	422	38.4	22.0
2 Bott.	90		7.3	21.1	25.0	8.0	158	14.4	21.5
3 Air		1300					3500		
3 Surf.			7.7	22.0	23.0	8.0	1122	32.1	26.5
3 Bott	100		7.3	21.1	25.0	7.9	581	16.6	25.3
4 Air		1330					3500		
4 Surf.			8.4	21.5	26.0	8.3	475	13.6	23.0
4 Bott.			8.1	21.0	26.0	8.1	185	5.3	22.5
5 Air		1020					3000		
5 Surf.			10.9	23.0	24.0	7.8	1056	35.2	23.0
5 Bott.	22		8.6	22.0	26.0	7.8	752	25.1	23.5
6 Air		940					3000		
6 Surf.			8.2	20.5	1.0	7.8	1082	36.1	23.5
6 Bott.			2.6	21.0	25.0	7.5	726	24.2	23.1
7A		1355					3500		
7S			7.5	21.0	25.0	8.0	1003	28.7	21.8
	50		7.5	21.0					
	100		7.4	21.0			436	12.4	21.5
	150		7.4	20.9	26.0		290	8.3	21.2
7B	200		7.1	20.8		8.0	198	5.7	21.2

##

SEPTEMBER 12, 1986 Weather: Overcast, breeze, occasional sun
Low Tide: 1135 e.s.t.

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		1005					2300		
1 Surf.			11.2	21.0	28.0	8.5	700	30.4	22.8
1 Bott.	57		11.2	21.0	28.0	8.5	290	12.6	22.8
2 Air		918					890		
2 Surf.			5.1	21.0	28.0	8.1	277	31.1	22.2
2 Bott.	58		4.6	21.0	28.0	8.0	106	11.9	22.2
3 Air		908					700		24.4
3 Surf.			6.5	20.9	28.0	8.2	264	37.7	22.8
3 Bott	70		7.7	20.6	28.0	8.2	132	18.9	22.8
4 Air		850					600		
4 Surf.			7.5	21.2	27.0	8.2	198	33.0	21.1
4 Bott.	50		6.3	21.0	28.0	8.2	145	24.2	21.1
5 Air		835					600		
5 Surf.			7.6	21.9	19.0	8.2	185	30.8	20.6
5 Bott.	42		5.6	22.0	23.0	8.2	53	8.8	21.1
6 Air		820					440		
6 Surf.			7.7	20.4	2.0	8.3	79	18.0	21.1
6 Bott.	47		3.2	22.0	16.0	7.8	53	12.0	21.1
7 Air		845					3000		
7 Surf.			7.3	20.7	28.0	8.0	726	24.2	
	50		7.2	20.7					
	100		7.2	20.7			422	14.1	
	150		7.2	20.7					
	200		7.1	20.6			264	8.8	
	250		7.1	20.6					
	300		7.1	20.6			158	5.3	
	350		7.1	20.6					
7 Bott.	378		6.6	20.6	28.0	8.0			

OCTOBER 10, 1986

Weather: Hazy sun, cool, breezy
Low Tide: 1017 e.s.t.

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		1125					4800		
1 Surf.			9.1	15.9	27.0	8.1	739	15.4	19.9
1 Bott.	50		9.0	16.0	27.5	8.0	396	8.3	17.5
2 Air		1045					4800		16.0
2 Surf.			7.7	14.5	26.5	7.9	990	20.6	17.5
2 Bott.	50		7.5	14.5	27.5	7.9	607	12.6	17.5
3 Air		900					1500		13.9
3 Surf.			7.5	13.0	26.5	7.9	713	47.5	15.2
3 Bott	50		8.4	13.0	26.5	7.9	475	31.7	15.2

4 Air		1255					1800		
4 Surf.			13.9	15.6	26.5	8.4	620	34.5	18.0
4 Bott.	30		13.6	14.9	26.5	8.4	594	33.0	18.0
5 Air		1330					1900		
5 Surf.	15		10.2	16.6	19.0	8.0	673	35.4	19.5
5 Bott.			10.2	16.6	19.0	8.0	673	35.4	
6 Air		1400					2000		14.5
6 Surf.			11.3	16.5	5.0	7.5	634	31.7	17.0
6 Bott.	50		9.2	13.0	21.5	7.9	581	29.1	21.0
7 Air		945					2000		
7 Surf.			7.6	14.0	27.0	8.0	607	30.4	18.0
7 Bott.	86		7.5	14.0	27.0	8.0	198	9.9	18.0
8 Air		1425							
8 Surf.			10.2	15.5	28.0	8.1			
8 Bott.	100		10.6	15.6	28.0	8.1			
9 Air		1445							
9 Surf.			10.8	16.1	28.0	8.2			
9 Bott.	85		10.8	16.1	28.0	8.2			
10 Air		1450							
10 Surf.			13.6	16.0	28.0	8.5			
10 Bott.	50		13.5	16.0	27.5	8.5			

NOVEMBER 7, 1986 Weather: Overcast, cool
Low Tide: 0858

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		905					265		
1 Surf.			8.3	9.9	27.0	7.8	90	33.9	10.5
1 Bott.	60		7.9	9.9	27.0	7.8	37	13.9	10.5
2 Air		1020					220		
2 Surf.			8.5	9.1	24.5	7.8	82	37.2	13.0
2 Bott.	50		8.1	9.1	26.5	7.7	40	18.0	13.0
3 Air		845					180		9.0
3 Surf.			8.1	8.9	24.0	7.7	59	33.0	9.9
3 Bott	100		5.3	8.9	26.5	7.7	18	10.3	10.0
4 Air		1130					310		10.0
4 Surf.			8.0	8.9	25.5	7.7	94	30.2	11.0
4 Bott.	49		14.6	9.2	26.5	8.3	66	21.3	11.1
5 Air		1200					300		12.0
5 Surf.			12.9	11.8	6.5	7.5	112	37.4	11.0
5 Bott.	26		10.6	8.9	25.0	7.8	59	19.8	12.0

6 Air		1235					450		12.5
6 Surf.			11.3	8.0	0.0	7.5	123	27.3	11.0
6 Bott.	17		7.7	8.5	24.0	7.6	99	22.0	11.0
7 Air		839					160		7.5
7 Surf.			8.1	9.9	26.0	7.8	49	30.5	10.5
	50		8.1	9.9			29	18.2	10.5
7 Bott.	70		8.0	9.9	26.5	7.8	21	13.2	10.5
8 Air		820					130		8.5
8 Surf.			7.8	8.9	26.5	7.7	36	27.4	9.5
8 Bott.	100		6.4	9.0	27.5	7.8	12	9.1	9.5
9 Air		809					145		7.5
9 Surf.			7.8	8.2	27.5	7.7	40	27.3	9.0
9 Bott.	86		7.4	8.5	27.5	7.7	16	10.9	9.0
10 Air		754					120		7.5
10 Surf.			7.8	8.1	27.0	7.7	37	30.8	9.0
10 Bott.	75		7.3	8.1	27.0	7.8	22	18.7	9.0

DECEMBER 12, 1986 — Weather: Overcast, cold, light breeze, water
Low Tide: 1458

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		1530					190		3.5
1 Surf.			11.4	5.1	26.0	7.8	45	23.7	6.0
1 Bott.	60		10.7	5.1	26.5	7.9	7	3.7	6.0
2 Air		1600					270		
2 Surf.			9.4	5.2	25.0	7.8	12	4.4	7.5
2 Bott.	50		8.8	5.2	26.0	7.8	8	2.9	7.5
3 Air		1325					430		3.0
3 Surf.			10.0	4.9	26.0	7.8	119	27.6	5.0
3 Bott	175		9.0	5.1	26.5	7.8	37	8.6	
4 Air		1340					290		4.0
4 Surf.			10.9	5.5	26.0	8.1	119	41.0	5.5
4 Bott.	50		9.7	5.6	26.0	7.9	50	17.3	6.0
5 Air		1755							
5 Surf.			12.0	5.1	24.0	7.9			
5 Bott.	70		10.5	5.1	26.0	8.0			
6 Air		1700							
6 Surf.			13.2	4.5	0.0	6.5			
6 Bott.	50		12.6	4.0	0.0	6.4			
7 Air		1310					460		3.5
7 Surf.			10.0	4.5	24.0	7.8	132	28.7	5.0
	50		9.9	4.5			79	17.2	5.0
	100		9.8	4.9			53	11.5	5.0
	150		9.4	5.0			33	7.2	5.5

	200		9.6	5.0			30	6.6	5.5
7 Bott.	275		8.8	5.0	25.0	7.8			
8 Air		1300					440		3.0
8 Surf.			10.8	3.5	21.5	7.8	132	30.0	4.0
8 Bott.	100		9.0	5.1	25.0	7.8	40	9.0	5.0
9 Air		1245					500		4.5
9 Surf.			10.2	4.5	22.5	7.8	158	31.7	6.5
9 Bott.	80		12.7	5.6	26.0	7.8	66	13.2	6.0
10 Air		1225					570		4.5
10 Surf.			10.2	4.9	24.0	7.8	172	30.1	6.0
10 Bott.	70		11.5	5.1	25.5	7.9	79	13.9	6.5

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JANUARY 21, 1987 Weather: Early overcast, sunny later, cold
Low Tide: 0916 e.s.t.

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		1015					770		2.0
1 Surf.			11.4	3.0	25.5	7.9	330	42.9	2.5
1 Bott.	50		11.3	3.0	25.0	7.8	66	8.6	2.5
2 Air		1110					5400		2.0
2 Surf.			11.7	1.7	25.0	7.9	462	8.6	3.0
2 Bott.	75		11.1	2.0	25.0	8.0	317	5.9	3.0
3 Air		930					460		1.0
3 Surf.			11.6	1.0	23.0	7.9	277	60.3	2.5
3 Bott	150		10.5	3.5	26.5	7.9	37	8.0	2.5
4 Air		1210					4200		6.0
4 Surf.			16.5	3.5	25.0	8.4	528	12.6	5.0
4 Bott.	24		16.9	3.5	26.0	8.4	462	11.0	5.0
5 Air		1245					700		4.0
5 Surf.			15.2	4.0	25.5	8.2	396	56.6	5.0
5 Bott.	19		15.3	4.2	27.0	8.3	132	18.9	5.0
6 Air		1330					3300		2.5
6 Surf.			14.3	2.5	0.0	8.3	911	27.6	4.0
6 Bott.	33		13.7	2.5	0.0	8.4	634	19.2	4.0
7 Air			Not Done						
7 Surf.					19.0	7.7			
7 Bott.					26.0	7.8			
8 Air		855					290		0.0
8 Surf.			13.3	1.0	6.0	8.0	73	25.0	1.5
8 Bott.	110		8.5	3.0	26.0	7.8	32	10.9	1.5
9 Air		841					150		0.0
9 Surf.			11.8	0.0	21.0	7.8	49	32.6	1.5
9 Bott.	100		10.2	2.0	26.0	7.8	22	15.0	1.5

10 Air							150		0.0
10 Surf.		825	11.4	0.1	22.0	7.9	33	22.0	1.5
10 Bott.	70		9.8	2.0	26.0	7.8	18	12.3	1.5

FEBRUARY 20, 1987 Weather: Sunny, cold, calm, pond frozen
Entire pond is frozen

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		945					4530		
1 Surf.			14.8	0.0	25.0	8.3	554	12.2	
1 Bott.	63		14.8	0.1	26.0	8.4	436	9.6	
2 Air		1035					5250		
2 Surf.			10.9	1.5	23.0	8.2	568	10.8	
2 Bott.	40		12.6	1.0	25.0	8.3	356	6.8	
3 Air		1200					3600		
3 Surf.			16.7	0.1	2.5	8.6	792	22.0	
3 Bott	125		15.0	0.1	26.5	8.3	198	5.5	
4 Air		1220					6450		
4 Surf.			18.6	1.5	3.5	8.3	779	12.1	
4 Bott.	0.0(ice)		17.6	4.0	20.0	8.7	119	1.8	
5 Air		1305	16.6	1.0	0.5	8.8	6510		
5 Surf.			15.7	1.2	3.0	8.4	673	10.3	
5 Bott.	17						238	3.6	
6 Air		1340					4950		
6 Surf.			15.6	4.0	0.0	8.3	528	10.7	
6 Bott.	26		15.5	4.0	0.0	8.2	449	9.1	
7 Air		1050					6000		
7 Surf.			14.5	0.1	20.5	8.0	686	11.4	
	50		14.5	.0			488	8.1	
	100		14.0	.0			317	5.3	
7 Bott.	150		14.0	.0	25.5	8.2	317	5.3	
8 Air		910					4050		
8 Surf.			15.3	1.0	20.5	7.9	528	13.0	
8 Bott.	100		13.5	0.0	26.0	7.9	285	7.0	
9 Air		810					850		
9 Surf.			16.0	1.0	3.0	7.9	317	37.3	
9 Bott.	80		12.9	0.1	23.0	7.9	95	11.2	
10 Air		730					450		
10 Surf.			11.9	1.0	20.0	7.7	297	66.0	
10 Bott.	30		16.9	1.0	26.0	7.6	38	8.5	

MARCH 5, 1987 Weather: Sunny, clear, cool
Low Tide: 0920

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		930					4950		
1 Surf.			14.1	0.5	25.0	8.2	528	10.7	
1 Bott.	50		14.5	1.0	26.0	8.1	449	9.1	
2 Air		840					4650		
2 Surf.			12.8	-1.0	24.0	7.9	356	7.7	
2 Bott.	65		12.5	-0.1	24.0	8.0	264	5.7	
3 Air		1000					6600		
3 Surf.			14.6	0.7	22.5	8.3	990	15.0	
3 Bott	70		14.7	0.5	22.0	8.2	554	8.4	
4 Air		1040					7200		
4 Surf.			16.8	2.5	23.0	8.3	620	8.6	
4 Bott.	25		17.2	2.5	23.5	8.3	594	8.3	
5 Air		1105					8010		
5 Surf.			16.4	6.9	7.5	8.2	726	9.1	
5 Bott.	12		6.3	6.9	8.0	8.2	488	6.1	
6 Air		1130					8100		
6 Surf.			13.1	2.9	0.0	8.1	713	8.8	
6 Bott.	25		13.3	2.9	0.0	7.8	634	7.8	
7 Air		900					4920		
7 Surf.			13.5	0.1	22.0	8.0	383	7.8	
	50		13.2	0.2			290	5.9	
	100		13.1	0.2			198	4.0	
7 Bott.	125		13.1	0.2	23.0	8.0	475	9.7	
8 Air		720					1350		
8 Surf.			12.0	0.5	22.5	8.0	475	35.2	
8 Bott.	45		12.4	0.5	20.0	7.9	218	16.1	
9 Air		740					2250		
9 Surf.			12.8	0.7	25.5	7.9	614	27.3	
9 Bott.	65		12.4	0.8	25.5	7.9	376	16.7	
10 Air		810					2580		
10 Surf.			14.1	1.0	25.5	7.9	812	31.5	
10 Bott.	65		14.7	0.1	26.0	7.9	475	18.4	

APRIL 23, 1987 Weather: Cloudy, misty, cool
Low Tide: 1343 e.s.t.

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		1340					690		12.5
1 Surf.			12.1	10.3	20.0	8.3	634	91.8	12.1
1 Bott.	50		11.7	10.2	20.0	8.3	337	48.8	12.0
2 Air		1420					950		

2 Surf.			11.1	10.6	12.0	8.3	832	87.5	15.5
2 Bott.	75		10.4	10.9	19.0	8.2	178	18.8	15.0
3 Air		1515					660		
3 Surf.			12.6	10.9	11.0	8.4	356	54.0	14.0
3 Bott	75		14.0	11.1	20.0	8.4	36	5.4	13.9
4 Air		1545					660		
4 Surf.			10.6	11.0	4.0	8.1	91	13.8	
4 Bott.	25		10.2	11.0	5.0	8.0	53	8.0	
5 Air		1610					675		
5 Surf.			9.1	11.2	0.0	7.8	238	35.2	
5 Bott.	25		9.0	11.2	1.0	7.7	139	20.5	
6 Air		1630					675		
6 Surf.			11.3	12.1	0.0	7.8	58	8.6	
6 Bott.	50		11.3	12.1	0.0	7.7	40	5.9	
7 Air		1440					600		
7 Surf.			12.8	10.9	20.0	8.4	495	82.5	13.9
	50		12.4	10.7			337	56.1	
	100		12.3	10.7			55	9.2	
7 Bott.	125		12.3	10.7	21.0	8.3	42	7.0	13.9
8 Air		1235					570		
8 Surf.			12.8	11.5	17.0	8.4	535	93.8	13.9
8 Bott.	75		12.3	11.7	19.0	8.4	238	41.7	13.9
9 Air		1210					780		
9 Surf.			12.0	10.3	21.0	8.2	515	66.0	
9 Bott.	75		11.8	10.3	21.0	8.2	297	38.1	
10 Air		1130					530		12.0
10 Surf.			12.0	10.1	22.0	8.2	297	56.0	11.9
10 Bott.	75		12.1	10.1	22.0	8.2	48	9.0	11.9

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MAY 20, 1987 Weather: Cloudy, cold, breezy, occ.rain
Low Tide: 1120 e.s.t.

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		1145					870		
1 Surf.			11.3	13.0	22.0	8.0	1	0.1	
1 Bott.	25		11.3	13.0	22.0	8.0	1	0.1	
2 Air		1215					680		
2 Surf.			9.9	13.0	18.0		185	27.2	
2 Bott.	50		9.2	13.0	21.0		33	4.9	
3 Air		845					570		
3 Surf.			11.5	13.0	16.0	8.0	185	32.4	
3 Bott	100		11.6	12.8	21.0	8.0	44	7.6	
4 Air		825					900		

4 Surf.			10.6	12.5	8.0	7.8	264	29.3	
4 Bott.	50		10.2	13.0	14.0	7.9	46	5.1	
5 Air		800					815		
5 Surf.			10.4	13.0	0.2	7.4	198	24.3	
5 Bott.	50		9.8	13.9	21.0	7.9	198	24.3	
6 Air		1300					300		
6 Surf.			12.8	15.0	0.0		224	74.8	
6 Bott.	50		12.8	15.0	0.0		185	61.6	
7 Air		1005					870		
7 Surf.			11.2	12.8	21.0	8.2	290	33.4	
	50		11.3	12.8			158	18.2	
	100		11.2	12.8			79	9.1	
	150		11.1	12.8			50	5.7	
	200		11.0	12.8			30	3.5	
	250		11.0	12.6			16	1.8	
	300		10.8	12.5			11	1.2	
	350		10.8	12.5			6	0.7	
	400		10.8	12.5			4	0.4	
	450		10.7	12.5			2	0.2	
	500		10.7	12.5			1	0.1	
7 Bott.	550		10.6	12.5	21.0	8.2	1	0.1	
8 Air		910					490		
8 Surf.			10.7	13.0	22.0	8.0	132	26.9	
8 Bott.	50		10.6	13.0	22.0	8.0	66	13.5	
9 Air		925					530		
9 Surf.			10.4	13.0	22.0	8.0	158	29.9	
9 Bott.	90		10.4	13.0	22.0	8.0	40	7.5	
10 Air		940					900		
10 Surf.			10.2	13.0	22.0	8.0	264	29.3	
10 Bott.	100		20.3	13.0	22.0	8.0	66	7.3	

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JUNE 17, 1987 — Weather: Full sun, a few ripples
Low Tide: 0954 e.s.t.

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		1103					3300		
1 Surf.			11.1	19.5	25.0	8.2	1096	33.2	
1 Bott.	35		11.1	19.5	26.0	8.2	766	23.2	
2 Air		1137					3400		
2 Surf.			11.0	21.8	25.0	8.3	1056	31.1	
2 Bott.	75		10.3	21.8	25.0	8.2	422	12.4	
3 Air		1010					3200		
3 Surf.			13.5	20.2	24.0	8.3	990	30.9	
3 Bott	100		12.8	19.0	26.0	8.4	211	6.6	
4 Air		812					2300		

4 Surf.			13.0	19.0	25.0	8.3	713	31.0	
4 Bott.	50		13.2	19.0	25.0	8.3	264	11.5	
5 Air		835					2400		
5 Surf.			10.8	19.0	23.0	8.0	792	33.0	
5 Bott.	25		11.2	19.0	23.0	8.0	462	19.3	
6 Air		1230					3300		
6 Surf.			13.6	23.5	1.0	8.2	1056	32.0	
6 Bott.	25		>20.0	24.0	15.0	9.3	871	26.4	
7 Air		952					3200		
7 Surf.			11.1	18.5	25.0	8.3	924	28.9	
	50		11.1	18.5			568	17.7	
	100		11.1	18.3			264	8.3	
	150		11.1	18.3			185	5.8	
	200		11.2	18.3			112	3.5	
	250		11.3	18.5			66	2.1	
	300		11.3	18.4			36	1.1	
	350		11.3	18.2			20	0.6	
	400		11.2	18.1			13	0.4	
7 Bott.	450		11.2	18.1	26.0	8.2	7	0.2	
8 Air		905					2900		
8 Surf.			11.4	18.2	26.0	8.2	792	27.3	
8 Bott.	57		12.1	18.0	26.0	8.2	396	13.7	
9 Air		920					3000		
9 Surf.			11.1	18.1	26.0	8.0	924	30.8	
9 Bott.	75		11.7	17.9	28.0	8.0	370	12.3	
10 Air		940					3000		
10 Surf.			11.5	19.9	26.0	8.2	924	30.8	
10 Bott.	75		11.5	19.9	26.0	8.2	449	15.0	

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JULY 15, 1987 — Weather: Sunny, breezy
Low Tide: 0832 e.s.t.

Station Depth	Depth (cm)	Time (est)	PB meter D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		1110					2600		
1 Surf.			10.3	23.0	25.5	8.2	1056	40.6	
1 Bott.	75		9.7	21.5	25.5	8.2	145	5.6	
2 Air		645					1600		
2 Surf.			7.0	20.2	25.0	8.0	343	21.5	
2 Bott.	50		7.0	20.1	25.0	8.0	158	9.9	
3 Air		823					2200		
3 Surf.			8.3	20.8	25.0	8.2	660	30.0	
3 Bott	100		7.9	20.8	25.0	8.2	158	7.2	
4 Air		758					2200		
4 Surf.			8.7	20.8	24.5	8.1	620	28.2	
4 Bott.	42		7.5	20.8	25.5	8.2	264	12.0	

5 Air		710					2000	
5 Surf.			8.7	21.1	20.5	8.0	528	26.4
5 Bott.	25		7.2	21.1	22.5	8.0	172	8.6
6 Air		1038					3400	
6 Surf.			8.8	21.8	1.0	7.7	1056	31.1
6 Bott.	25		18.0	23.9	16.0	8.3	845	24.8
7 Air		848					2700	
7 Surf.			7.9	20.8	24.0	8.2	792	29.3
	50		7.2	20.5			660	24.4
	100		7.0	20.5			528	19.6
	150		7.0	20.5			396	14.7
	200		6.7	20.5			330	12.2
	250		6.6	20.4			198	7.3
	300		6.3	20.3			132	4.9
7 Bott.	320		5.5	20.2	25.5	8.2	86	3.2
8 Air	Not done							
8 Surf.								
8 Bott.								
9 Air		909					2600	
9 Surf.			7.8	21.0	25.0	8.0	792	30.5
9 Bott.	100		6.9	21.0	25.0	8.0	356	13.7
10 Air	Not done							
10 Surf.								
10 Bott.								

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AUGUST 14, 1987 Weather:Hazy to full sun, occ. clouds, breeze
Low Tide: 0855 e.s.t.

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		755					1300		
1 Surf.			8.1	20.3	26.0	7.9	502	38.6	
1 Bott.	50		10.4	20.5	25.5	7.9	449	34.5	
2 Air		710					700		
2 Surf.			5.7	20.5	24.5	7.5	206	29.4	
2 Bott.	50		5.9	20.5	24.5	7.6	119	17.0	
			8/15/87						
3 Air		1050		(1145 est)			3100		
3 Surf.			8.1	25.5	26.0	8.3	924	29.8	
3 Bott	140		6.8	24.0	26.0	8.2	224	7.2	
			8/15/87						
4 Air		920		(1200 est)			2800		
4 Surf.			9.9	27.0	25.5	8.0	766	27.3	
4 Bott.	50		9.5	27.0	26.0	8.1	515	18.4	
			8/15/87						
5 Air		855		(1215 est)			2500		
5 Surf.			13.7	28.5	26.0	8.0	634	25.3	
5 Bott.	50		10.8	28.3	25.5	8.0	356	14.3	

			8/15/87						
6 Air		1155		(1230 est)			2900		
6 Surf.			9.7	25.0	0.0	8.3	884	30.5	
6 Bott.	50		14.0	28.0	21.5	8.8	700	24.1	
			8/15/87						
7 Air		1015		(1130 est)			2800		
7 Surf.			8.1	25.5	26.0	8.3	884	31.6	
	50		8.1	25.5			581	20.7	
	100		8.0	25.0			330	11.8	
	150		7.8	24.5			211	7.5	
	200		7.4	24.0			132	4.7	
	250		7.0	24.0			98	3.5	
	300						66	2.4	
	350						41	1.5	
	400						29	1.0	
	450						18	0.7	
7 Bott.	500				26.5	8.2	12	0.4	
8 Air	Notdone								
8 Surf.									
8 Bott.									
9 Air		946					2700		
9 Surf.			7.9	21.1	26.0	8.3	805	29.8	
9 Bott.	50		7.5	21.0	26.0	8.2	356	13.2	
10 Air	Not done								
10 Surf.									
10 Bott.									

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SEPTEMBER 11, 1987 Weather: Full to hazy sun, calm
Low Tide: 0734 e.s.t.

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		1040					2500		
1 Surf.			9.2	23.0	26.0	7.8	462	18.5	
1 Bott.	50		8.0	22.5	26.0	7.8	330	13.2	
2 Air		1007					1800		
2 Surf.			8.0	22.7	26.0	7.9	462	25.7	
2 Bott.	100		7.4	22.7	26.0	7.9	158	8.8	
3 Air		800					1200		
3 Surf.			8.0	22.0	25.0	7.9	396	33.0	
3 Bott	120		5.3	22.2	26.0	7.8	132	11.0	
4 Air		725					920		
4 Surf.			7.7	21.9	22.0	7.8	264	28.7	
4 Bott.	50		7.4	22.0	25.0	7.8	145	15.8	
5 Air		642					450		
5 Surf.			5.2	23.4	22.0	7.3	132	29.3	
5 Bott.	50		3.3	23.3	25.0	7.3	59	13.2	

6 Air		1125							
6 Surf.			10.8	21.9	0.0	8.0			
6 Bott.	50		12.6	24.5	20.0	8.0			
7 Air		810					1500		
7 Surf.			8.3	22.0	26.0	7.9	422	28.2	
	50		8.3	22.0			290	19.4	
	100		7.0	22.1			185	12.3	
	150		6.6	22.1			119	7.9	
	200		6.6	22.1			86	5.7	
	250		6.4	22.1			58	3.9	
	300		6.3	22.1			40	2.6	
	350		6.3	22.1			28	1.8	
	400		6.2	22.1			20	1.3	
	450		6.2	22.1			13	0.9	
	500		6.1	22.1			9	0.6	
	550		6.1	22.1			6	0.4	
	600		6.1	22.1			4	0.3	
7 Bott.	625		6.0	22.1	26.0	7.9			
8 Air									
8 Surf.									
8 Bott.									
9 Air									
9 Surf.									
9 Bott.									
10 Air		840					1500		
10 Surf.			6.6	22.8	26.0	7.9	462	30.8	
10 Bott.	150		6.0	22.5	26.0	7.8	92	6.2	

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OCTOBER 15, 1987 — Weather: Full sun, light breeze
Low Tide: 1133 e.s.t.

Station Depth	Depth (cm)	Time (est)	D.O. (ppm)	Temp. (oC)	Salin. (ppt)	pH	Light (uE/m2/s)	% Surf. Light	Temp (oC)
1 Air		1010					2300		
1 Surf.			9.8	15.0	26.0	7.8	607	26.4	
1 Bott.	50		9.8	14.9	26.0	7.8	396	17.2	
2 Air		1040					2300		
2 Surf.			8.5	13.4	25.0	7.7	620	27.0	
2 Bott.	100		8.6	13.2	26.0	7.7	290	12.6	
3 Air		1100					2300		
3 Surf.			11.6	13.5	25.0	8.0	686	29.8	
3 Bott	60		11.4	13.2	26.0	8.0	290	12.6	
4 Air		1130					2300		
4 Surf.			12.5	14.8	25.0	8.2	634	27.5	
4 Bott.	50		13.4	14.2	25.0	8.3	488	21.2	
5 Air		1200					2200		
5 Surf.			13.3	18.0	25.0	8.3	660	30.0	

5 Bott.	50		14.2	16.2	24.0	8.3	383	17.4
6 Air		1235					2400	
6 Surf.			>20.0	15.0	0.0	8.4	607	25.3
6 Bott.	40		>20.0	15.0	24.0	8.4	383	16.0
7 Air		920					1700	
7 Surf.			10.2	12.9	25.0	7.9	488	28.7
	50		10.1	12.8			304	17.9
	100		9.6	13.1			198	11.6
7 Bott.	150		9.6	13.1	25.0	8.0	158	9.3
8 Air	Not done							
8 Surf.								
8 Bott.								
9 Air		840					1600	
9 Surf.			10.3	12.2	25.0	7.8	462	28.9
9 Bott.	66		10.4	12.2	25.0	7.8	290	18.2
10 Air	Not done							
10 Surf.								
10 Bott.								

****

Appendix Table B. Total suspended solids data.

HOLLY POND TOTAL SUSPENDED SOLIDS

Station	Month	Time of Low Tide	Time of Sample	Surface g/l	Bottom g/l
1	5/86	900	854	0.203	
	6/86	1134	1344	0.061	0.084
	7/86	1005	1115	0.051	0.090
	9/86	1135	1005	0.047	0.098
	10/86	1017	1125	0.086	0.119
	11/86	858	905	0.050	0.112
	12/86	1458	1530	0.120	0.258
	1/87	916	1015	0.201	0.174
	2/87	946	945	0.056	0.099
	3/87	920	930	0.035	0.071
	4/87	1343	1340	0.085	0.100
	5/87	1120	1145	0.192	0.181
			Mean:	0.099	0.126
			SD:	0.062	0.053
			CV:	0.622	0.423
2	5/86	900	1110	0.085	
	6/86	1134	1300	0.091	0.209
	7/86	1005	1225	0.049	0.057
	9/86	1135	918	0.066	0.078
	10/86	1017	1045	0.050	0.087
	11/86	858	1020	0.024	0.046
	12/86	1458	1600	0.052	0.073
	1/87	916	1110	0.081	0.111
	2/87	946	1035	0.063	0.082
	3/87	920	840	0.033	0.029
	4/87	1343	1420	0.003	0.078
	5/87	1120	1215	0.107	0.078
			Mean:	0.059	0.084
			SD:	0.029	0.045
			CV:	0.488	0.528
3	5/86	900	1230	0.017	
	6/86	1134	1230	0.007	0.006
	7/86	1005	1300	0.051	0.058
	9/86	1135	908	0.061	0.058
	10/86	1017	900	0.065	0.215
	11/86	858	845	0.032	0.033
	12/86	1458	1325	0.046	0.039
	1/87	916	930	0.086	0.097
	2/87	946	1200	0.049	0.169
	3/87	920	1000	0.046	0.032
	4/87	1343	1515	0.028	0.049
	5/87	1120	845	0.040	0.048
			Mean:	0.044	0.073
			SD:	0.021	0.061
			CV:	0.468	0.827

HOLLY POND TOTAL SUSPENDED SOLIDS

Station	Month	Time of Low Tide	Time of Sample	Surface g/l	Bottom g/l
4					
	5/86	900	1315	0.170	
	6/86	1134	1145	0.073	0.062
	7/86	1005	1330	0.059	0.115
	9/86	1135	850	0.081	0.089
	10/86	1017	1255	0.062	0.101
	11/86	858	1130	0.037	0.095
	12/86	1458	1340	0.050	0.121
	1/87	916	1210	0.110	
	2/87	946	1220	0.003	0.054
	3/87	920	1040	0.033	0.040
	4/87	1343	1545	0.057	0.055
	5/87	1120	825	0.022	0.102
			Mean:	0.063	0.083
			SD:	0.042	0.027
			CV:	0.668	0.324
5	5/86	900	1355	0.142	
	6/86	1134	1130	0.054	0.066
	7/86	1005	1020	0.054	0.116
	9/86	1135	835	0.045	0.121
	10/86	1017	1330	0.049	0.075
	11/86	858	1200	0.005	0.047
	12/86	1458	1755	0.039	0.047
	1/87	916	1245	0.090	
	2/87	946	1305	0.002	0.049
	3/87	920	1105	0.056	0.102
	4/87	1343	1610	0.019	0.103
	5/87	1120	800	0.014	0.078
			Mean:	0.047	0.080
			SD:	0.037	0.027
			CV:	0.791	0.338
6	5/86	900	1430	0.059	
	6/86	1134	1100	0.000	0.048
	7/86	1005	940	0.009	0.077
	9/86	1135	820	0.017	0.038
	10/86	1017	1400	0.005	0.080
	11/86	858	1235	0.000	0.150
	12/86	1458	1700	0.003	0.003
	1/87	916	1330	0.022	0.017
	2/87	946	1340	0.006	0.006
	3/87	920	1130	0.000	0.000
	4/87	1343	1630	0.016	0.012
	5/87	1120	1300	0.011	0.014
			Mean:	0.012	0.040
			SD:	0.016	0.044
			CV:	1.251	1.086

HOLLY POND TOTAL SUSPENDED SOLIDS

Station	Month	Time of Low Tide	Time of Sample	Surface g/l	Bottom g/l
7	6/86	1134	1200	0.081	0.057
	7/86	1005	1355	0.085	0.078
	9/86	1135	845	0.063	
	10/86	1017	945	0.063	0.106
	11/86	858	839	0.038	0.034
	12/86	1458	1310	0.035	0.040
	1/87	916	1330	0.017	0.070
	2/87	946	1050	0.050	0.094
	3/87	920	900	0.026	0.027
	4/87	1343	1440	0.025	0.035
	5/87	1120	1005	0.044	0.039
			Mean:	0.048	0.058
			SD:	0.022	0.026
			CV:	0.452	0.454
8	10/86	1017	1425	0.053	0.067
	11/86	858	820	0.042	0.033
	12/86	1458	1300	0.035	0.041
	1/87	916	855	0.047	0.099
	2/87	946	910	0.032	0.086
	3/87	920	720	0.017	0.033
	4/87	1343	1235	0.038	0.060
	5/87	1120	910	0.040	0.105
			Mean:	0.038	0.065
			SD:	0.010	0.027
			CV:	1.591	1.200
9	10/86	1017	1445	0.043	0.064
	11/86	858	809	0.032	0.029
	12/86	1458	1245	0.041	0.081
	1/87	916	841	0.109	0.158
	2/87	946	810	0.015	0.040
	3/87	920	740	0.038	0.046
	4/87	1343	1210	0.066	0.081
	5/87	1120	925	0.046	0.054
			Mean:	0.049	0.069
			SD:	0.026	0.038
			CV:	1.591	1.200
10	10/86	1017	1450	0.082	0.057
	11/86	858	754	0.031	0.029
	12/86	1458	1225	0.040	0.085
	1/87	916	825	0.083	0.126
	2/87	946	730	0.021	0.023
	3/87	920	810	0.032	0.028
	4/87	1343	1130	0.052	0.041
	5/87	1120	940	0.052	0.063

HOLLY POND TOTAL SUSPENDED SOLIDS

Station	Month	Time of Low Tide	Time of Sample	Surface g/l	Bottom g/l
			Mean:	0.049	0.056
			SD:	0.022	0.033
			CV:	1.591	1.200

Appendix Table C. Tidal studies data.

HOLLY POND TIDAL STUDY

Time Depth	Depth (m)	Time Secchi	Secchi (m)	Time Salin. pH	Surf. Salin. (mg/l)	Bott. Salin. (mg/l)	Surf. pH	Bott. pH	Time Temp. Oxyg.	Surf. Temp. (oC)	Bott. Temp. (oC)	Surf. Oxyg. (mg/l)	Bott. Oxyg. (mg/l)
August 5, 1986 Dam in Place													
1040	1.79	1040	1.24	1040	28.0	28.0	8.0	7.0	1040	24.5	24.1	10.2	6.1
1115	1.88	1115	1.17	1115	27.0	28.0	8.0	7.9	1115	24.1	23.5	8.6	6.8
1130	1.92	1130	1.01										
1156	2.11	1156	1.11	1145	27.0	27.0	8.0	7.9	1145	23.3	23.1	9.0	7.0
1233	2.16	1215	1.19	1215	29.0	29.0	8.0	8.0	1215	24.1	23.1	9.3	7.1
1330	1.96	1330	1.00	1330	26.0	28.0	8.1	8.0	1330	25.5	23.6	10.6	7.2
1403	1.80	1403	1.34	1403	26.0	27.0	8.1	8.0	1403	26.0	23.8	10.8	8.5
1428	1.75	1428	1.27	1428	27.0	28.0	8.2	8.1	1435	26.0	23.8	11.6	9.0
June 11, 1987 Dam Breached													
845	4.83	845	1.80	900	24.0	24.5	7.7	7.7	909	15.5	15.0	8.5	7.3
926	4.56	923	1.64	926	23.0	24.0	7.8	7.6	913	15.5	15.2	8.4	7.9
		950	1.71	953	24.0	24.0	7.7	7.7	1009	15.1	15.0	8.6	8.4
1028	4.59	1015	1.64	1025	24.5	24.0	7.7	7.7					
1043	4.93	1043	1.62										
1102	5.20	1102	1.70	1053	26.0	26.0	7.7	7.7	1107	15.0	14.9	8.8	8.6
1145	6.43	1145	1.31	1124	26.0	26.0	7.7	7.7	1148	16.3	15.0	9.2	8.5
1214	7.50	1159	1.44	1156	26.0	26.5	7.7	7.7	1217	16.0	15.0	8.9	8.7
		1241	1.54	1223	26.0	26.5	7.7	7.7	1246	16.7	15.1	9.0	8.7
		1304	1.70	1253	26.0	26.5	7.8	7.8	1311	17.0	15.6	9.0	8.8
1334	6.12	1345	1.48	1323	26.0	26.5	7.8	7.8	1345	17.0	15.2	9.0	9.0
1413	5.20	1353	1.57	1353	26.0	26.5	7.8	7.8	1406	17.3	15.2	9.3	8.9
1434	5.20	1433	1.51	1423	26.0	26.5	7.8	7.8	1442	17.8	15.3	9.6	9.0
1507	5.00	1505	1.77	1455	26.0	26.5	7.9	7.8	1514	18.0	15.3	9.6	8.9
1533	4.53	1533	1.53	1523	26.0	26.5	7.9	7.8	1543	18.1	15.7	9.4	9.2
1558	4.68	1557	1.83	1553	26.0	26.5	7.8	7.8					
August 11, 1987. Dam Repaired													
944	5.70	941	2.00	944	25.0	25.0	7.6	7.6	946	19.1	19.8	6.5	3.3
1007	4.94	1005	1.83	1018	24.5	25.5	7.7	7.7	1010	19.6	19.9	7.3	3.3
1037	4.61	1035	1.93	1035	24.5	26.0	7.8	7.7	1043	19.9	19.8	7.2	3.6
1101	4.32	1100	1.94	1116	26.5	26.5	7.7	7.6	1106	20.1	19.5	6.7	3.9
1125	4.78	1122	1.90						1125	19.8	19.8	6.2	6.4
1141	6.55	1151	1.89	1143	26.0	26.0	7.8	7.8					
1209	7.00	1207	2.00	1210	26.5	26.0	7.9	7.8	1155	19.8	19.8	7.2	6.7
1237	7.30	1235	1.73						1215	20.0	19.9	7.5	6.8
1300	8.24			1243	26.0	26.0	7.9	7.8	1245	20.1	19.9	7.8	7.3
1306	8.19	1311	1.83	1306	25.0	25.0	8.1	8.1	1313	21.3	19.8	9.7	6.9
1330	8.14												
1413	6.16	1411	1.74	1413	26.0	26.0	8.2	7.9	1418	21.3	19.9	13.1	5.8
1445	4.71	1447	1.71	1445	26.0	26.0	8.1	7.9	1452	21.1	20.5	11.3	6.9
1505	4.00	1506	1.81						1511	20.9	20.6	9.2	7.1

HOLLY POND TIDAL STUDY

Time Depth	Depth (m)	Time Secchi	Secchi (m)	Time Salin. pH	Surf. Salin. (mg/l)	Bott. Salin. (mg/l)	Surf. pH	Bott. pH	Time Temp. Oxyg.	Surf. Temp. (oC)	Bott. Temp. (oC)	Surf. Oxyg. (mg/l)	Bott. Oxyg. (mg/l)
September 25, 1987 Dam Repaired													
940	3.50	940	2.00	940	24.0	25.0	7.9	7.8	940	18.0	18.5	9.4	8.0
1015	3.00	1010	2.08	1010	24.0	25.0	8.0	7.7	1025	18.5	18.9	9.6	7.8
1037	2.33	1037	2.01	1037	26.0	27.0	8.2	8.0	1047	17.2	18.5	9.8	8.9
1102	3.37	1102	1.95	1102	25.0	25.0	8.2	8.1	1102	19.0	19.0	8.3	8.2
1138	3.36	1130	1.83	1130	27.0	27.0	8.4	8.4	1140	19.0	19.0	8.7	8.5
1150	3.57			1145	27.0	27.0	8.1	8.1					
1210	4.31	1205	1.88	1205	27.0	27.0	8.2	8.2	1205	19.2	19.1	8.8	8.7
1230	6.48	1240	1.69	1230	26.0	26.0	8.2	8.2	1252	19.0	19.0	9.6	8.9
1340	4.30	1340	1.92	1340	25.0	27.0	8.1	8.1	1340	19.2	19.2	10.6	9.8
1410	4.00	1410	1.74	1410	25.0	26.0	8.1	8.1	1410	19.1	19.2	11.0	9.0
1435	4.15	1435	1.78	1435	25.0	26.0	8.2	8.1	1444	19.1	19.1	10.1	9.4
1525	3.56	1510	1.75	1510	25.0	26.0	8.2	8.1	1518	19.1	19.1	11.2	9.5
1535	3.59	1535	1.77	1535	25.0	26.0	8.2	8.2	1542	19.1	19.2	11.9	9.9

Appendix Table D. Macoalgal biomass (g freshweight 0.25 m^{-2}) on May 28, 1986.

HOLLY POND

MACROALGAL BIOMASS
(g/0.25m2)

MAY 28, 1986

GROUP	SPECIES	QUAD	STA.1 1 SUB	1 INT	STA.2 2 SUB	2 INT	STA.3 3 SUB	3 INT	STA.4 4 SUB	4 INT	STA.5 5 SUB	5 INT	STA.6 6 SUB	6 INT
BROWN														
		A	34.6	0.0	0.8	0.0	2.0	0.0	9.7	0.0	1.9	0.0	0.0	0.0
		B	49.4	41.1	11.8	0.0	1.9	3.1	1.5	0.0	11.1	0.0	0.0	0.0
		C	7.4	0.0	0.1	0.0	2.4	3.1	0.0	0.0	8.8	0.0	0.0	0.0
	Petalonia	AVG	30.5	13.7	4.2	0.0	2.1	2.1	3.7	0.0	7.3	0.0	0.0	0.0
		A	0.0	12.1	52.7	1.3	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
		B	30.1	9.9	68.1	3.0	0.2	0.5	0.0	0.0	0.0	0.0	0.0	0.0
		C	2.5	20.2	108.3	0.9	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0
	Scytosiphon	AVG	10.9	14.1	76.4	1.7	0.1	0.7	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.1	0.0	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.7	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	1.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Laminaria	AVG	0.4	0.4	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fucus	AVG	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RED		A	11.2	15.8	0.0	0.0	71.5	109.3	0.0	0.0	0.0	0.0	0.0	0.0
		B	5.6	8.2	0.0	0.0	35.8	54.7	0.0	0.0	0.0	0.0	0.0	0.0
		C	1.9	0.0	0.0	0.0	0.2	450.7	0.0	0.0	0.0	0.0	0.0	0.0
	Chondrus	AVG	6.2	8.0	0.0	0.0	35.8	204.9	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Polysiphonia nigr.	AVG	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	18.0	0.0	0.0	3.1	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	23.3	8.6	0.0	58.6	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	8.4	0.0	0.0	8.5	0.0	0.0	0.0
	Polysiphonia harv.	AVG	0.0	0.0	0.0	0.0	0.0	16.6	2.9	0.0	23.4	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	8.2	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	1.3	0.0	0.0	0.0
		C	0.5	0.0	0.0	0.0	0.0	0.0	216.5	0.0	0.5	0.0	0.0	0.0
	Gracilaria	AVG	0.2	0.0	0.0	0.0	0.0	0.0	74.5	0.0	3.3	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Ceramium	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GREEN														
		A	0.0	2.0	0.3	3.3	0.8	4.1	0.0	0.0	1.7	0.0	25.0	0.0
		B	0.0	18.5	0.0	16.8	0.0	0.2	0.2	0.0	9.5	0.0	6.9	0.0
		C	4.0	51.0	0.6	14.0	0.0	0.6	0.0	0.0	4.7	0.0	0.4	0.0
	Enteromorpha	AVG	1.3	23.8	0.3	11.4	0.3	1.6	0.1	0.0	5.3	0.0	10.8	0.0

HOLLY POND MACROALGAL BIOMASS (g/0.25m2)

MAY 28, 1986

GROUP SPECIES	QUAD	STA.1 1 SUB	1 INT	STA.2 2 SUB	2 INT	STA.3 3 SUB	3 INT	STA.4 4 SUB	4 INT	STA.5 5 SUB	5 INT	STA.6 6 SUB	6 INT
	A	0.0	29.3	50.0	37.3	0.0	122.8	572.2	0.0	669.0	0.0	0.0	0.0
	B	0.0	22.2	23.5	9.1	2.5	113.9	330.8	0.0	465.5	0.0	0.1	0.0
	C	0.0	91.9	75.5	0.0	4.9	95.3	663.2	0.0	660.3	0.0	0.0	0.0
Ulva	AVG	0.0	47.8	49.7	15.5	2.5	110.7	522.1	0.0	598.3	0.0	0.0	0.0
	A	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Cladophora	AVG	0.0	0.1	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spongomorpha	AVG	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percusaria	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0

Appendix Table E. Macoalgal biomass (g freshweight 0.25 m^{-2}) on September 13, 1986.

HOLLY POND

SEPT. 13, 1986

MACROALGAL BIOMASS
(g/0.25m2)

		STA.1		STA.2			STA.3		STA.4		STA.5	STA.6	
GROUP SPECIES	QUAD	1 SUB	1 INT	2 SUB	2 INT	2 INT'	3 SUB	3 INT	4 SUB	4 INT	5 SUB	6 SUB	6 INT
BROWN													
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Petalonia	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scytosiphon	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Laminaria	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	25.1	0.0	43.9	22.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	63.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fucus	AVG	0.0	29.7	0.0	14.6	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RED													
	A	3.6	0.0	0.4	0.0	0.0	112.4	0.1	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	79.5	19.1	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	134.9	0.0	0.0	0.0	0.0	0.0	0.0
Chondrus	AVG	1.2	0.0	0.1	0.0	0.0	108.9	6.4	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polysiphonia nigr.	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.8	0.3	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Polysiphonia harv.	AVG	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	1.9	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.8	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.0	0.0	0.0	0.0	0.0
Gracilaria	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.5	9.3	0.9	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ceramium	AVG	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	1.7	0.0	0.9	0.0	0.0	0.0	0.1	1672.5	10.9	597.4	0.0	0.0
	B	0.2	0.1	2.5	0.0	0.0	0.4	3.2	688.3	0.1	466.3	0.0	0.0
	C	0.7	0.0	0.4	0.0	0.0	0.1	0.0	624.1	0.0	356.2	0.0	0.0
Agardhiella	AVG	0.9	0.0	1.3	0.0	0.0	0.2	1.1	999.0	3.7	473.3	0.0	0.0

HOLLY POND

SEPT. 13, 1986

MACROALGAL BIOMASS
(g/0.25m2)

GROUP SPECIES	QUAD	STA.1 1 SUB	1 INT	STA.2 2 SUB	2 INT	2 INT'	STA.3 3 SUB	3 INT	STA.4 4 SUB	4 INT	STA.5 5 SUB	STA.6 6 SUB	6 INT
GREEN													
	A	0.0	6.9	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	31.5	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0
Enteromorpha	AVG	0.0	2.3	0.0	10.5	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0
	A	6.6	0.0	15.5	0.0	1.4	0.0	36.1	13.3	130.3	1.2	0.0	0.0
	B	6.1	0.1	9.1	5.2	0.0	0.8	26.2	0.0	55.6	0.0	0.0	0.0
	C	5.1	0.0	1.9	0.0	0.0	0.0	21.5	0.0	95.6	0.0	0.0	0.0
Ulva	AVG	5.9	0.0	8.8	1.7	0.5	0.3	27.9	4.4	93.8	0.4	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cladophora	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spongomorpha	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percusaria	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blidingia	AVG	0.0	0.0	0.0	1.4	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Codium	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0

Appendix Table F. Macoalgal biomass (g freshweight 0.25 m^{-2}) on March 6, 1987.

HOLLY POND

MACROALGAL BIOMASS
(g/0.25 m2)

MARCH 6, 1987

GROUP SPECIES	QUAD	STA.1 1 S	1 I	STA.2 2 S	2 I	STA.3 3 S	3 I	STA.4 4 S	4 I	STA.5 5 S	5 I	STA.6 6 S	6 I
BROWN													
	A	2.4	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Petalonia	AVG	0.8	0.0	.0	0.0	0.0	.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scytosiphon	AVG	0.3	0.0	0.0	0.0	0.0	.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	1381.0	0.0	156.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	1367.0	0.0	107.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	1453.0	0.0	13.4	0.0	0.0	0.0	107.5	0.0	0.0	0.0	0.0
Fucus	AVG	0.0	1400.3	0.0	92.7	0.0	0.0	0.0	35.8	0.0	0.0	0.0	0.0
	A	0.0	0.0	1.3	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.0	0.3
	B	3.6	0.0	28.2	0.0	1.0	1.0	0.1	0.0	0.0	0.3	0.0	0.3
	C	0.0	0.0	22.4	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.0	0.3
Diatoms	AVG	1.2	0.0	17.3	0.0	0.3	0.3	0.1	0.0	0.0	0.3	0.0	0.3
RED													
	A	3.5	0.0	0.0	0.0	105.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	2.6	0.0	0.0	0.0	198.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	118.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chondrus	AVG	2.1	0.0	0.0	0.0	140.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	201.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	221.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	1923.0	0.0	0.0	0.0	0.0	0.0
Agardhiella	AVG	0.0	0.0	0.0	0.0	0.0	0.0	781.7	0.0	0.0	0.0	0.0	0.0
GREEN													
	A	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Enteromorpha	AVG	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.1	0.0	0.0	.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ulva	AVG	0.0	.0	0.0	0.0	.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.1	0.0	27.5	0.0	1.3	0.0	5.7	0.0	0.0	0.0	0.0
	B	0.0	1.6	0.0	32.5	0.0	2.0	0.0	5.6	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	37.4	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0
Blidingia/ Urospora	AVG	0.0	0.6	0.0	32.5	0.0	1.1	0.0	4.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monostroma	AVG	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOLLY POND

MARCH 6, 1987

MACROALGAL BIOMASS
(g/0.25 m2)

GROUP SPECIES	QUAD	STA.1 1 S	1 I	STA.2 2 S	2 I	STA.3 3 S	3 I	STA.4 4 S	4 I	STA.5 5 S	5 I	STA.6 6 S	6 I
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Ulothrix	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Microspora	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3

Appendix Table G. Macoalgal biomass (g freshweight 0.25 m^{-2}) on June 16, 1987.

HOLLY POND

JUNE 16, 1987

MACROALGAL BIOMASS
(g/0.25 m2)

GROUP	SPECIES	QUAD	STA.1 1S	1I	1I'	STA.2 2S	2I	2I'	STA.3 3S	3I	STA.4 4S	4I	STA.5 5S	STA.6 6S
BROWN														
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Petalonia	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Scytosiphon	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Laminaria	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	1.2	538.0	0.0	0.0	0.0	36.0	0.0	0.0	4.4	0.0	0.0	0.0
		B	0.0	501.5	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	204.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fucus	AVG	0.4	414.7	0.0	0.0	0.0	12.1	0.0	0.0	1.5	0.0	0.0	0.0
RED														
		A	0.0	0.0	0.0	0.0	0.0	0.0	298.6	0.0	0.0	0.0	0.0	0.0
		B	21.7	0.0	0.0	0.0	0.0	0.0	321.2	0.0	0.0	0.0	0.0	0.0
		C	128.7	0.0	0.0	0.0	0.0	0.0	110.5	0.0	0.0	0.0	0.0	0.0
	Chondrus	AVG	50.1	0.0	0.0	0.0	0.0	0.0	243.4	0.0	0.0	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Polysiphonia nigr.	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	16.2	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.8	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0
	Polysiphonia harv.	AVG	0.0	0.0	0.0	0.0	0.0	0.0	5.4	0.0	6.3	0.0	0.0	0.0
		A	23.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	14.4	0.0	0.0	0.0	0.0	0.0	0.0	8.4	0.0
		C	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0
	Gracilaria	AVG	7.7	0.0	0.0	5.4	0.0	0.0	0.0	0.0	18.6	0.0	2.8	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Ceramium	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	40.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Agardhiella	AVG	13.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOLLY POND MACROALGAL BIOMASS (g/0.25 m2)

JUNE 16, 1987

GROUP SPECIES	QUAD	STA.1 1S	1I	1I'	STA.2 2S	2I	2I'	STA.3 3S	3I	STA.4 4S	4I	STA.5 5S	STA.6 6S
GREEN													
	A	0.0	0.0	0.0	0.0	6.0	0.0	0.0	58.3	0.0	93.0	0.0	30.1
	B	0.0	340.0	0.0	0.0	59.5	0.0	0.0	50.8	0.0	93.3	0.0	21.4
	C	0.0	0.0	0.0	0.0	66.5	0.0	0.0	38.6	0.0	170.3	0.0	56.8
Enteromorpha	AVG	0.0	113.3	0.0	0.0	44.0	0.0	0.0	49.2	0.0	118.9	0.0	36.1
	A	198.9	0.0	0.0	110.2	0.0	0.0	213.3	0.0	810.9	0.0	187.6	0.0
	B	397.0	0.1	0.0	158.3	0.0	0.0	127.6	0.0	888.8	0.0	71.9	0.0
	C	202.3	0.0	0.0	183.8	0.0	0.0	119.5	19.3	813.5	0.0	44.6	0.0
Ulva	AVG	266.1	0.0	0.0	150.8	0.0	0.0	153.5	6.4	837.7	0.0	101.4	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cladophora	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spongomorpha	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percusaria	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	360.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blidingia	AVG	0.0	0.0	120.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Codium	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix Table H. Macoalgal biomass (g freshweight 0.25 m^{-2}) on September 10, 1987.

HOLLY POND

SEPT. 10, 1987

TOTAL MACROALGAL BIOMASS
(g/0.25 m2)

GROUP SPECIES ZONE:	STA.1 1 S	1 I	STA.2 2 S	2 I	STA.3 3 S	3 I	STA.4 4 S	4 I	STA.5 5 S	5 I	STA.6 6 S	6 I
BROWN ALGAE	0.0	120.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fucus	0.0	120.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RED ALGAE	83.4	0.5	26.1	0.0	0.0	54.3	136.1	0.0	38.2	0.0	0.0	0.0
Chondrus	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polysiphonia harveyii	0.0	0.0	0.2	0.0	0.0	54.3	5.6	0.0	2.6	0.0	0.0	0.0
Gracilaria	53.1	0.1	0.7	0.0	0.0	0.0	19.3	0.0	1.4	0.0	0.0	0.0
Agardhiella	24.6	0.4	25.2	0.0	0.0	0.0	111.2	0.0	34.2	0.0	0.0	0.0
GREEN ALGAE	5.0	68.3	25.7	16.7	0.0	76.4	468.4	0.3	24.3	0.0	0.0	0.0
Enteromorpha	0.0	0.3	0.0	0.1	0.0	52.6	462.0	0.3	0.0	0.0	0.0	0.0
Ulva	5.0	4.1	25.4	16.6	0.0	20.2	6.4	0.0	24.3	0.0	0.0	0.0
Blidingia	0.0	64.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Codium	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Zones: S = Subtidal, I = Intertidal

HOLLY POND

MACROALGAL BIOMASS
(g/0.25 m2)

SEPT. 10, 1987

			STA.1			STA.2		STA.3			STA.4			STA.5	STA.6
GROUP	SPECIES	QUAD	1 S	1 I	1 I'	2 S	2 I	3 S	3 I	3 I'	4 S	4 I	4 I'	5 S	6 S
BROWN															
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Petalonia	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Scytosiphon	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Laminaria	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.0	254.7	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	195.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	149.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		D	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fucus	AVG	0.0	120.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RED															
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	21.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		D	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Chondrus	AVG	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Polysiphonia nigr.	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.9	0.0	0.0	271.3	0.0	0.9	0.0	0.0	2.7	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.2	0.0	0.0	3.1	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	7.2	0.0
		D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.4	0.0	0.0	0.0	0.0
	Polysiphonia harv.	AVG	0.0	0.0	0.0	0.2	0.0	0.0	54.3	0.0	5.6	0.0	0.0	2.6	0.0

HOLLY POND

SEPT. 10, 1987

MACROALGAL BIOMASS
(g/0.25 m2)

GROUP	SPECIES	QUAD	STA.1 1 S	1 I	1 I'	STA.2 2 S	2 I	STA.3 3 S	3 I	3 I'	STA.4 4 S	4 I	4 I'	STA.5 5 S	STA.6 6 S
		A	24.1	0.4	0.0	3.5	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.0
		B	156.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.5	0.0	0.0	6.3	0.0
		C	63.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.9	0.0	0.0	0.0	0.0
		D	17.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
		E	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0
	Gracilaria	AVG	53.1	0.1	0.0	0.7	0.0	0.0	0.0	0.0	19.3	0.0	0.0	1.4	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Ceramium	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	17.8	0.8	0.0	126.0	0.0	0.0	0.0	0.0	56.1	0.0	0.0	15.8	0.0
		B	47.1	1.0	0.0	0.0	0.0	0.0	0.0	0.0	111.5	0.0	0.0	143.4	0.0
		C	22.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	177.8	0.0	0.0	0.0	0.0
		D	18.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	203.5	0.0	0.0	11.6	0.0
		E	17.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.9	0.0	0.0	0.0	0.0
	Agardhiella	AVG	24.6	0.4	0.0	25.2	0.0	0.0	0.0	0.0	111.2	0.0	0.0	34.2	0.0
GREEN															
		A	0.0	0.9	0.0	0.0	0.6	0.0	0.0	281.0	455.0	0.0	1.7	0.0	0.0
		B	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	796.9	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	516.7	0.0	0.0	0.0	0.0
		D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	270.8	0.0	0.0	0.0	0.0
		E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	270.6	0.0	0.0	0.0	0.0
	Enteromorpha	AVG	0.0	0.3	0.0	0.0	0.1	0.0	0.0	56.2	462.0	0.0	0.3	0.0	0.0
		A	2.9	1.9	0.0	78.1	4.2	0.0	0.0	100.9	2.2	0.0	0.0	10.9	0.0
		B	10.7	18.4	0.0	13.0	79.0	0.0	0.0	0.0	19.8	0.0	0.0	1.9	0.0
		C	3.4	0.0	0.0	13.4	0.0	0.0	0.0	0.0	3.4	0.0	0.0	91.8	0.0
		D	3.8	0.0	0.0	12.2	0.0	0.0	0.0	0.0	0.4	0.0	0.0	2.5	0.0
		E	4.0	0.0	0.0	10.3	0.0	0.0	0.0	0.0	6.4	0.0	0.0	14.6	0.0
	Ulva	AVG	5.0	4.1	0.0	25.4	16.6	0.0	0.0	20.2	6.4	0.0	0.0	24.3	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cladophora	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Spongomorpha	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOLLY POND

MACROALGAL BIOMASS
(g/0.25 m2)

SEPT. 10, 1987

GROUP SPECIES	QUAD	STA.1 1 S	1 I	1 I'	STA.2 2 S	2 I	STA.3 3 S	3 I	3 I'	STA.4 4 S	4 I	4 I'	STA.5 5 S	STA.6 6 S
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percusaria	AVG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	321.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blidingia	AVG	0.0	0.0	64.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Codium	AVG	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix Table I. Macoalgal biomass (g freshweight 0.25 m^{-2}) on June 6, 1988.

HOLLY POND

TOTAL MACROALGAL BIOMASS
(g/0.25 m2)

JUNE 6, 1988

GROUP SPECIES ZONE:	STA.1 1 S	1 I	STA.2 2 S	2 I	STA.3 3 S	3 I	STA.4 4 S	4 I	STA.5 5 S	5 I	STA.6 6 S	6 I
BROWN ALGAE	339.2	2158.6	315.7	.0	299.9	0.2	17.5	0.0	31.5	0.0	0.0	0.0
Petalonia	324.3	0.0	0.0	0.0	4.0	0.2	17.5	0.0	31.5	0.0	0.0	0.0
Scytosiphon	1.0	3.7	0.5	.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Laminaria	8.3	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fucus	0.0	2154.9	313.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ectocarpus	5.6	0.0	0.0	0.0	295.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RED ALGAE	6.1	0.0	0.0	0.0	295.9	0.0	149.7	0.0	62.1	0.0	0.0	0.0
Chondrus	5.9	0.0	0.0	0.0	295.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polysiphonia harveyii	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agardhiella	0.2	0.0	0.0	0.0	0.0	0.0	144.8	0.0	61.8	0.0	0.0	0.0
Gracilaria	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.0	0.3	0.0	0.0	0.0
GREEN ALGAE	8.6	51.3	49.6	34.0	5.9	91.9	172.3	0.8	5.5	26.3	0.0	12.0
Enteromorpha	0.1	40.9	9.4	21.4	0.0	91.9	0.6	0.6	0.0	11.2	0.0	12.0
Ulva	8.5	0.0	40.2	11.6	5.9	0.0	171.7	0.0	5.5	15.1	0.0	0.0
Blidingia	0.0	10.4	0.0	1.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0

Zones: S = Subtidal, I = Intertidal

HOLLY POND MACROALGAL BIOMASS (g/0.25 m2)

JUNE 6, 1988

GROUP SPECIES	QUAD	STA.1 1 S	1 I	STA.2 2 S	2 I	STA.3 3 S	3 I	STA.4 4 S	4 I	STA.5 5 S	5 I	STA.6 6 S	6 I
BROWN													
	A	813.0	0.0	0.0	0.0	2.0	0.6	27.2	0.0	11.6	0.0	0.0	0.0
	B	118.2	0.0	0.0	0.0	0.0	0.0	15.5	0.0	31.1	0.0	0.0	0.0
	C	41.7	0.0	0.0	0.0	10.0	0.0	9.7	0.0	51.8	0.0	0.0	0.0
Petalonia	AVG	324.3	0.0	0.0	0.0	4.0	0.2	17.5	0.0	31.5	0.0	0.0	0.0
	A	1.1	6.8	0.3	.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.1	1.4	.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	1.8	2.8	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scytosiphon	AVG	1.0	3.7	0.5	.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.8	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	23.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Laminaria	AVG	8.3	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	1568.0	0.0	332.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	2391.0	0.0	166.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	2505.8	0.0	443.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fucus	AVG	0.0	2154.9	0.0	313.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ectocarpus	AVG	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RED													
	A	4.3	0.0	0.0	0.0	191.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	7.7	0.0	0.0	0.0	348.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	5.6	0.0	0.0	0.0	348.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chondrus	AVG	5.9	0.0	0.0	0.0	295.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polysiphonia harv.	AVG	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	A	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	185.0	0.0	0.0	0.0
	B	0.5	0.0	0.0	0.0	0.0	0.0	70.3	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	364.0	0.0	0.4	0.0	0.0	0.0
Agardhiella	AVG	0.2	0.0	0.0	0.0	0.0	0.0	144.8	0.0	61.8	0.0	0.0	0.0
	A	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.8	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.0	.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	10.1	0.0	0.0	0.0	0.0	0.0
Gracilaria	AVG	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.0	0.3	0.0	0.0	0.0
GREEN													
	A	0.2	45.6	6.7	29.5	0.0	162.4	0.9	0.9	0.0	1.3	0.0	15.0
	B	0.0	73.7	9.2	19.0	0.0	78.6	0.0	0.8	0.0	12.2	0.0	11.4
	C	0.1	3.5	12.4	15.7	0.0	34.7	1.0	0.0	0.0	20.0	0.0	9.7
Enteromorpha	AVG	0.1	40.9	9.4	21.4	0.0	91.9	0.6	0.5	0.0	11.2	0.0	12.0

HOLLY POND

MACROALGAL BIOMASS (g/0.25 m2)

JUNE 6, 1988

GROUP SPECIES	QUAD	STA.1 1 S	1 I	STA.2 2 S	2 I	STA.3 3 S	3 I	STA.4 4 S	4 I	STA.5 5 S	5 I	STA.6 6 S	6 I
	A	19.8	0.0	27.3	2.8	11.9	0.0	129.9	0.0	4.5	5.4	0.0	0.0
	B	5.7	0.0	33.9	9.0	5.9	0.0	157.6	0.0	0.0	38.7	0.0	0.0
	C	0.0	0.0	59.5	23.0	0.0	0.0	227.5	0.0	12.0	1.2	0.0	0.0
Ulva	AVG	8.5	0.0	40.2	11.6	5.9	0.0	171.7	0.0	5.5	15.1	0.0	0.0
	A	0.0	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	2.6	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	20.8	0.0	0.6	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
Blidingia	AVG	0.0	10.4	0.0	1.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0

Appendix Table J. Percent cover of macoalgae for 0.25 m^{-2} quadrats on May 28, 1986.

CANOPY PERCENT COVER MAY, 1986

Species	I-Subtidal A	B	C	X	I-Lower Intertidal A	B	C	X	I-Higher Intertidal A	B	C	X
RED ALGAE												
Chondrus	0	0	2	0.67	20	0	0	6.67	0	0	0	0.00
Gracilaria	0	0	1	0.33	0	0	1	0.33	0	0	0	0.00
Hildenbrandia	0	0	0	0.00	0	0	1	0.33	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	71	57	0	42.67
Laminaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Petalonia	12	10	3	8.33	0	43	0	14.33	0	0	0	0.00
Scytosiphon	0	0	1	0.33	1	1	0	0.67	0	0	0	0.00
GREEN ALGAE												
Blidingia	0	0	0	0.00	0	0	0	0.00	10	0	0	3.33
Enteromorpha	0	0	1	0.33	27	15	49	30.33	0	3	27	10.00
Ulothrix	0	0	0	0.00	0	0	0	0.00	1	1	0	0.67
Ulva	0	0	1	0.33	24	15	49	29.33	0	0	0	0.00
SUBSTRATE	rock				rock,mud sand				rock, barnacles			
	88	90	91	89.67	28	26	0	18.00	18	39	73	43.33
				100.00				100.00				100.00

CANOPY PERCENT COVER MAY, 1986

	II-Subtidal				II-Lower Intertidal				II-Upper Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Chondrus	0	0	0	0.00	0	0	0	0.00	0			0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00	0			0.00
Hildenbrandia	0	0	0	0.00	0	0	0	0.00	0			0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	5			5.00
Laminaria	5	4	0	3.00	0	0	0	0.00	0			0.00
Petalonia	0	3	0	1.00	0	0	0	0.00	0			0.00
Scytosiphon	8	9	13	10.00	1	1	1	1.00	0			0.00
Blidingia	0	0	0	0.00	0	0	0	0.00	5			5.00
Enteromorpha	0	0	0	0.00	9	2	5	5.33	0			0.00
Ulothrix	0	0	0	0.00	0	0	0	0.00	0			0.00
Ulva	17	4	18	13.00	14	13	8	11.67	0			0.00
SUBSTRATE	Mussel Bed				Mussel Bed				Rock,Pebbles,Sand			
	70	80	69	73.00	76	84	86	82.00	90			90.00
				100.00				100.00				100.00

CANOPY PERCENT COVER MAY, 1986

CANOPY PERCENT COVER

	III-Subtidal				III-Lower Intertidal				III-Upper Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Chondrus	60	60	1	40.33	4	4	0	2.67	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Hildenbrandia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Laminaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Petalonia	0	0	1	0.33	0	0	0	0.00	0	0	0	0.00
Scytosiphon	0	0	0	0.00	1	0	0	0.33	0	0	0	0.00
GREEN ALGAE												
Blidingia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Enteromorpha	0	0	0	0.00	0	0	0	0.00	100	100	100	100.00
Ulothrix	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Ulva	0	0	9	3.00	95	96	100	97.00				
SUBSTRATE	Sand				Sand & Rock				Rock & Cobble			
	40	40	89	56.33	0	0	0	0.00	0	0	0	0.00
				100.00				100.00				100.00

CANOPY PERCENT COVER MAY, 1986

	IV-Subtidal				V-Subtidal				VI-Subtidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Chondrus	0	0	0	0.00	0			0.00	0	0	0	0.00
Gracilaria	1	1	1	1.00	0			0.00	0	0	0	0.00
Hildenbrandia	0	0	0	0.00	1			1.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0			0.00	0	0	0	0.00
Laminaria	0	0	0	0.00	0			0.00	0	0	0	0.00
Petalonia	0	0	0	0.00	0			0.00	0	0	0	0.00
Scytosiphon	1	1	1	1.00	0			0.00	0	0	0	0.00
GREEN ALGAE												
Blidingia	0	0	0	0.00	0			0.00	0	0	0	0.00
Enteromorpha	0	0	0	0.00	0			0.00	40	5	1	15.33
Ulothrix	0	0	0	0.00	0			0.00	0	0	0	0.00
Ulva	98	98	98	98.00	99			99.00				
SUBSTRATE	Black Muck				Stony Gravel				Sand & Gravel Flat			
	0	0	0	0.00	0			0.00	60	95	99	84.67
				100.00				100.00				100.00

Appendix Table K. Percent cover of macoalgae for 0.25 m^{-2} quadrats on Sepember 13, 1986.

CANOPY PERCENT COVER SEPTEMBER, 1986

Species	I-Subtidal				I-Lower Intertidal			
Quadrat:	A	B	C	X	A	B	C	X
RED ALGAE								
Agardhiella	0	0	0	0.00	0	0	0	0.00
Chondrus	1	0	0	0.33	0	0	0	0.00
Gracilaria	1	1	1	1.00	0	0	0	0.00
Polysiphonia	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE								
Fucus	0	0	0	0.00	1	30	70	33.67
GREEN ALGAE								
Blidingia	0	0	0	0.00	0	0	0	0.00
Enteromorpha	0	0	0	0.00	50	0	4	18.00
Ulva	10	9	7	8.67	0	4	0	1.33
SUBSTRATE	Sand				Rock			
	88	90	92	90.00	49	66	26	47.00
				100.00				100.00

CANOPY PERCENT COVER SEPTEMBER, 1986

	II-Subtidal				II-Lower Intertidal				II-Upper Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Agardhiella	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Chondrus	1	0	0	0.33	0	0	0	0.00	0	0	0	0.00
Gracilaria	1	2	1	1.33	0	0	0	0.00	0	0	0	0.00
Polysiphonia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	17	17	0	11.33
GREEN ALGAE												
Blidingia	0	0	0	0.00	0	0	0	0.00	9	25	0	11.33
Enteromorpha	0	0	0	0.00	9	25	0	11.33	14	7	8	9.67
Ulva	11	11	5	9.00	0	4	0	1.33	0	0	0	0.00
SUBSTRATE	Mussels, rock & sand				Rock & Sand				Mussels,rocks & pebbles			
	87	87	94	89.33	91	71	100	87.33	60	51	92	67.67
				100.00				100.00				100.00

CANOPY PERCENT COVER   SEPTEMBER, 1986

	III-Subtidal				III-Lower Intertidal			
Quadrat:	A	B	C	X	A	B	C	X
RED ALGAE								
Agardhiella	0	1	0	0.33	0	3	0	1.00
Chondrus	15	23	25	21.00	0	4	0	1.33
Gracilaria	0	0	0	0.00	0	0	0	0.00
Polysiphonia	0	1	0	0.33	0	0	0	0.00
BROWN ALGAE								
Fucus	0	0	0	0.00	0	0	0	0.00
GREEN ALGAE								
Blidingia	0	0	0	0.00	0	0	0	0.00
Enteromorpha	0	0	0	0.00	4	0	3	2.33
Ulva	0	1	0	0.33	55	32	33	40.00
SUBSTRATE	Sand				Sand & Rock			
	85	74	75	78.00	41	61	64	55.33
				100.00				100.00

CANOPY PERCENT COVER SEPTEMBER, 1986

	IV-Lower Intertidal				V-Lower Intertidal				VI-Lower Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Agardhiella	100	100	93	97.67	0	0	0	0.00	0	0	0	0.00
Chondrus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Polysiphonia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
GREEN ALGAE												
Blidingia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Enteromorpha	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Ulva	0	0	7	2.33	100	100	100	100.00				
SUBSTRATE	Black Muck				Stony Gravel				Sand & Gravel Flat			
	0	0	0	0.00	0	0	0	0.00	100	100	100	100.00
				100.00				100.00				100.00

Appendix Table L. Percent cover of macoalgae for 0.25 m^{-2} quadrats on March 6, 1987.

CANOPY PERCENT COVER MARCH, 1987

Species	I-Subtidal A	B	C	X	I-Lower Intertidal A	B	C	X	I-Higher Intertidal A	B	C	X
RED ALGAE												
Chondrus	4	3	0	2.33	2	0	0	0.67	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	1	0.33	0	0	0	0.00
Hildenbrandia	0	0	0	0.00	0	0	1	0.33	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	80	79	84	81.00
Laminaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Petalonia	1	0	0	0.33	0	1	1	0.67	0	0	0	0.00
Scytosiphon	0	0	1	0.33	2	1	0	1.00	0	0	0	0.00
GREEN ALGAE												
Blidingia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Enteromorpha	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Ulothrix	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Ulva	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
SUBSTRATE	Rock				Rock				Rock			
	95	97	99	97.00	96	98	97	97	20	21	16	19
				100.00				100.00				100.00

CANOPY PERCENT COVER MARCH, 1987

	II-Subtidal				II-Lower Intertidal				II-Upper Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Chondrus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Hildenbrandia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	35	24	3	20.67
Laminaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Petalonia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Scytosiphon	1	0	0	0.33	0	0	0	0.00	0	0	0	0.00
Diatoms	4	88	70	54.00	0	0	0	0.00	0	0	0	0.00
Blidingia	0	0	0	0.00	0	0	0	0.00	50	59	68	59.00
Enteromorpha	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Ulothrix	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Ulva	2	0	0	0.67	0	0	0	0.00	0	0	0	0.00
SUBSTRATE	Mussel Bed				Rock, pebbles sand				Rock,Pebbles,Sand			
					0	73	36	36.33	6	9	3	6.00
	93	12	30	45	Mussel Bed				Mussel shells			
					100	27	64	63.67	9	8	26	14.33
				100.00				100.00				100.00

CANOPY PERCENT COVER MARCH, 1987

	III-Subtidal				III-Intertidal			
Quadrat:	A	B	C	X	A	B	C	X
RED ALGAE								
Chondrus	24	45	27	32.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00
Hildenbrandia	0	0	0	0.00	0	0	0	0.00
Porphyra	2	5	0	2.33				
BROWN ALGAE								
Fucus	0	0	0	0.00	0	0	0	0.00
Laminaria	0	0	0	0.00	0	0	0	0.00
Petalonia	0	0	0	0.00	0	1	0	0.33
Scytosiphon	0	0	0	0.00	0	0	1	0.33
Diatoms	0	0	0	0.00	0	3	0	1.00
GREEN ALGAE								
Blidingia	0	0	0	0.00	19	28	0	15.67
Enteromorpha	0	1	0	0.33	0	0	0	0.00
[illegible]arix	0	0	0	0.00	0	0	0	0.00
Ulva	1	0	0	0.33	0	0	33	11.00
Monostroma	5	0	20	8.33	0	0	1	0.33
SUBSTRATE	Sand				Sand & Rock			
	68	49	53	56.67	81	68	65	71.33
				100.00				100.00

CANOPY PERCENT COVER MARCH, 1987

	IV-Subtidal				IV-Intertidal			
Quadrat:	A	B	C	X	A	B	C	X
RED ALGAE								
Chondrus	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00
Hildenbrandia	0	0	0	0.00	0	0	0	0.00
Agardhiella	91	100	87	92.67	0	0	0	0.00
BROWN ALGAE								
Fucus	0	0	0	0.00	0	0	24	8.00
Laminaria	0	0	0	0.00	0	0	0	0.00
Petalonia	0	0	0	0.00	0	0	0	0.00
Scytosiphon	0	0	0	0.00	0	0	0	0.00
GREEN ALGAE								
Blidingia	0	0	0	0.00	81	80	9	56.67
Enteromorpha	0	0	0	0.00	0	0	0	0.00
Ulothrix	0	0	0	0.00	0	0	0	0.00
Ulva	0	0	0	0.00	0	0	0	0.00
SUBSTRATE								
	Black Muck				Black Muck			
	9	0	13	7.33	19	20	67	35.33
				100.00				100.00

CANOPY PERCENT COVER MARCH, 1987

	V-Subtidal				VI-Subtidal			
Quadrat:	A	B	C	X	A	B	C	X
RED ALGAE								
Chondrus	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00
Hildenbrandia	0	0	0	0.00	0	0	0	0.00
Agardhiella	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE								
Fucus	0	0	0	0.00	0	0	0	0.00
Laminaria	0	0	0	0.00	0	0	0	0.00
Petalonia	0	0	0	0.00	0	0	0	0.00
Scytosiphon	0	0	0	0.00	0	0	0	0.00
Diatoms	1	1	1	1.00	1	1	1	1.00
GREEN ALGAE								
Blidingia	0	0	0	0.00	0	0	0	0.00
Enteromorpha	0	0	0	0.00	0	0	0	0.00
Ulothrix	0	0	0	0.00	0	0	0	0.00
Ulva	0	0	0	0.00	1	1	1	1.00
SUBSTRATE								
Black Muck	99	99	99	99.00	98	98	98	98.00
				100.00				100.00

Appendix Table M. Percent cover of macoalgae for 0.25 m^{-2} quadrats on June 16, 1987.

CANOPY PERCENT COVER JUNE 16, 1987

Species	I-Subtidal				I-Lower Intertidal				I-Higher Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Chondrus	0	0	17	5.67	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	1	0.33	0	0	0	0.00	0	0	0	0.00
Hildenbrandia	0	0	1	0.33	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	95	79	73	82.33	0	0	2	0.67
Laminaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Petalonia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Scytosiphon	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
GREEN ALGAE												
Blidingia	0	0	0	0.00	0	0	0	0.00	54	54	10	39.33
Enteromorpha	54	50	38	47.33	0	1	0	0.33	0	0	0	0.00
Ulothrix	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Ulva	42	50	38	43.33	0	9	13	7.33	0	0	0	0.00
SUBSTRATE	Rock/sand/gravel				Barnacles/mussels/oyster				Barnacles/rock			
	4	0	5	3.00	5	11	14	10.00	46	46	88	60.00
				100.00				100.00				100.00

CANOPY PERCENT COVER JUNE 16, 1987

	II-Subtidal				II-Lower Intertidal				II-Upper Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Chondrus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Hildenbrandia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	5	1	0	2.00
Laminaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Petalonia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Scytosiphon	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Blidingia	0	0	0	0.00	0	0	0	0.00	9	1	30	13.33
Enteromorpha	1	0	0	0.33	1	41	43	28.33	0	0	0	0.00
Ulothrix	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Ulva	80	93	100	91.00	10	40	40	30.00	0	0	0	0.00
SUBSTRATE	Rock/mussels				Mussel/mud/shell/pebbles				Bare rock/barnacles			
	19	7	0	8.67	89	19	17	41.67	86	98	70	84.67
				100.00				100.00				100.00

CANOPY PERCENT COVER JUNE 16, 1987

	III-Subtidal				IV-Subtidal				IV-Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
					0	0	0	0.00	0	0	0	0.00
Chondrus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Hildenbrandia	0	0	0	0.00	0	6	0	2.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Laminaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Petalonia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Scytosiphon	0	0	0	0.00								
GREEN ALGAE												
Blidingia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Enteromorpha	34	38	33	35.00	0	0	0	0.00	80	57	0	45.67
Ulothrix	0	0	0	0.00	100	94	100	98.00	3	0	100	34.33
Ulva	34	15	20	23.00								
SUBSTRATE	Bare rock				Mud							
	32	47	47	42.00	0	0	0	0.00	17	43	0	20.00
				100.00				100.00				100.00

CANOPY PERCENT COVER JUNE 16, 1987

	V-Intertidal				VI-Intertidal			
Quadrat:	A	B	C	X	A	B	C	X
RED ALGAE								
Agardhiella	0	0	0	0.00	0	0	0	0.00
Chondrus	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00
Polysiphonia	0	0	2	0.67	0	0	0	0.00
BROWN ALGAE								
Fucus	0	0	0	0.00	0	0	0	0.00
Diatoms	0	0	0	0.00	0	0	0	0.00
Petalonia	0	0	0	0.00	0	0	0	0.00
GREEN ALGAE								
Blidingia	0	0	0	0.00	0	0	0	0.00
Enteromorpha	0	8	6	4.67	92	100	90	94.00
Ulva	100	85	14	66.33	0	0	0	0.00
SUBSTRATE								
	0	7	78	28.33	8	0	10	6.00
				100.00				100.00

Appendix Table N. Percent cover of macoalgae for 0.25 m^{-2} quadrats on September 10, 1987.

CANOPY PERCENT COVER SEPTEMBER 10, 1987

Species	I-Subtidal				I-Lower Intertidal				I-Upper Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Agardhiella	14	8	4	8.67	0	0	0	0.00	0	0	0	0.00
Chondrus	0	2	4	2.00	0	0	0	0.00	0	0	0	0.00
Gracilaria	6	30	19	18.33	0	0	0	0.00	0	0	0	0.00
Polysiphonia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	72	58	98	76.00	2	4	2	2.67
Scytosiphon	1	0	0	0.33	0	0	0	0.00	0	0	0	0.00
GREEN ALGAE												
Blidingia	0	0	0	0.00	0	0	0	0.00	28	68	35	43.67
Enteromorpha	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Ulva	3	2	1	2.00	0	0	0	0.00	0	0	0	0.00
SUBSTRATE	Sand/pebbles/shell/rock				Rock/barnacles/mussels				Bare rock, barnacles			
	76	58	72	68.67	28	42	2	24.00	70	28	63	53.67
				100.00				100.00				100.00

CANOPY PERCENT COVER SEPTEMBER 10, 1987

	II-Subtidal				II-Lower Intertidal				II-Upper Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Agardhiella	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Chondrus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Polysiphonia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
GREEN ALGAE												
Blidingia	0	0	0	0.00	0	0	0	0.00	10	7	23	13.33
Enteromorpha	0	0	0	0.00	26	1	0	9.00	0	0	0	0.00
Ulva	26	12	16	18.00	26	17	2	15.00	0	0	0	0.00
SUBSTRATE	Mussels,rock & sand				Rock/sand/barnacles/shell				Mussels,rocks & pebbles			
	74	88	84	82.00	48	82	98	76.00	90	93	77	86.67
				100.00				100.00				100.00

CANOPY PERCENT COVER SEPTEMBER 10, 1989

	III-Subtidal				III-Upper Subtidal				III-Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Agardhiella	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Chondrus	16	5	13	11.33	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Polysiphonia	0	0	0	0.00	32	86	51	56.33	1	3	0	1.33
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
GREEN ALGAE												
Blidingia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Enteromorpha	0	0	0	0.00	0	0	0	0.00	3	17	15	11.67
Ulva	0	0	0	0.00	1	0	2	1.00	33	0	64	32.33
SUBSTRATE	Sand/mud/rock				Sand/rock/gravel				Pebbles/rock/sand/gravel			
	84	95	87	88.67	67	14	47	42.67	63	80	21	54.67
				100.00				100.00				100.00

CANOPY PERCENT COVER SEPTEMBER 10, 1987

	IV-Subtidal				IV-Intertidal			
Quadrat:	A	B	C	X	A	B	C	X
RED ALGAE								
Agardhiella	16	0	10	8.67	0	0	0	0.00
Chondrus	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00
Polysiphonia	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE								
Fucus	0	0	0	0.00	0	0	0	0.00
GREEN ALGAE								
					0	0	1	0.33
Blidingia	0	0	0	0.00	11	2	9	7.33
Enteromorpha	84	100	90	91.33	0	0	0	0.00
Ulva	0	0	0	0.00	0	0	0	0.00
SUBSTRATE	Black muck				Bare rock			
	0	0	0	0.00	89	98	90	92.33
				100.00				100.00

CANOPY PERCENT COVER SEPTEMBER 10, 1987

	V-Subtidal				V-Intertidal				VI-Lower Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Agardhiella	0	0	3	1.00	0	0	0	0.00	0	0	0	0.00
Chondrus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Polysiphonia	0	3	0	1.00	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
GREEN ALGAE												
Ulvaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Blidingia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Enteromorpha	0	0	0	0.00	0	1	5	2.00	15	0	0	5.00
Ulva	94	1	6	33.67	14	15	10	13.00	0	0	0	0.00
SUBSTRATE	Soft mud				Muds				Sand & Gravel Flat			
	6	96	91	64.33	86	84	85	85.00	85	100	100	95.00
				100.00				100.00				100.00

Appendix Table O. Percent cover of macoalgae for 0.25 m^{-2} quadrats on June 6, 1988.

CANOPY PERCENT COVER JUNE, 1988

Species	I-Subtidal				I-Lower Intertidal				I-Higher Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Chondrus	2	0	1	1.00	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Hildenbrandia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	2	14	74	30.00	40	61	64	55.00
Laminaria	4	0	20	8.00	0	0	0	0.00	0	0	0	0.00
Petalonia	79	97	35	70.33	0	0	0	0.00	0	0	0	0.00
Scytosiphon	0	0	0	0.00	5	1	2	2.67	0	0	0	0.00
GREEN ALGAE												
Blidingia	0	0	0	0.00	0	0	0	0.00	6	2	16	8.00
Enteromorpha	0	0	0	0.00	39	63	3	35.00	0	0	0	0.00
Ulothrix	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Ulva	6	3	0	3.00	0	0	0	0.00	0	0	0	0.00
SUBSTRATE												
	9	0	44	17.67	54	22	21	32.33	54	37	20	37.00
				100.00				100.00				100.00

CANOPY PERCENT COVER JUNE, 1988

	II-Subtidal				II-Lower Intertidal				II-Upper Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Chondrus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Hildenbrandia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	12	6	16	11.33
Laminaria	5	0	0	1.67	0	0	0	0.00	0	0	0	0.00
Petalonia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Scytosiphon	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Blidingia	0	0	0	0.00	0	0	0	0.00	0	8	2	3.33
Enteromorpha	1	0	0	0.33	0	0	0	0.00	0	0	0	0.00
Ulothrix	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Ulva	28	36	71	45.00	19	26	64	36.33	0	0	0	0.00
SUBSTRATE												
	66	64	29	53.00	81	74	36	63.67	88	86	82	85.33
				100.00				100.00				100.00

CANOPY PERCENT COVER JUNE, 1988

III-Subtidal Quadrat:	A	B	C	X	III-Intertidal A	B	C	X
RED ALGAE								
Chondrus	11	20	20	17.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00
Hildenbrandia	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE								
Fucus	0	0	0	0.00	0	0	0	0.00
Laminaria	0	0	0	0.00	0	0	0	0.00
Petalonia	2	0	10	4.00	0	0	0	0.00
Scytosiphon	0	0	0	0.00	0	0	0	0.00
GREEN ALGAE								
Blidingia	0	0	0	0.00	0	0	0	0.00
Enteromorpha	0	0	0	0.00	100	60	45	68.33
Ulothrix	0	0	0	0.00	0	0	0	0.00
Ulva	4	2	0	2.00	0	0	0	0.00
SUBSTRATE								
	83	78	70	77.00	0	40	55	31.67
				100.00				100.00

(Right-hand table heading: CANOPY PERCENT COVER)

CANOPY PERCENT COVER JUNE, 1988

	IV-Subtidal				IV-Intertidal			
Quadrat:	A	B	C	X	A	B	C	X
RED ALGAE								
Agardhiella	0	12	8	6.67	0	0	0	0.00
Chondrus	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00
Polysiphonia	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE								
Fucus	0	0	0	0.00	0	0	0	0.00
Diatoms	0	0	0	0.00	0	0	0	0.00
Petalonia	0	0	0	0.00	0	0	0	0.00
GREEN ALGAE								
Blidingia	0	0	0	0.00	0	0	17	5.67
Enteromorpha	0	0	0	0.00	100	87	0	62.33
Ulva	100	88	92	93.33	0	0	0	0.00
SUBSTRATE								
	0	0	0	0.00	0	13	83	32.00
				100.00				100.00

CANOPY PERCENT COVER JUNE, 1988

	V-Subtidal				V-Intertidal				VI-Intertidal			
Quadrat:	A	B	C	X	A	B	C	X	A	B	C	X
RED ALGAE												
Agardhiella	4	4	0	2.67	0	0	0	0.00	0	0	0	0.00
Chondrus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Gracilaria	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Polysiphonia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
BROWN ALGAE												
Fucus	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Diatoms	0	0	0	0.00	0	0	0	0.00	1	1	1	1.00
Petalonia	8	3	3	4.67	0	0	0	0.00	0	0	0	0.00
GREEN ALGAE												
Blidingia	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Enteromorpha	0	0	0	0.00	1	8	30	13.00	17	13	11	13.67
Ulva	2	0	0	0.67	4	92	0	32.00	0	0	0	0.00
SUBSTRATE												
	86	93	97	92.00	95	0	70	55.00	82	86	88	85.33
				100.00				100.00				100.00