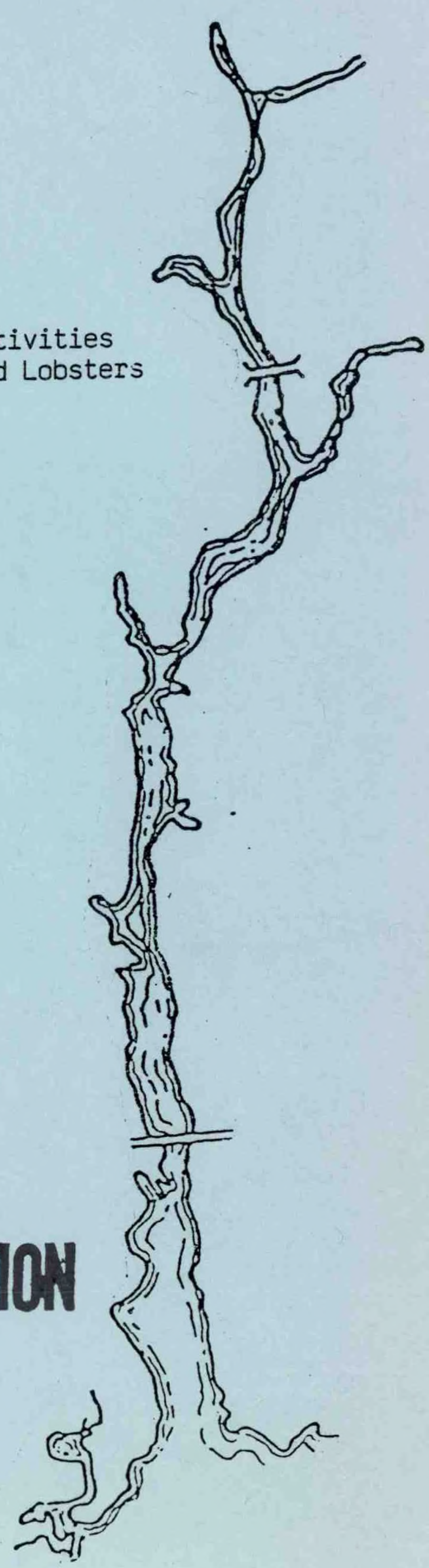
Connecticut Coastal Zone Management Program

The Effects of Energy-related Transport Activities on Benthic Marine Plants, Fish, Shellfish and Lobsters in the Thames River Estuary

Marine Sciences Institute
University of Connecticut

Final Report

November 1, 1984



The Effects of Energy-related Transport Activities on Benthic Marine Plants, Fish, Shellfish and Lobsters in the Thames River Estuary

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Final Report

to

Office of Policy and Management
State of Connecticut

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Financial assistance for this document has been provided by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration of the U.S. Department of Commerce under the Coastal Zone Management Act of 1972 as amended, which assistance is administered by the State of Connecticut, Office of Policy and Management.

ACKNOWLEDGMENT

The authors gratefully acknowledge the contributions of the following scientists and technicians at the Marine Sciences Institute:

Peter Auster
Prentiss Balcom
John Bayreuther
Kurt Buchholz
Nancy Buermeyer
Larry Burch
Donna Johnson
Art Lima
Spencer Trombley
Susan Wolf

Thanks are due also to Sidney Quarrier of the CT Department of Natural Resources for providing photogrammetric base maps, to Ron Rozsa and Jessie Arnold of the CT Coastal Area Management program for providing coastal survey information, and to Dr. Donald Rhoads of Yale University and Mr. William Cox of the CT Office of Policy and Management for their guidance during the project and review of this manuscript.

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There are no pages numbered 5 and 75. However, no text, tables or figures have been omitted.

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1.0 Introduction

1.1 Objectives

This study was undertaken to assess the distribution and abundance of marine plant beds in and near New London Harbor, their importance to finfish and shellfish of the area, and their potential vulnerability to further development of the harbor as a major energy port. The work was designed and conducted by personnel of the Marine Sciences Institute of the University of Connecticut in 1983.

The waters of eastern Long Island Sound are relatively pristine compared with the central and western Sound. Since a comprehensive ecosystem study of this area has never been undertaken, this study provides an initial step toward that goal. It establishes an ecological data base with special emphasis on benthic plants and associated animal communities by:

1. Collating data from previous studies.
2. Conducting new field studies to identify, quantify, locate and evaluate plant communities.
3. Integrating the previous studies and the new field results into an ecosystem framework.
4. Applying the composited ecological information to CEIP management goals.

The primary frame of reference is the lower harbor of the Thames River where most of the port expansion is expected to occur.

1.2 How this study addresses CEIP goals

Dramatic increases in petroleum imports in recent years and additional proposals for marine development indicate that the Thames River represents an under-utilized port which will be expanding. Energy industries and energy-user industries, including the substantial government presence in the area, will increase the demand for energy products.

Port development presents potential hazards to marine plant communities and the finfish, shellfish and lobster populations dependent on them for food and habitat. The plants may be lost completely through dredging, facilities construction or high physical stress associated with frequent vessel traffic. Their function may be lost or impaired by increased turbidity of the water or additions of pollutants. Turbidity may reduce their production capacity, while pollutants may become adsorbed to their fronds or incorporated into their tissues. Any significant damage to the habitat or reduction and pollution of the food supply may be expected to affect associated animal populations.

This study focuses on marine plants as a basic support component of the Thames River ecosystem. It seeks to provide answers to the following questions:

1. Is there any evidence that present levels of energy-related transport and transfer activities are impacting benthic plants in the Thames River area to the detriment of finfish and shellfish?
2. Is there any evidence that expansion of energy-related activities in this river will cause impact?
3. What types of management procedures might be implemented to minimize any impacts?

1.3 Summary of Major Results

1.3.1 Ecological Characteristics

Benthic macrophyte communities of the New London Harbor area were found to be far more widespread and diverse than previous studies have indicated. Eelgrass beds were relatively localized, but benthic algae were not confined to hardrock areas as conventionally assumed; they occupied extensive areas of soft bottom, utilizing cobbles, gravel, shell, worm tubes and debris as substrate for attachment.

Most of the plant beds were located in the lower harbor and adjacent coastal waters; no significant growth areas were found north of the White Island / Green's Harbor area.

Many of the algal species had seasonal patterns of abundance. Compared to highly fluctuating seasonal abundances of phytoplankton, the macroalgal communities were relatively stable. Median biomass levels for spring and summer respectively were 484 and 540 gdw/m^2 (grams dry weight per square meter), about twice as high as winter and fall levels (320 and 339 gdw/m^2).

The areas with the greatest seasonal variations in biomass were those exposed to fall and winter storms and heavily dominated by kelp because the plants were torn loose from larger rocks or simply weighed their moorings on smaller rocks and drifted away. Studies conducted only during stormy seasons in such areas will grossly underestimate plant production, and our results have provided a re-evaluation for one such under-assessment involving the proposed Black Ledge containment site.

Drift algae were ubiquitous to the area and appeared to be in a healthy, productive state, forcing a re-evaluation of their functional status; conventionally, drift algae are assumed to be in a state of death and decay, unless they are one of the recognized pelagic species such as *Sargassum*. A high degree of mobility during the lifetime of traditionally attached species appears to be a characteristic of this area. Such mobility greatly extends their range of influence within the river and adjacent coastal waters.

The presence of macrophytes greatly increased living space per unit area compared to bare substrate; the plant beds were found to be supporting animal assemblages which were richly varied, extremely abundant, and active year-round. Some of the most abundant epifauna were species known to be prime food items for important finfish and shellfish of the local commercial and recreational fishery. The plant beds were also utilized as nursery areas for the young of many large species, including local fishery species.

The area supports a healthy ecosystem despite its history of industrial and military use as a port. A key to the stability and resiliency of the system is believed to lie in the diversity and heterogeneity of its structural elements. This stability probably due in large measure to the presence of the widespread, abundant and heterogeneous macroalgal community. Of the three types of primary producers within the system, phytoplankton, eelgrass and macroalgae, the macroalgae impart the greatest spatial and temporal stability to their associated communities.

1.3.2 Management considerations

The present study found that major subtidal algal beds are spatially separated from industrialized zones of the harbor, and that intertidal algae were sparse along industrialized shorelines as were biota taken in benthic dredge hauls adjacent to those shorelines, all of which indicate that present port activities are affecting the harbor ecosystem. There were no major benthic plant beds north of the Green's Harbor area.

Past studies of benthic infauna in the harbor channel indicate that the area is physically stressed. Such stress may well be attributed directly to vessel traffic, dredging and associated port activites. Heavy pollution stress was found in vessel berthing and launching areas and near municipal and industrial outfalls.

On the other hand, this study detected no evidence for direct impact from transiting vessels on major algal beds located immediately adjacent to the channel at the mouth of the harbor, and no evidence for impact from present port activities on animal communities associated with these algal beds.

With careful planning and management, the New London Harbor area can probably accommodate expansion of port activities without greatly increasing impacts beyond present levels, providing port development is confined to inner harbor areas north of the major algal beds. The proposed location of the DOT coal facility meets this requirement. It is strongly recommended that the proposal to build a dredge spoil containment basin on Black Ledge be discarded on both ecological and hydrological grounds. Building a barrier at the western entrance to Pine Island Bay may be advisable. The barrier was originally sought to protect the embayment from storm surges, but it may be even more useful in protecting the Poquonnock River shellfish and macrophyte beds from harbor pollution.

The following ecological hazards have been identified with respect to port development activities:

1. Increased potential for grounding and collision associated with increased traffic within a narrow harbor, limited berthing and anchorage facilities, frequency of heavy fog, and strategic nature

the harbor as a military port.

2. Chronic and episodic spills of petroleum and other hazardous cargo from grounding or collision in the harbor or harbor approaches, transfer activities at the port, or seepage from storage facilities.

3. Dredging, if it is conducted within plant beds or during critical spawning or migration periods.

4. Loss of habitat areas to port development if such development is not confined to upper harbor areas north of the algal habitats or if major vessel anchorage basins are developed within the harbor.

A number of countermeasures could be addressed in the planning stages of port development which would greatly reduce the potential for impact.

1. Localized physical damage and turbidity adjacent to port facilities could be minimized if port development were focused along shorelines which are already impacted and if management plans were devised to control traffic levels within the river, enforce safe docking and transfer procedures, enforce deployment of protective barriers during transfers and provide for rapid detection and response when spills occur.

2. Depending on the degree of spillage, the location, and the tidal and meteorological conditions, it is highly likely that a moderate to heavy spill of oil or other pollutants in the harbor would necessitate rapid action to prevent the pollutant from spreading to algal beds, from being carried upstream to areas of lowered oxygen content or from blocking off the river as a zone of passage. If plant beds or drifting plants become contaminated, they may have to be removed to landfill areas. The procurement of appropriate equipment and landfill dumping permits in anticipation of these special environmental needs would mitigate the pollution hazard by reducing the response time to a major spill.

3. Operational procedures could be developed for the protection of critical areas such as algal beds, zones of passage, spawning and nursery areas and shellfish beds. An accurate hydrologic model is needed to predict the movement of pollutants from specific potential point sources created by port activities under a variety of meteorological conditions specific to New London Harbor. Better information should be gathered on the soft-bottom communities of the shoal areas of the lower harbor and the ecosystem north of the study area included in this report. A program could be devised to continue baseline surveillance of water quality and ecological resources of the river, including commercial and recreational landings of fish and shellfish.

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2.0 Collation of Previous Studies

2.1 The Thames River as an Energy Port

The Thames River is an estuary 25.8 km (12 mi) long located in Southeastern Connecticut beginning at Norwich, CT, and terminating at the juncture of Long Island Sound and Fishers Island Sounds (Fig.2-1). It receives significant waterbourne traffic at ports located all along its length from the New London/Groton area to the city of Norwich, at its head (Fig. 2-2). In the lower harbor, Pfizer Pharmaceutical, Hess Oil Company, and the Electric Boat Division of General Dynamics line the east bank of the river. On the west bank are City Coal Company, Naval Underwater Systems Center, New London City and Connecticut State Piers, and terminals for three ferry lines. North of the I-95 bridge are the Coast Guard Academy, U.S. Navy Submarine Base, a Northeast Utilities fossil fuel power station, and Dow Chemical Company. Small tankers carry home heating oil and other petroleum products to the city of Norwich at the head of the river.

Coal, petroleum products and chemicals have been the leading commodities of waterborne traffic to the river. Imports of petroleum products, including kerosene, gasoline, distilled oil and residual oil, totalled 590,960 short tons in 1971 (8), 3,032,978 short tons in 1976 (5), and 3,386,175 short tons in 1979 (31), for an increase of 473% in petroleum imports between 1971 and 1979. In addition, 225 short tons of fuel wood and charcoal were imported in 1979.

New London Harbor has the greatest potential for expanson of commercial traffic of all the harbors on the Connecticut shoreline, and there are strong incentives to increase its energy-related traffic. The Navy has recently dredged the harbor to 42 feet (12.8 m) at mean low water which makes it deeper by 7 feet than the two other major harbors in the state, New Haven and Bridgeport (31). New London is by far the closest port to the ocean, being located less than five nautical miles (9.3 km) north of the exit from Long Island Sound at The Race.

The New England River Basins Commission has proposed that all petroleum receiving and distribution facilities in Connecticut be consolidated into three ports, New London, New Haven and Bridgeport, and that all tank storage facilities be located inland from the receiving port, thus alleviating any limitations New London might have as a port due to non-availability of dockside acreage for storage tanks (14).

Waterborne coal traffic on the Sound stood at 3.5 million tons in the mid-60's, but was phased out entirely by 1971 (8). However, the last energy crisis and the establishment of Project Independence, a movement to reduce New England's reliance on foreign oil, has brought about serious interest in re-establishing coal as a fuel base here (14). The present Persian Gulf tensions reinforce the assumption that energy crises will be repetitive events for the industrialized world. The DOT has recommended that if a coal terminal is to be built in Connecticut, it should be sited at Winthrop Point beneath the I-95 highway bridge (Fig. 2-2) and that New London should provide coal service to the entire state. The projected annual demand is 2,360,000

Figure 2-1 Location of the Thames River system in southeastern Connecticut.

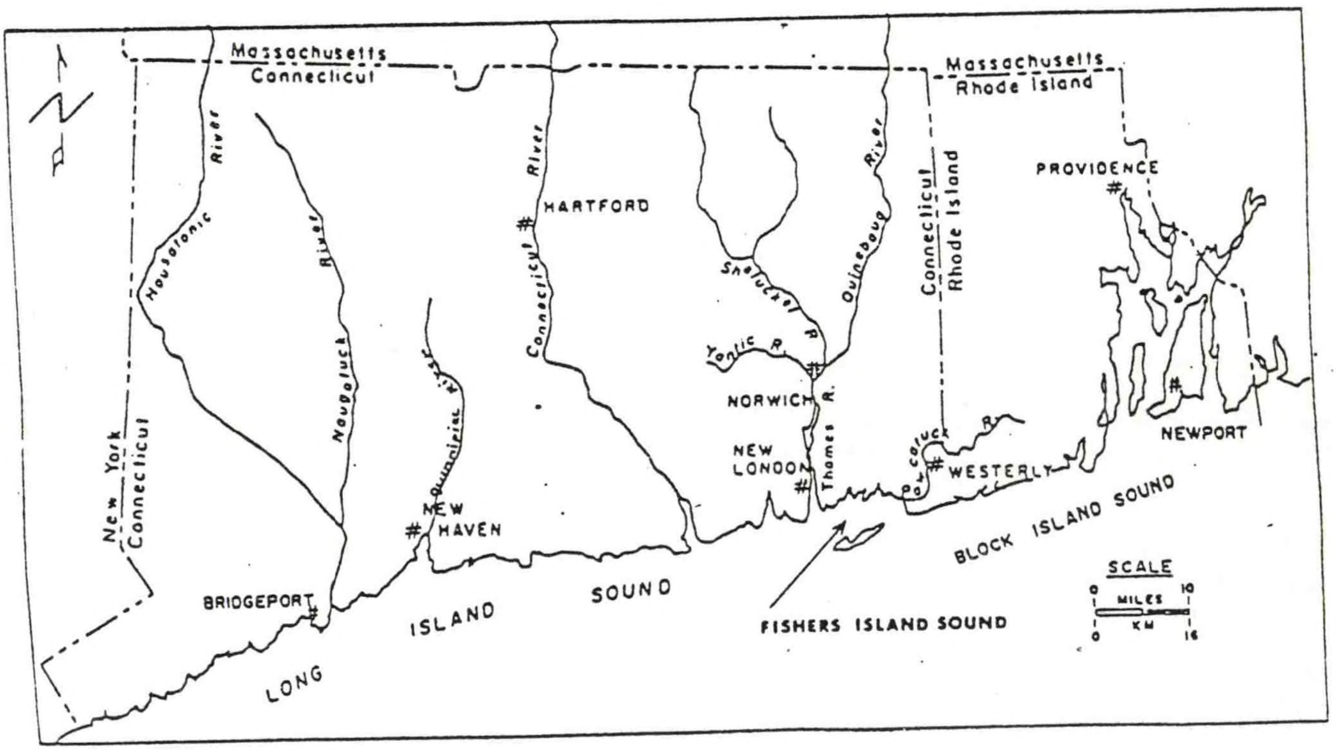
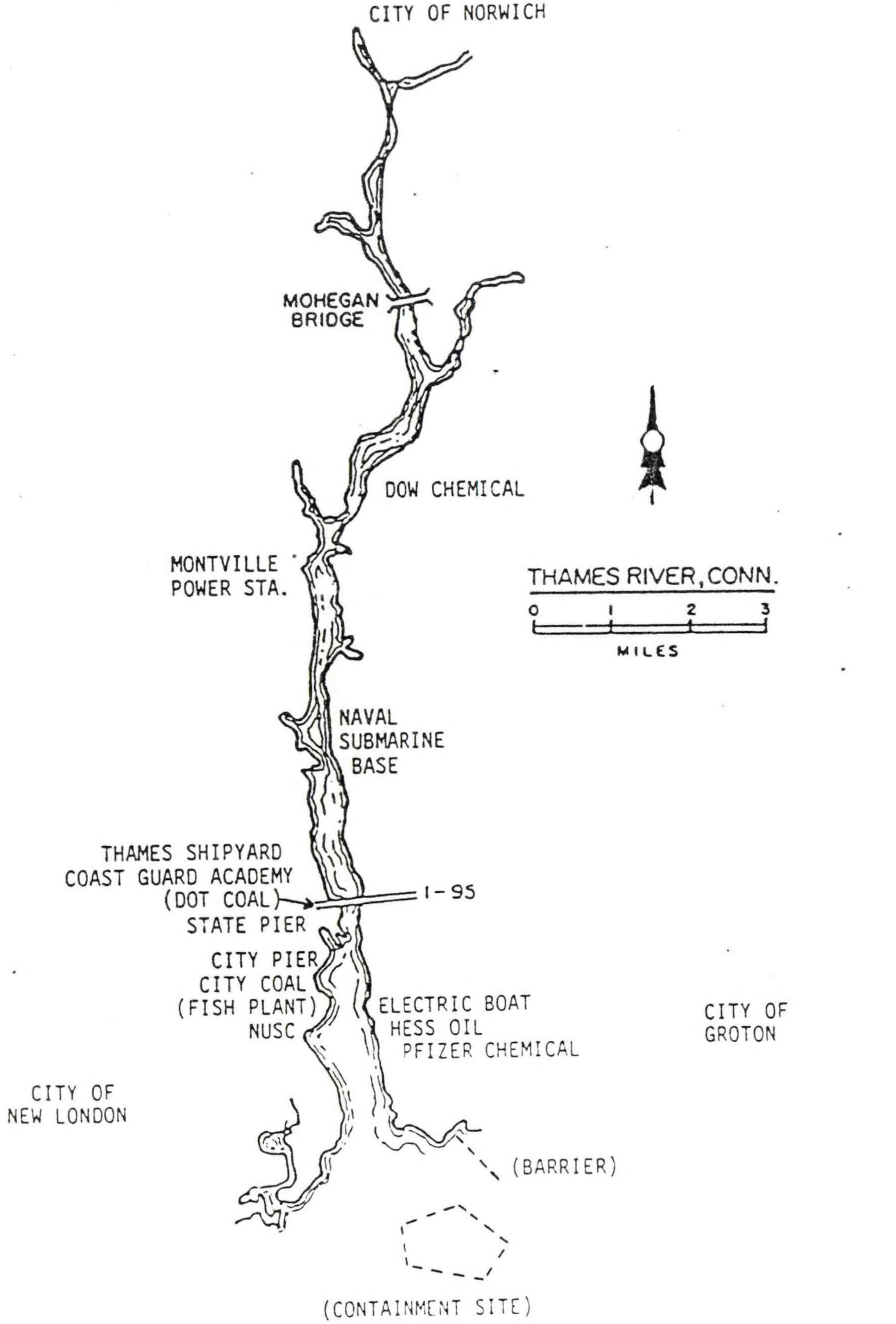


Figure 2-2 Municipal, state, federal and industrial facilities along the Thames River. Proposed facilities are indicted by ().



tons, primarily for utility companies (8).

In terms of overall port development, a study commissioned by the Connecticut Port Authority (6) has concluded the following:

> "On the basis of favorable marine-navigation considerations, New London is superior to New Haven or Bridgeport by a substantial margin. However, on the basis of ultimate deep-draft potential and ultimate potential for flexibility to meet future concept demands, New London stands alone as the only port which could be readily adapted to meet more stringent requirements. Ecological factors become more favorable as one moves eastward along the coast. In this regard, New London is also in a better position than the other ports."

The main growth in port activities has been increasing military-related activities and increasing petroleum imports. The population in the Southeastern Connecticut region is increasing. In 1960 it stood at 179,000. By 1970 it had increased 23% to 220,000; by 1990 it is expected to be 274,000 and by 2020, 333,000 (13). The lower harbor already accommodates outfalls from two major sewage treatment plants and there are several additional treatment plants upstream (Fig. 2-2). Thus the impact from population pressure is already being felt and will increase with further port development.

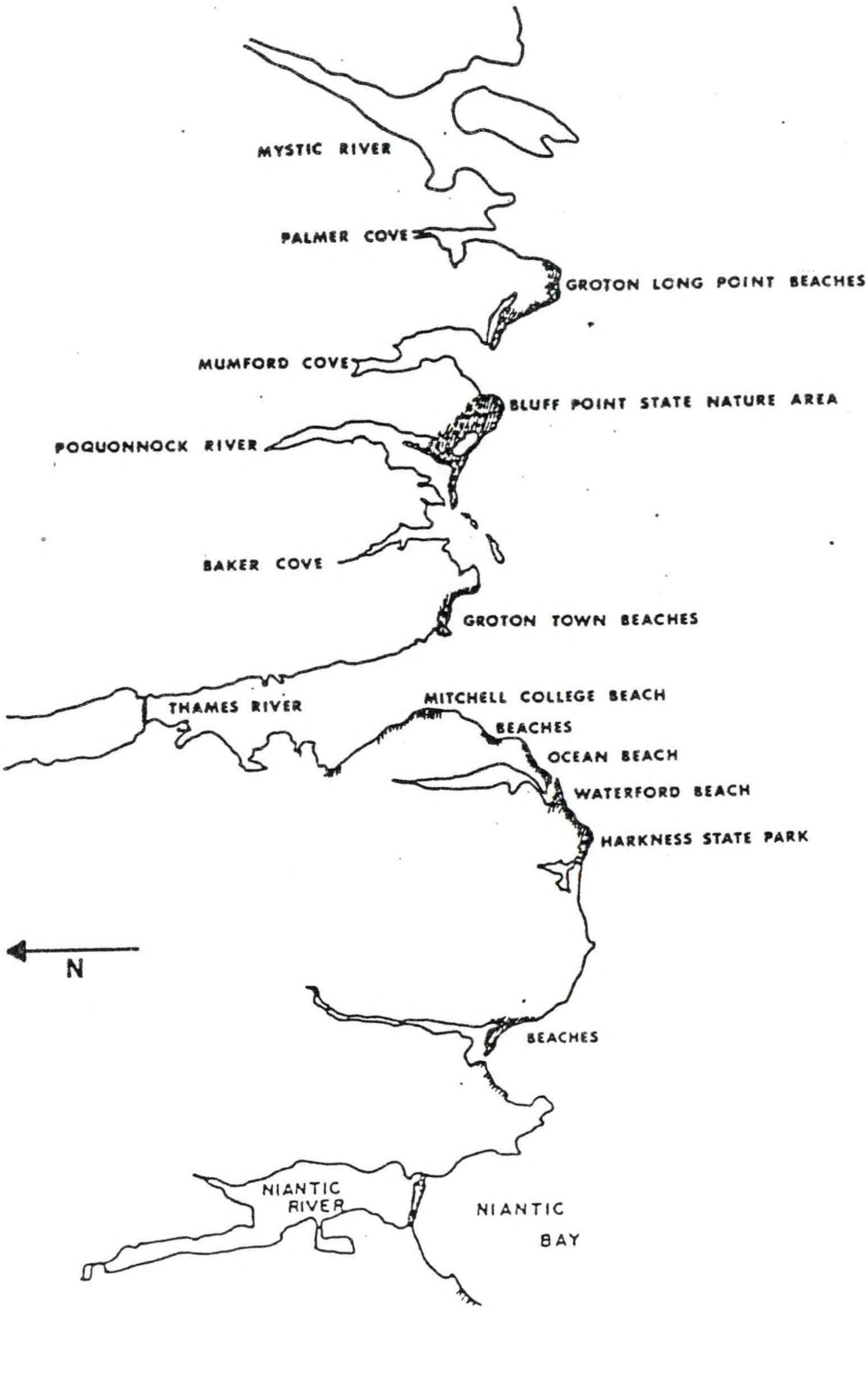
The Connecticut Port Authority Study, in the same report cited above, included the following caution:

> "This is not to say that the New London area can tolerate development without careful control of any potential ecological impact, but only that the ecological hazards may be lessened and easier to control at this site...."

A Long Island Sound Planning Study (13) cites the urgent need to protect the relatively unpolluted recreational areas which lie immediately adjacent to the Thames River, such as the Poquonnock and Mystic estuaries to the east and Alewife Cove, Jordan Cove and the Niantic River to the west (Fig. 2-3). Except for Alewife Cove and inner areas of Jordan Cove, these areas are open for shellfish harvesting. Many beaches, parks and natural areas are located in and near the estuary. Commissions within the communities adjacent to New London have programs underway for improving and maintaining these estuaries as healthy environments for swimming, fishing and shellfishing.

The Thames River and surrounding waterways are already heavily utilized by recreational boaters and fishermen (31). Several marinas are presently being expanded. Quahogs were commercially harvested from the lower harbor in 1984 for replanting in purging beds elsewhere. Commercial oyster beds have long been located in the area of Mamacoke Island north of the I-95 bridge. These oysters are also transported to purging beds outside the river before they are marketed. There are proposals to the city of New London to rebuild its commercial fishing fleet by establishing a fish processing plant in the vicinity of Shaws

Figure 2-3 Proximity of public recreational areas to the Thames River industrial port.



Cove (7) (Fig. 2-2). There is one proposal by the Town of Groton to create a harbor of refuge at the mouth of Baker Cove by building a surge-control barrier at Eastern Point, and another to build a containment island at Black Ledge to support many aniticipated dredging projects (32). Despite these active environmentally-dependent programs, there have been no attempts to develop a coherent understanding about the needs of Thames River ecosystem or to secure its health as a basic resource.

2.2 The Thames River as an Ecosystem

2.2.1 Physical and Chemical Characteristics

The Thames River estuary is formed by the confluence of the Yantic and Shetucket Rivers at Norwich. Its drainage basin covers 3526 km2 (1400 mi2). The river follows a relatively straight north-south course and empties into Long Island Sound (LIS) at the western end of Fishers Island Sound (Fig. 2-1).

A dredged channel runs the entire length of the river. Its depth in the lower harbor is 12.8 m (42 ft). Between the bridges and the Submarine Base it is 10 m (33 ft), and north of that it is 7.6 m (25 ft). The channel hugs the east bank between the river mouth and the Submarine Base, with most of the western 2/3 to 3/4 of riverbed lying above the 5.5-m (18 ft) contour. North of the Submarine Base, most of the area outside the channel lies within the 1.8 m (6 ft) contour. We have made a conservative estimate from reported Secci disk readings (11) that all areas within the 5.5-m contour receive sufficient light for plant growth most of the time.

Annual freshwater discharge to the river is highly variable, depending on precipitation and temperature. Estimates for 1970, 1971 and 1974 averaged 3.9, 3.6 and 4.6 million m^3 per day, but irregular cycles of wet or dry years affect the discharge by 50% or more (36,37). Monthly precipitation in the region is only mildly seasonal (3), but the effects of winter storage by freezing and summertime loses to transpiration and evaporation in the watershed result in strong seasonal cycles in discharge rates. Rates are usually highest from March through May and lowest from June through September. About 80% of this discharge enters the river from the Yantic and Shetucket Rivers at Norwich (27).

The estuary is tidal along its entire length. The mean tidal range is 0.79 m (2.6 ft) at New London, increasing to 0.94 m (3.1 ft) at Norwich due to a resonant effect of the channel. Spring tides increase the range by 0.30 m (1.0 ft) (34). The mean tidal prism is 13.3 million m^3 (470 million ft^3), which exceeds the average freshwater discharge by about 6:1. Thus the estuary is a tidally dominated system.

Despite the high tidal water: freshwater ratio, the river usually remains stratified to its mouth. This is probably due to its relatively straight, narrow channel, the high relief of its banks which protect it from wind mixing, and the fact that 80% of the freshwater enters at the head of the estuary, giving it a flume-like hydrology. Bottom water is salt all the way to Norwich. This stratification results in poor mixing between surface and bottom waters.

An important consequence of the river's hydrodynamic regime is that flushing times for surface water entering at Norwich are only 0.5 to 2 days, which is short for a system of this size. The lower flushing time corresponds to periods of high discharge and vice versa. Bottom water, on the other hand, requires 19 days or more to flush completely (27). These flushing times are important determinants of the fate and effects of pollutants entering the system.

Sediments over most of the river bottom are fine sand and silt washed down from inland (33). Course gravel and rock deposits occupy a narrow margin along the riverbank. In some areas there are deposits up to 27.4 m (90 ft) of highly organic, very soft silt. Sediments in the channel are reportedly dark grey and black clayey-silts with organic contents of 0.15 - 5.04% and water contents of 46 - 65% (2,38). There is little sediment data for the bulk of the harbor area, which lies outside the channel, except for the western shoals area north of the I-95 bridge, where the sediments are reported to vary from highly organic clayey-silt to coarse sand (29). In the vicinity of Black Ledge, off the mouth of the harbor (Fig. 2-2), deep sediments in and near the ship channel consist of fine clayey-silts similar to those in the river (2,28, 38). As the bottom shoals toward the ledge, the sediments grade to finer sands, then coarse sand and gravel, and finally to ledge with cobble at depths of 2-3 m (5-10 ft).

In the upper half of the river, the high organic content in the sediments, high temperatures, long flushing times and poor mixing between surface and bottom layers combine to produce oxygen depletions in the bottom waters during summer months. At such times these waters contain only 0-3 ppm dissolved oxygen. The oxygen demand is so great that neither photosynthesis nor tidal flushing can alleviate the condition, which is so stressful that the area becomes devoid of demersal fishes (29).

These anoxic conditions alone represent a serious biological impact. They become even more serious, however, because low oxygen commonly produces synergistic effects with other stressful factors, ie if oxygen levels are low, an organism's tolerance for other factors is often greatly lowered. A factor which frequently combines synergistically with low oxygen is temperature. Although the harbor area itself is better flushed, and its oxygen content reportedly rarely drops below 80% saturation, pollutants entering from the harbor may be carried upstream by tidal action and thus become increasingly harmful to biota as the oxygen levels decline.

Nutrient levels in the river are high compared with those in Long Island Sound (9,21,24), and reflect anthropogenic loadings from several sewage treatment plants and Pfizer Pharmaceutical Co. (Fig 2-2). These loadings are particularly important in sustaining phytoplankton and benthic algal growth in summer when nutrients in Long Island Sound waters are low.

2.2.2 Biological Characteristics

Phytoplankton communities in the Thames River have not been studied directly, but some estimates of their production levels may be inferred from surveys of chlorophyll concentrations (9,21). Chlorophyll is a highly variable parameter, but some general seasonal patterns applicable to LIS and temperate systems in general have been discussed by Riley (23). Concentrations are highest in western LIS and lowest in eastern LIS (Table 2-1), and this gradient is attributed to a concomitant gradient in nutrient levels. Chlorophyll variations in the temperate zone characteristically occur as a series of short duration, highly volatile seasonal oscillations which correspond to peaks and crashes in the phytoplankton populations conventionally attributed to a combination of three factors: solar illumination, nutrient availability and zooplankton grazing. For a conventional cycle, the highest peaks occur in late winter or early spring in response to increasing solar illumination. This peak is followed by a sharp crash as nutrients become exhausted and zooplankton grazing intensifies. If nutrients are sufficiently replenished through recycling, a second smaller peak may occur in late summer or early fall.

This seasonal pattern is often assumed to be ubiquitous in marine systems of the temperate zone, but the timing and the intensity of the blooms are highly unpredictable from year to year. Moreover, the pattern may be completely disrupted by local processes. Riley's data for eastern LIS do not show the strong classical patterns which develop in the central and western Sound, and neither do the data from several consecutive years at stations near Millstone Point, only a few kilometers west of the Thames River (22,40).

Data for the River are too few to detect seasonal peaks with any confidence, but all of the available summer measurements are consistently and significantly higher than measurements at any other time of the year (9,22). Moreover, chlorophyll concentrations in the lower river are consistently higher than in eastern LIS. Concentrations in the highly stratified surface waters of the upper river may be twice those in lower river (Table 2-2). Concentrations in the upper river exceed even the highest levels reported by Riley for the western Sound. Thus Thames River phytoplankton production patterns deviate substantially from classical seasonal patterns. River production appears to be driven by high summer temperatures coupled with sustained nutrient levels from anthropogenic sources and lowered flushing rates associated with seasonally low freshwater runoff, rather than by the natural factors cited by Riley.

The temporal variations in chlorophyll over a partial tidal cycle are contained in Table 2-3. These data have been presented because they show a pattern which provides a convenient demonstration of a phenomenon called tidal recycling, which is relevant for any dissolved or particulate constituent in the water column, including pollutants. Recycling occurs because tidal water typically moves upstream and downstream as a series of cohesive water masses. These masses tend to retain their individual characteristics because they do not mix readily with adjacent water masses over the time scales of a tidal cycle. In this particular example, a portion of the ebbing water mass which contains high levels of chlorophyll moves upstream again on the flood tide with little or no dilution, resulting in a phase lag

Table 2-1. Ranges for chlorophyll in Long Island Sound, Millstone Point, New London Ledge, and Thames River from various studies. Units are mg/m^3. River stations are keyed to Fig. 2-4.

SAMPLING LOCATION	SCHEDULE	RANGE	SOURCE
LONG ISLAND SOUND			RILEY (23)
EASTERN	MAR 54 - NOV 55	0.5-3.5	
CENTRAL	MAR 54 - NOV 55	1.5-22	
WESTERN	MAR 54 - NOV 55	4-24	
MILLSTONE POINT			
OUTFALL 1977	JAN-DEC	0.5-12.8	NUSCO (18)
OUTFALL 1978	JAN-OCT	0.2-8.5	NUSCO (19)
OFFSHORE 1975	MAR-JUN-OCT	1.4-4.4	NUSCO (15)
THAMES RIVER			
STA A NL LEDGE	JUL 74	3.6	RATHEON (21)
STA A NL LEDGE	FEB, JUL 75	1-6	FENG (9)
STA B-O	JUL 74-MAY 76	1-38	FENG (9)
STA B-X	JUL 74, AUG 75	7-175	RATHEON (21)
STA B (MOUTH)	AUG TIDAL CYCLE	21-175	RATHEON (21)
STA M (UPSTREAM)	AUG TIDAL CYCLE	11-95	RATHEON (21)

Figure 2-4 Station loctions for chlorophyll measurements reported in Tables 2-1 and 2-2.

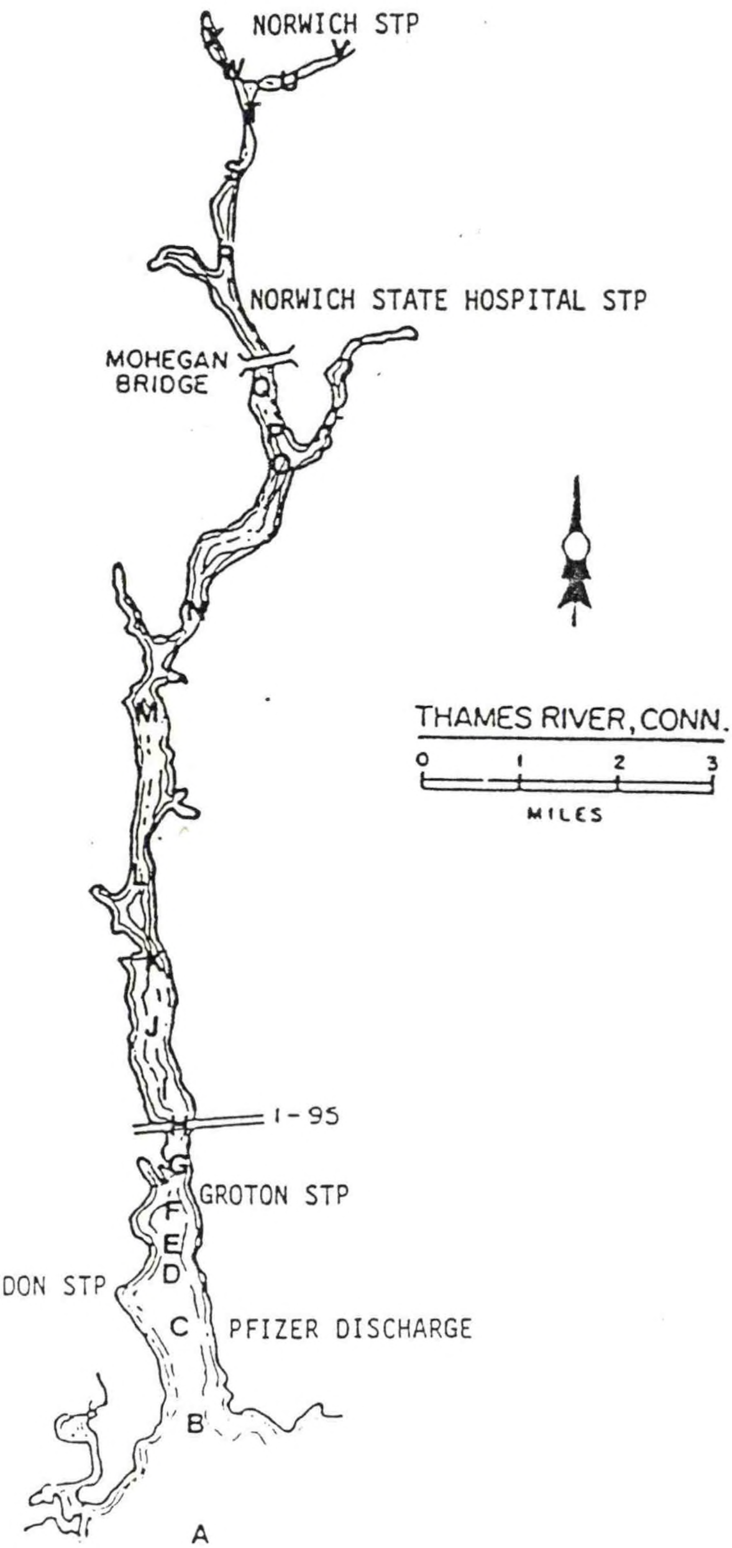


Table 2-2. Seasonal and spatial comparisons of chlorphyll in the Thames River from previous studies. Stations are keyed to Figure 2-4. Sources of data are Ratheon (21), Feng (9). Units are mg/m³.

STATION		RATHEON 7/11-12/74	RATHEON AUGUST 6-7, 1975		FENG JULY 1975		FENG FEB 1975	
Sta	Loction	MEAN	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM
A	NEAR N.L. LEDGE LIT	3.6			4	6	1	1
B	RIVER MOUTH		63.2	44.2				
C	PFIZER				12	7	1	1
D	OPPOSITE HESS OIL	10.7	65	45.2				
E					29	7.5	1	2
F	OPP. NUSC/BELOW GSTP	0						
G			55.1	58.7				
H	UNDER I-95 BRIDGE	6.7						
I					39	7	1	2.5
J			55.1	74.9	49	7.5	1	1
K								
L	SMITH CV/OPP CC STAK	16						
M	OPP. MONTVILLE PS	34.1	52.4	60.5				
N			62.3	83.2				
O					38	8	1	3
P	BUOY 26/BELOW HOSP.	9.8						
Q			153.8	25.3				
R	BUOY 40	8.9						
S			108.1	11.6				
T	RTE 12/MOUTH SHET.R.	7.1						
U			116.4	18.1				
V	8TH ST BR. OFF RT 12	12.3						
W			174.6	25.3				
X	SHERMAN ST BR/YAN R.	0						

DISCHARGES ON RIVER

	DESCRIPTION
1	NORWICH STP
2	NORWICH HOSP. STP
3	DOW CHEMICAL
4	MONTVILLE POWER STA
5	GROTON STP
6	NEW LONDON STP
7	PFIZER CHEMICAL

Table 2-3. Temporal variability of chlorophyll (mg/m3) in the River mouth (Sta F) and upstream (Sta M) over a portion of tide. Keyed to Figure 2-4. Data are from Ratheon (19) August, 1975.

		STATION 1			STATION 5	
TIDE	TIME	SURFACE	BOTTOM	TIME	SURFACE	BOTTOM
FLOOD	0715	62.4	54.1	0830	47.8	11.3
EBB	1100	74.8	41.6	1100	20.8	47.8
EBB	1200	37.4	20.8	1200	68.6	74.8
EBB	1300	60.8	47.8	1300	74.8	74.8
EBB	1400	79.1	62.4	1430	74.8	83.2
EBB	1500	83.2	54.1	1530	79.0	62.4
EBB	1600	87.3	62.4	1600	89.4	68.6
FLOOD	1700	81.1	60.3	1715	89.4	87.3
FLOOD	1800	81.1	45.7	1800	87.3	94.8

between the change in chlorophyll concentration values and the change in tidal direction. Similarly, a pollutant spilled in the harbor may maintain its concentration longer than a generalized mixing equation would predict, and may repeatedly bathe areas both upstream and downstream from its point of entry. The phenomenon is generally stronger in upstream areas because of the restrictions imposed by the river banks and the more pronounced vertical stratification of the water column, but it can be detected to a lesser degree in data from a station at the mouth of the river, which are also included in the table.

There is relatively little information about benthic plant communities in the Thames River. A small study of attached seaweeds at the mouth of the harbor was conducted in August 1976 (23). Thirteen genera were reported, distributed in two broad zones. *Chondrus crispus* dominated the shallower zone, which extended from MLW to 1.4 m at mean densities of 556 grams dry weight (gdw)/m^2 (Standard deviation(SD) = 222). *Phyllophora* sp dominated the deeper zone, from 1.4 m to 3.0 m at densities of 478 gdw/m^2 (SD=138). A study of attached seaweeds was conducted at Black Ledge in October and November, 1981, to evaluate the area for construction of the proposed dredge spoil containment island cited in Section 2.1 (28). Fifty-two species were reported, with a biomass range of 4.3 -152 gdw/m^2. A third study, conducted in 1973 between the I-95 bridge and the Submarine Base (Fig. 2-2), reported 6 species in negligible quantities (<1 gdw/^{2}), except in one highly localized area nearshore where there were abundant patches of green alga, *Ulva lactuca,* and eelgrass, *Zostera marina* (29). A fourth study, conducted in the lower Harbor area, was not primarily concerned with benthic algae, but reported 10 species as an incidental adjunct to reporting on the animals of the area (10).

In all, 62 species were reported (Table 2-4), but the general impressions left by all but the August 1976 (22) study was that benthic plants were relatively unimportant in the area either because their densities were very low (28) or because they were confined to hardrock substrate which comprised a relatively small proportion of subtidal bottom area (10,29).

Several studies of benthic invertebrates are available (10,22,28,29). Appendix Table A1-A through A1-D contains a composited inventory of the species reported. The number of taxa (76 Polychaetes, 52 Crustaceans, 43 Molluscs and 28 in 9 other phyla) is impressive but somewhat unmanageable. The table is useful for qualitatively comparing the species found in different habitats and for identifying those species which are most ubiquitous in the area.

However, with respect to a composite analysis, the information provided by such independent studies, i.e. the suite of species captured and their importance ratings in terms of numbers or biomass per unit effort, depend heavily on the method of collection and the spatial and temporal scales of the sampling program. Recognizing the inherent difficulties in comparing or combining studies, we have extracted from the inventory a series of assemblages based on the dominant species found within each of a number of catagories such as location, substrate type and sampling methodology (Table 2-5).

Table 2-4. Benthic plant species (Refs 11, 22, 28, 29). Area I= north of I-95 bridge, II = bridge to river mouth, III = Black Ledge area. Common=found in this study.

Species	Area I	Area I	Area I	Common
Green Algae (Chlorophyta)				
Bryopsis plumosa			X	
Chaetomorpha linum			X	X
Chaetomorpha melagonium			X	
Cladophora albida			X	X
Cladophora sericea			X	X
Codium fragile	X	X		X
Enteromorpha clathrata			X	
Enteromorpha flexuosa			X	
Enteromorpha intestinalis			X	
Enteromorpha prolifera			X	
Protoderma marinum		X		
Rhizoclonium tortuosum			X	X
Ulothrix flacca		X		
Ulva lactuca	X	X	X	X
Brown Algae (Phaeophyta)				
Desmarestia aculeata			X	X
Desmerestia sp			X	
Ectocarpus fasciculatus			X	
Ectocarpus siliculosus			X	X
Fucus vesiculosus		X		X
Fucus spp	X			
Giffordia granulosa			X	
Giffordia mitchelliae			X	
Giffordia sandriana			X	
Laminaria saccharina		X	X	X
Sphacelaria cirrosa			X	
Red Algae (Rhodophyta)				
Agardhiella tenera		X		
Audouinella daviesii			X	
Audouinella secundata			X	
Ahnfeltia plicata			X	X
Antithamnion americanum			X	X
Antithamnion cruciatum			X	X
Bangia atropurpurea			X	X
Bonnemaisonia hamifera			X	X
Callithamnion baileyi			X	X
Callithamnion byssoides			X	X
Callithamnion corymbosum			X	
Callithamnion roseum			X	X
Ceramium rubrum			X	X
Champia parvula			X	X
Chondria tenuissima		X	X	
Chondrus crispus	X	X	X	X
Corallina officinalis			X	X
Cystoclonium purpureum			X	X
Daysa baillouviana			X	X
Dosya pedicellata		X		
Goniotrichum alsidii			X	
Gracillaria foliifera		X		
Gracillaria verrucosa	X			
Grinnelia americana		X	X	X
Lomentaria baileyana			X	X
Lomentaria orchadensis			X	
Nemalion helminthoides			X	
Palmaria palmata		X		X
Phyllophora pseudoceranoides			X	X
Phyllophora truncata			X	X
Polysiphonia denuda			X	X
Polysiphonia harveyi			X	X
Polysiphonia nigrescens			X	X
Polysiphonia urceolata			X	X
Polysiphonia sp			X	
Polyides sp	X		X	
Porphyra leucosticta			X	X
Porphyra umbilicalis			X	
Vascular plants (Spermatophyta)				
Zostera marina	X	X		X
Total:	7	14	53	35

Table 2-5. Representative benthic communities of the lower Thames River and Harbor Mouth, with respect to methodology and areas of sampling. Area I=above Submarine Base to I-95 Bridge, Area II=I-95 Bridge to Harbor Mouth, Area III= Harbor Mouth to Black Ledge and New London Ledge. Major taxonomic catagories are identified as follows: A=amphipod, An=anemone, B=bivalve, D=decapod, E=echinoderm, G=gastropod.

Area	Substrate	Sampling Methodology and Location	Dominant taxa
I	Softbottom	Beach seine, nearshore	*Palaemonetes pugio* (D), *Crangon septemspinosa* (D), *Callinectes sapidus* (D).
		Grab sampler, western shoals	*Gammarus oceanicus* (A), *Ilyanassa obsoleta* (G), *Scoloplos robustus*(P) *Mercenaria mercenaria* (B), *Pectenaria goldii*, *Mya arenaria* (B).
		Benthic dredge, western shoals	*Scoloplos robustus*, *Crangon septemspinosa* (D), *Asterias forbesi*(E) *Mercenaria mercenaria* (B), *Sabellaria vulgaris*(P).
		Grab sampler, channel	*Mercenaria mercenaria* (B), *Yoldia limatula* (B), *Potamilla* *Potamilla reniformis*(P), *Pectinaria goldii*(P), *Nephthys caeca*(P).
		Benthic dredge, channel	*Asterias forbesi* (E), *Crangon septemspinosa* (D), *Potamilla reniformis*(P), *Mercenaria mercenaria* (B)
II	Softbottom	Grab sampler, upper harbor channel	*Streblospio benedicti*(P), *Nephthys picta*, *Nephthys incisa*(P), *Tellina agilis* (B), *Yoldia limatula* (B).
		Grab sampler, polluted channel & *eastern shoals*	*Streblospio benedicti*(P), *Oligochaetes*, *Capitella capitata*(P), *Polidora ligni*(P), *Nephthys incisa*(P)
		Grab sampler, harbor mouth channel	*Ampelisca vadorum* (A), *Nephthys incisa*(P), *Nephthys picta*(P)
II	Rocky outcrop	Diver quadrat, MLW to 3 m	*Lacuna vincta* (G), Unid. copepod, *Jaera marina* (I), *Jassa falcata* (A), *Corophium acutum* (A)
IV	Rock ledge	Diver quadrat, 1.5 m to 3 m	1) *Mitrella lunata* (G), *Mytilus edulis* (B), *Lepidonotus squamatus*(P).
			2) *Anachis avara* (G), *Harmathoe imbricata*(P), *Metridium senile* (An).
	Sand/gravel	Diver quadrat, 3 m to 6 m	1) *Exogone sp*(P), *Polycirrus eximius*(P), *Capitella capitata*(P), Oligochaetes, *Polygordius sp*(P), *Leptochelia savigni* (A).
			2) *Unciola irrorata* (A), *Ampelisca vadorum* (A), *Spiophanes bombyx*(P).
	Silt/clay	Benthic grab, 6 m to 9 m	1) *Aricidea sp*(P), *Mediomastus ambiseta*(P), *Nephthys incisa*(P), *Nucula proxima* (B).
			2) *Ampelisca abdita* (A), *Corophium benelli* (A), *Anaitides maculata*(P)

Among the larger benthic invertebrates, the river supports hard clams, *Mercenaria mercenaria*, soft clams, *Mya arenaria*, lobsters, *Homarus americanus*, blue crabs, *Callinectes sapidus*, and whelks, *Busycon canaliculatum*, all of which are valuable in the local commercial and recreational fishery (Table 2-6). There are also starfish, *Asterias forbesi*, which are serious predators of commercial shellfish. These species are present throughout the study area. They appear in Table 2-5 only in Area I bacause their capture requires larger sampling gear (i.e. seines and benthic dredges) than was used in the other studies.

Two highly abundant species are the grass shrimp, *Palaemonetes pugio*, and the sand shrimp, *Crangon septemspinosa*, which are major food items for many fishes, including winter flounder and others of importance to the commercial and recreational fishery (Table 2-7). These shrimp are ubiquitous to the study area but they are epibenthic and highly motile and therefore not readily captured by benthic grab samplers.

Infaunal assemblages have been more extensively sampled in the study area. In the area between the I-95 bridge and the mouth of the harbor, however, sampling has been confined to areas in and near the ship channel. These assemblages were dominated by polychaete worms and amphipods which are also important food items of finfish. Polychaetes, molluscs and crustaceans made up the majority of the softbottom assemblages. Polychaetes and bivalve molluscs tended to dominate in the upstream end of the system and in stressed areas. Gastropod molluscs and crustaceans became more abundant in the downstream and coastal portions. Hardrock communities have a large proportion of crustaceans and gastropod molluscs, which are more specialized for an epibenthic life-style, although errant polychaetes are also abundant. Anemon es, blue mussels, soft clams, starfish and sea urchins are more abundant in the coastal portion of the study area than in the river. The complimentary nature of hardrock and softbottom communities and the shift in species between the river and the Sound can be seen in the comparative listings in Appendix Table A1 and Table 2-5.

The surveys, particularly in the harbor area, were not exhaustive, but the high diversity of fauna and the presence of such species as sand shrimp, lobsters, isopods and amphipods indicates that the area is relatively healthy and that the benthos is not chronically oxygen-depleted. Several localized areas were cited as strssed by pollution based on their impoverished faunal assemblages. These were the docking area at the Submarine Base, an old marine railway and channel area at Thames Shipyard, shoals along the east bank of the river north of Electric Boat, the channel leading to NUSC, and a portion of the main channel off Pfizer (Fig. 2-4). The entire study area is closed to shellfishing, but quahogs and oysters found just north of the map area covered in Fig.2-4 are harvested and taken to purging grounds by commercial fishermen.

Several finfish studies have been conducted in the area (29,37). Fifty species have been compiled from these studies (Table 2-8), which also included the dredged materials disposal area a short distance south of our defined study area. Many of the species listed are important in the recreational and commercial fishery of the region (Table 2-6). The rich diversity of marine fishes in Area I shows that

Table 2-6. Species listed in Connecticut commercial fishery records for eastern Long Island Sound.

Listed name	Other common name	Scientific Name
Alewives	Herring	*Alosa pseudoharengus*
Anglerfish	Goosefish	*Lophius americanus*
Blackback flounder	Winter flounder	*Pseudopleuronectes americanus*
Blueback herring	Herring	*Alosa aestivalis*
Bluefish		*Pomatomus saltatrix*
Butterfish		*Peprilus triancanthus*
Cod	Atlantic cod	*Gadus morrhua*
Dab	Hogchoker	*Trinectes maculatus*
Eels	American eel	*Anguilla rostrata*
Fluke	Summer flounder, sole	*Paralicthys dentatus*
Haddock		*Melanogrammus aeglefinus*
Hake, red		*Urophycis chuss*
Hake, white		*Urophycis tenuis*
Herring, sea		*Clupea harengus*
Mackerel	Atlantic mackerel	*Scomber scombrus*
Menhaden	Bunker	*Brevoortia tyrannus*
Ocean perch	Redfish	*Sebastes marinus*
Ocean pout		*Macrozoarces americanus*
Pollock		*Pollachus virens*
Scup	Porgy	*Stenotomus chrysops*
Sea Bass	Black sea bass	*Centropristis striata*
Sea Robins		*Prionotus spp*
Sea trout	Weakfish	*Cynoscion regalis*
Shad	American shad	*Alosa sapidissima*
Sharks, dogfish	Spiny	*Squalus acanthial*
	Smooth	*Mustelus canis*
Sharks, unclassified		
Skates	Raja sp.	*Raja spp*
Striped bass	Striped bass	*Morone saxatilis*
Swellfish	Puffer	*Sphoeroides maculatus*
Swordfish		*Xiphias gladius*
Tautog	Blackfish	*Tautoga onitis*
Tilefish	Cusk	*Brosme brosme*
Tuna	Blackfin tuna	*Thunnus atlanticus*
White perch		*Morone americana*
Whiting	Silver hake	*Merluccius bilinearis*
Yellowtail flounder		*Limanda ferruginea*
Squid		*Loligo*
Crab	Blue crab	*Callinectes sapidus*
Crab	Rock crab	*Cancer borealis*
Lobsters	American lobster	*Homarus americanus*
Hard clams	Quahog	*Mercenaria mercenaria*
Conchs	Whelk	*Busycon spp.*
Oysters (spring)		*Crassostrea virginica*
Oysters (fall)		*Crassostrea virginica*
Sea scallops		*Placopecten magellanicus*
Bay scallops		*Aequipecten irradians*

Table 2-7. Items identified from fishgut analysis (26,36).

Group	Taxon	Common name
Annelida		
Polychaetes	*Ampharete acutifrons*	
	Ampharete sp	
	Axiothella sp	
	Glycera americana	Blood worm
	Glycera sp	Blood worm
	Hypaniola grayi	
	Lepidonotus squamatus	Scale worm
	Nepthys sp	
	Nereis sp	Sand worm
	Pectenaria gouldii	
	Pherusa affinis	
Mollusca		
Bivalves	*Ensis directus*	Razor clam
	Mulinia lateralis	
	Musculus niger	
	Mytilus edulis	Blue mussel
Snails	*Nassarius sp*	Mud snail
Cephalopods	*Loligo sp*	Squid
Arthropoda		
Crustaceans	*Ampelisca vadorum*	Amphipod
	Caprella sp	Amphipod
	Corophium sp	Amphipod
	Gammarus sp	Amphipod
	Leptocheirus pinguis	Amphipod
	Photis sp	Amphipod
	Phoxocephalus sp	Amphipod
	Unciola irrorata	Amphipod
	Neomysis americana	Mysid shrimp
	Cancer sp	Rock crab
	Caridean shrimp	Sand or grass shrimp
	Crab larvae	
	Crangon septemspinosus	Sand shrimp
	Pagurus sp	Hermit crab
Porifera	Sponge, unid.	
Cnidaria	Hydrozoans, unid.	
Nemertea	Nemertean, unid.	
Chordata		
Fish	*Gasterosteus sp*	Stickleback
	Menidia sp	Silversides
	Peprilus triacanthus	Butterfish
	Pseudopleuronectes americanus	Winter flounder (young)
	Unid. fish eggs	

Table 2-8. Finfish species reported from the study area composited from several reports. Area I = north of I-95 bridge, Area II = bridge to mouth, Disposal area is several km south of study area in LIS. Data collated from References 26, 33, 36. * = unpub.

Scientific name	Common name	AREA I	AREA II	Disposal site
Alosa aestivalis	Blueback herring	x		x
Alosa pseudoharengus	Alewife	x		x
Alosa sapidissima	American shad	x		
Alosa spp.	Herring	x		
Ammodytes americanus	American sand lance			x
Anchoa mitchilli	Bay anchovy	x		
Anguilla rostrata	American eel	x		
Apeltes quadracus	Fourspine stickleback	x		
Brevoortia tyrannus	Atlantic menhaden	x		
Cynoscion regalis	Weakfish (sea trout)		X	
Cyprinodon variegatus	Sheepshead minnow	x		
Fundulus heteroclitus	Common killifish	x		
Fundulus majalis	Striped killifish	x		
Gasterosteus aculetus	Threespine stickleback	x		
Gobiosoma bosci	Naked gobi	x		
Hemitripterus americanus	Sea raven			x
Leiostomus xanthurus	Spot	x		
Lepomis gibbosus	Pumpkin seed	x		
Lophosetta maculata	Sand dab	X	X	
Macrozoarces americanus	Ocean pout			x
Marone americana	White perch	x		
Marone salatilis	Striped bass	x		
Merluccius bilinearis	Silver hake	x		
Microgadus tomcod	Atlantic tomcod	x		
Minidia beryllina	Tidewater silverside	x		
Minidia menidia	Atlantic silverside	x		x
Moracanthus hespidus	Planehead filefish		X	x
Mugil cephalus	Striped mullet	x		
Mustelus canis	Smooth dogfish	X	X	x
Myxocephalus aenaeus	Grubby	x		x
Myxocephalus octodecemspinosus	Longhorn sculpin	X		x
Opsanus tau	Oyster toadfish	x		
Osmerus mordax	Rainbow smelt	x		x
Paralicthys dentatus	Summer flounder, fluke		x	
Paralichthys oblongus	Fourspot flounder	x		x
Pepsrilus triancanthus	Butterfish	x		x
Pholis gunnellus	Rock Gunnel	x		x
Pomatomus saltatrix	Bluefish	x	X	x
Prionotus carolinus	Northern searobin			x
Prionotus evolans	Striped searobin	x	X	
Pseudopleuronectes americanus	Winter flounder	x	X	x
Raja erinacea	Little skate			x
*Scomber scombrus**	Atlantic mackerel*		X	X
Scophthalmus aquosus	Windowpane flounder	x		
Stenotomus chrysops	Scup	x		
Syngnathus fuscus	Northern pipefish	x		
Tautoga onitis	Tautog	x		x
Tautogolabrus adspersus	Cunner	x	X	x
Trinectes maculatus	Hogchoker	x		
Urophycis chuss	Red hake			

the harbor area consititutes an important zone of passage for many of these species.

Table 2-9 lists species collected by beach seine within the 1-m contour north of the I-95 bridge (29). The assemblages consisted of small-sized fishes, many of which are important in the diets of larger commercial and recreational species, and several of which were the juveniles of those larger species. Shallow waters are known to provide important feeding and refuge areas for small fishes, in part because these areas trap and concentrate organic particles which are eaten directly by the fishes or serve as food for their prey. This trapping effect, however, also causes shallow areas to concentrate pollutants, which is an important consideration for impact avoidance and mitigation efforts. In this shoreline study, the area beneath the I-95 bridge was depauperate compared to the areas to the north, suggesting that substantial impact may already have occurred there.

The finfish of the area utilize the river in a number of ways. Some, such as menhaden, bluefish, striped bass and mackerel, are long-range coastal migrants which enter the Sound and utilize the river area for feeding before moving on along the coast. Their arrivals are heralded by both commercial and recreational fishermen. Less noticed are the young of many of these species, which may stay longer in the shallow areas of the river. Some, such as the winter flounder, whiting, porgy, weakfish and tautog, form indigenous LIS populations which move inshore during certain seasons to feed or to spawn. Their young then utilize the estuary as a nursery ground. Young flounder, which utilize the Thames and many other Connecticut estuaries for spawning, is the most economically important indigenous fish population in LIS. Other species, such as herring and alewife, utilize the river as a zone of passage to their spawning grounds in freshwater.

In a narrow river such as the Thames, it is important that port development downstream does not introduce chronic or episodic pollutants or create other conditions which would inhibit finfish from entering the river or affect them as they pass upstream or trap them in upstream areas.

Table 2-9. Shoreline finfish found within the 1-meter contour (26).

Scientific name	Common name
Anchoa mitchilli	Bay anchovy
Anguilla rostrata	American eel
Apeltes quadracus	Stickleback
Cyprinodon variegatus	Sheepshead minnow
Fundulus heteroclitus	Common killifish
Fundulus majalis	Striped killifish
Gasterosteus aculetus	Stickleback
Leiostomus xanthurus	Spot
Lepomis gibbosus	Pumpkin seed
Marone americana	White perch
Microgadus tomcod	Atlantic tomcod
Minidia beryllina	Silversides
Minidia menidia	Silversides
Mugil cephalus	Striped mullet
Opsanus tau	Oyster toadfish
Pomatomus saltatrix	Bluefish
Pseudopleuronectes americanus	Winter flounder
Syngnathus fuscus	Northern pipefish
Tautoga onitis	Tautog

3.0. New Field Studies

3.1 Introduction

The field effort was designed to supplement the existing base of environmental information with specific information on the identity, location and abundance of benthic plant communities in the vicinity of New London harbor. Primary focus was placed on the subtidal hardrock algae (seaweeds) and their associated animal communities, which are the least well-studied habitat in the region.

Given the scarcity of substantive information about this community, it was necessary to consider the following possibilities:

1. That substantial benthic macrophyte production may occur on any available substrate such as shells, cobbles, pilings,&other plants, and thus occur in areas other than outcropping ledges and large boulders.

2. That algae torn loose from rocky areas may continue to function as a productive component of the system and not immediately become part of the detrital pool.

3. That drifting algae in either the productive or detrital state may move in and out of the harbor area, thus becoming a siginficant factor in the whole question of pollution and its containment.

The study area was chosen to include the immediate zones of potential impact from an energy port established in the New London-Groton area. As defined in Figure 3-1, the area encompasses 8.15 km^2 between Bailey Point and New London Ledge, which corresponds approximately with the outer end of the dredged channel.

3.2 Methods

3.2.1 Preparation of Base Maps

Mylar base maps for the study area were prepared on a scale of 1:24000 by tracing the 1980 editions of USGS Orthophoto Quadrangle maps. Base maps on a scale of 1:12000 were prepared by tracing photogrammetrically reproduced 2X enlargements of the orthophotos obtained especially for this study by CT Dept of Natural Resources (DNR).

A LORAN grid, which extended LORAN lines into the river area for navigational purposes, was prepared by making LORAN readings at 31 station points inside the river beyond the normal LORAN chart coverage and outside the river at known points covered by LORAN charts (Fig. 3-2). The chart was used to locate the dredge and video transects.

Figure 3-1 Boundaries of the study area in the Lower Thames River. The area encompasses 8.15 sq km.

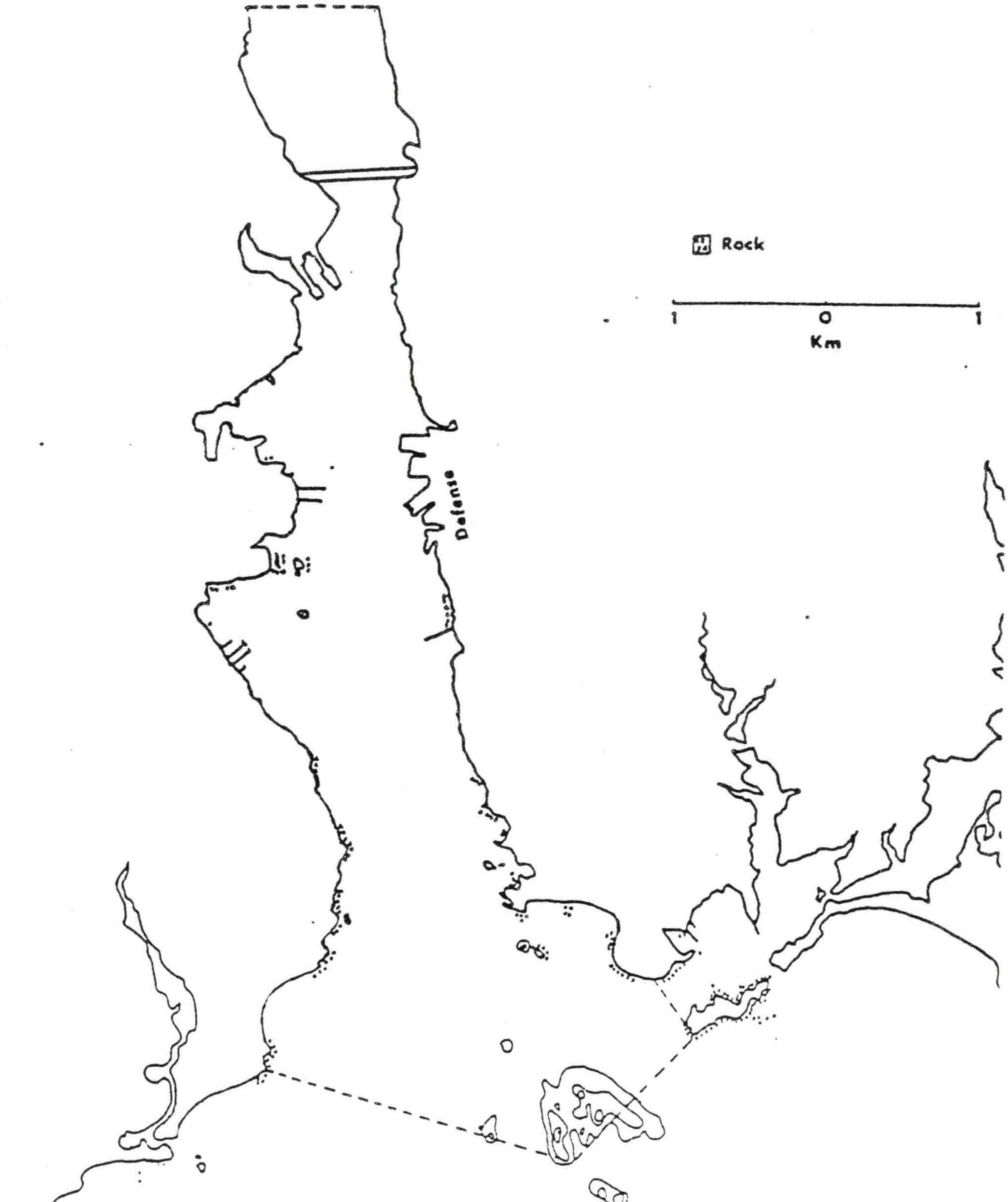
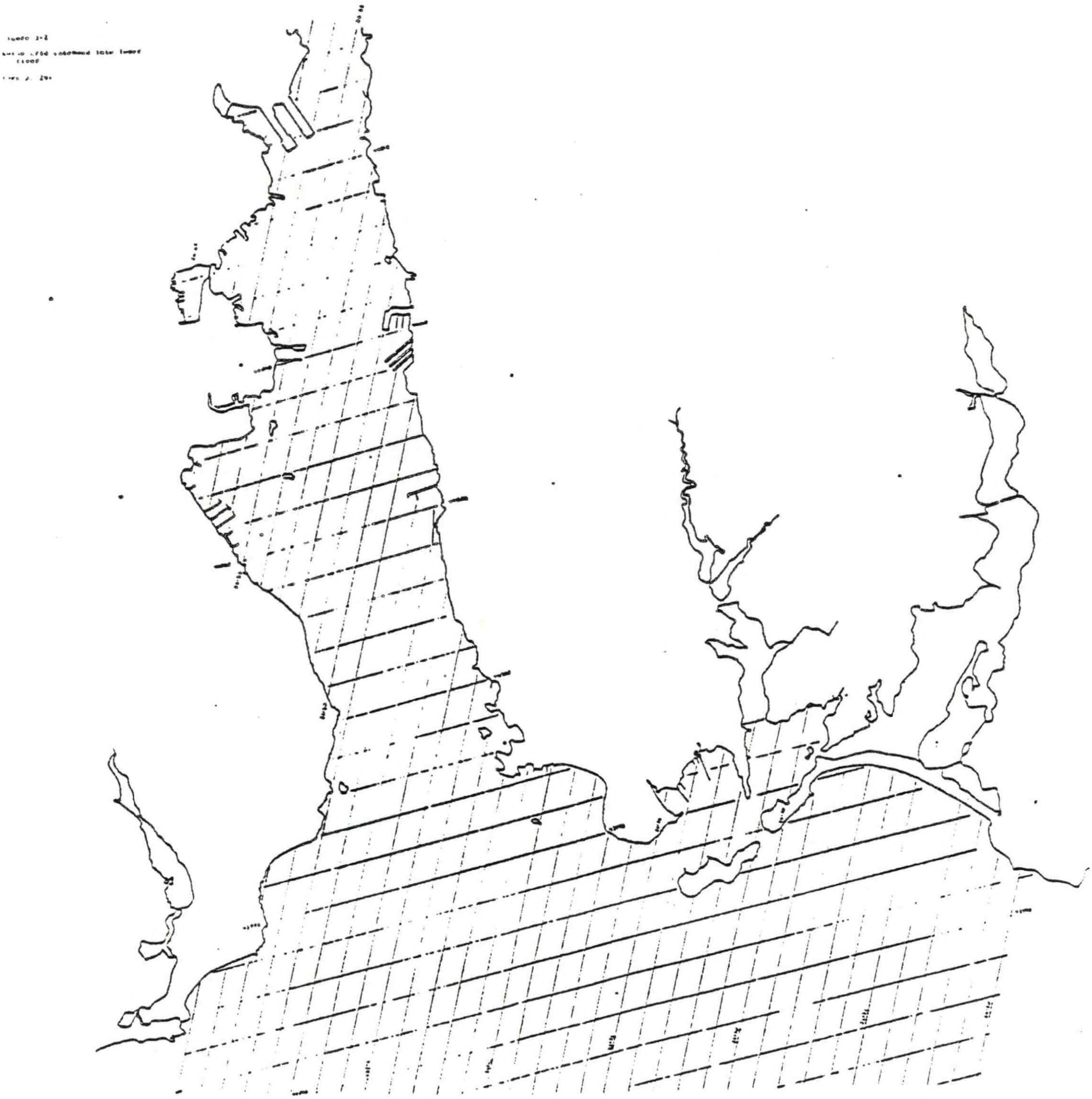


Figure 3-2 LORAN grid extended into the lower river area from empirical measurements. The chart scale is 12000:1.

(Submitted as a large figure)



3.2.2 Aerial Photographs.

Two sets of aerial photos were obtained (Table 3-1) utilizing the services of Coastal Aero-Surveys Inc of Groton CT. The first survey utilized a combination of high-quality, full-spectrum, 70 mm color-negative and color-positive films in side-by-side Hasselblad cameras shooting simultaneously from an elevation of 3,000-ft (305 m) for a scale of 1:1500, Selected areas were then photographed from 1,000 ft for a scale of 1:500. The best time of day for maximum penetration with minimum glare is 0900-1000 and 1500-1600 hrs. It took eight weeks before low water and minimum wind riffle coincided with the proper timing for the survey. Sixty-four frames of each film type were exposed. Coverage included both sides of the river and adjacent areas of the LIS/FIS shoreline.

The color negative film produced the best results, but water penetration was not significantly better than the Coastal Area Management (CAM) aerials which used infra-red (IR) film. The color positive results were overexposed through contractor error. The size of the negative (70 mm) was much inferior to the 260-mm negative of the CAM aerials.

The second aerial flight was conducted with an experimental camera provided by Aero-Marine Surveys. It utilized 240-mm full-spectrum color film which had better resolution and afforded a more convenient size for analysis. Water penetration was better than either the Hasselblad photos or the CAM IR photos. These latter photos were projected to scale onto the 1:1600 mylar base maps using a zoom transfer scope. The image of the plant beds was traced by hand and a qualitative estimate was made for % of bottom coved by the plants.

3.2.3 Shoreline Surveys.

Two visual surveys of intertidal and shallow subtidal plant communities were made by boat along the shoreline throughout the study area (Table 3-1). The plant species making up the obvious components of the community were identified visually and mapped. Species which could not be identified readily were returned to the lab for microscopic identification.

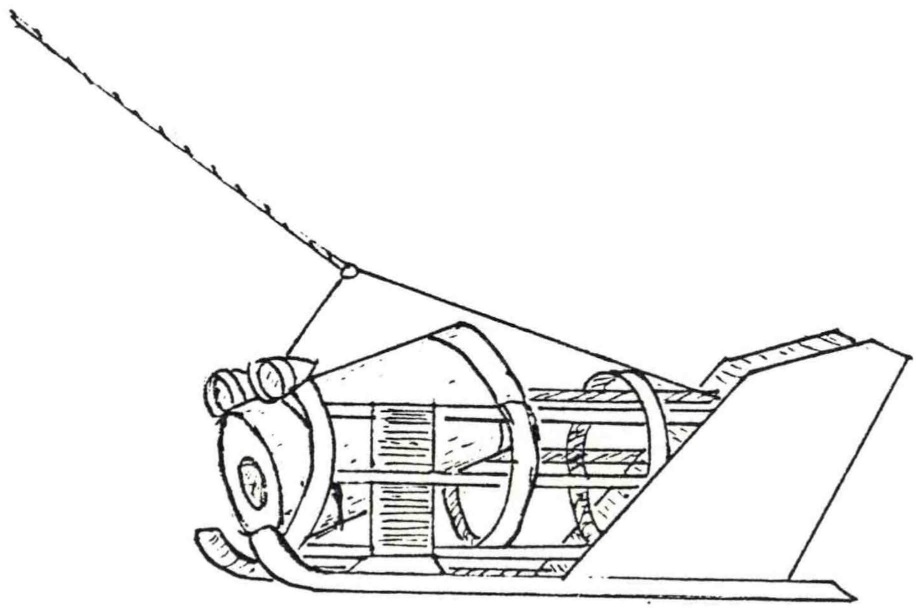
3.2.4 Underwater video surveys.

A series of recordings were taped using an underwater video camera system mounted on a custom-made submersible sled fitted with two 300-W projection lamps (Fig. 3-3). Output was cabled to an onboard monitor and a VHS 1/2-in tape casette recorder. The field of view and distortion of the projected image due to camera angle were calibrated underwater using a 1m X 3m PVC frame gridded to 10cm X 10 cm with twine. The screen image covered a trapezoidal area of about 0.3 m^2. The field of view forward along the bottom was 75 cm deep. It was 35 cm wide directly in front of the camera (bottom of TV screen) and 50 cm wide at maximum field depth (top of screen). Depth readings from a fathometer and observations from the onboard video monitor were vocally recorded onto the tape during the operation. Transects were chosen to coincide with dredging transects and to compare sheltered versus exposed and deep versus shallow portions of

TABLE 3-1. Field sampling dates. Stations are plotted in Figures 3-3 through 3-5.

TYPE OF SAMPLING	SEASON	DATE
DIVER QUADRAT COLLECTIONS	WINTER	JAN 4, 13, 18
	SPRING	MAY 16, 17, 24, 26; JUN 21
	SUMMER	JULY 19, 20, 28; AUG 2, 9
	FALL	DEC 13, 14, 15
BENTHIC DREDGING	WINTER	JAN 11, 12; FEB 4
	SPRING	MAY 25
VIDEO SURVEYS	WINTER	JAN 3, 4
	SPRING	MAY 24, 26, 27
	SUMMER	JULY 13, 14
SHORLINE SURVEYS	SPRING	MAR 30
	SUMMER	JUN 30; JUL 1
AERIAL SURVEYS	SPRING	JUN 29
	SUMMER	SEPT 10
INTERTIDAL/SUBTIDAL	SUMMER	AUG 17, 23
HOBS COVE RECONNAISSANCE	SUMMER	AUG 11
BLACK LEDGE RECONNAISSANCE	SUMMER	JUL 20, 28
LORAN EXTENSION	SUMMER	JUN 21; JUL 11
DIOPATRA COMMUNITY	WINTER	JAN 13

Figure 3-3 Video camera mounted on benthic sled. The camera mounted in the central housing connects to an onboard monitor and VCR recorder on the towing vessel. Two photo floodlamps provide lighting for the camera.



the study area, but it was not always possible to fulfill this plan. The video sled could not be used over irregular rocky substrate, and boulders on the bottom caused damage to the lights and alignment of the camera on several occasions. Neither could it be used successfully in very soft sediments because it sank into the mud and stirred up sediment which blocked the view. It was most useful over relatively flat areas of the bottom with fine sand to small cobbles where it could deliniate transitions between habitats over relatively long distances. The locations of the successful transects are shown in Figs. 3-4 to 3-6.

3.2.5 Benthic dredging.

Benthic dredging was carried out in winter and late spring (Table 3-1), using an oyster dredge with a rectangular opening 74 cm (29 in) wide X 22 cm (8.7 in) high fitted with a 4.5 cm stretch mesh bag. Attempts were made to standardize the transects by maintaining a constant rpm and dredging over a standard time period. It was difficult to judge how comparable the transects were, however. In some hauls the dredge was filled to overflowing with kelp which might have been fished from the entire transect or might have filled the net from a single large deposit and prevented further collection. Where the bottom was too soft, the dredge filled with mud, posing similar concerns for its effectiveness over the length of the transect.

The locations of the dredge hauls were intended to provide qualitative information on the general distribution of the algal drift community over softbottom substrate. During summer, dredging in areas J and K were suspended because the bottom was too soft. Dredging at Greens Harbor was suspended after initial trials because too many boat moorings had been placed in the area.

3.2.6 Quadrat Sampling

A quadrat is an explicitly defined area. For quantitative sampling purposes, it is usually defined by a framework placed over the substrate. In this study an open square metal frame measuring 0.5 m on a side was placed over the rock substrate and all algae within the frame were collected.

Fifty-seven quadrats were collected covering four seasons (Table 3-2). Divers collected seaweed and animals from within a 0.25 m^2 frame using an air-lift sampler fitted with a 0.5 mm mesh Nitex trapping bag. The method was estimated to miss only 1% to 2% of the material under normal conditions. Under the worst conditions encountered (a winter station on an exposed shore) it may have missed as much as 10% of the material.

Placement of the quadrat was not random. Divers first sought an area typical of the dominant community at the station. They then chose a second community, if there was one, otherwise they selected a second quadrat from the same assemblage. If they observed a third obviously different assemblage, they collected an extra sample. This approach, which is obviously biased, was based on background information (22) which indicated that subtidal algal communities existed as broad zones and that usually two or at most three zones inhabited the relatively

Figure 3-4 Location of video transects and benthic dredge transects during the winter survey. Video transects are identified with a V. Letters are standardized station areas.

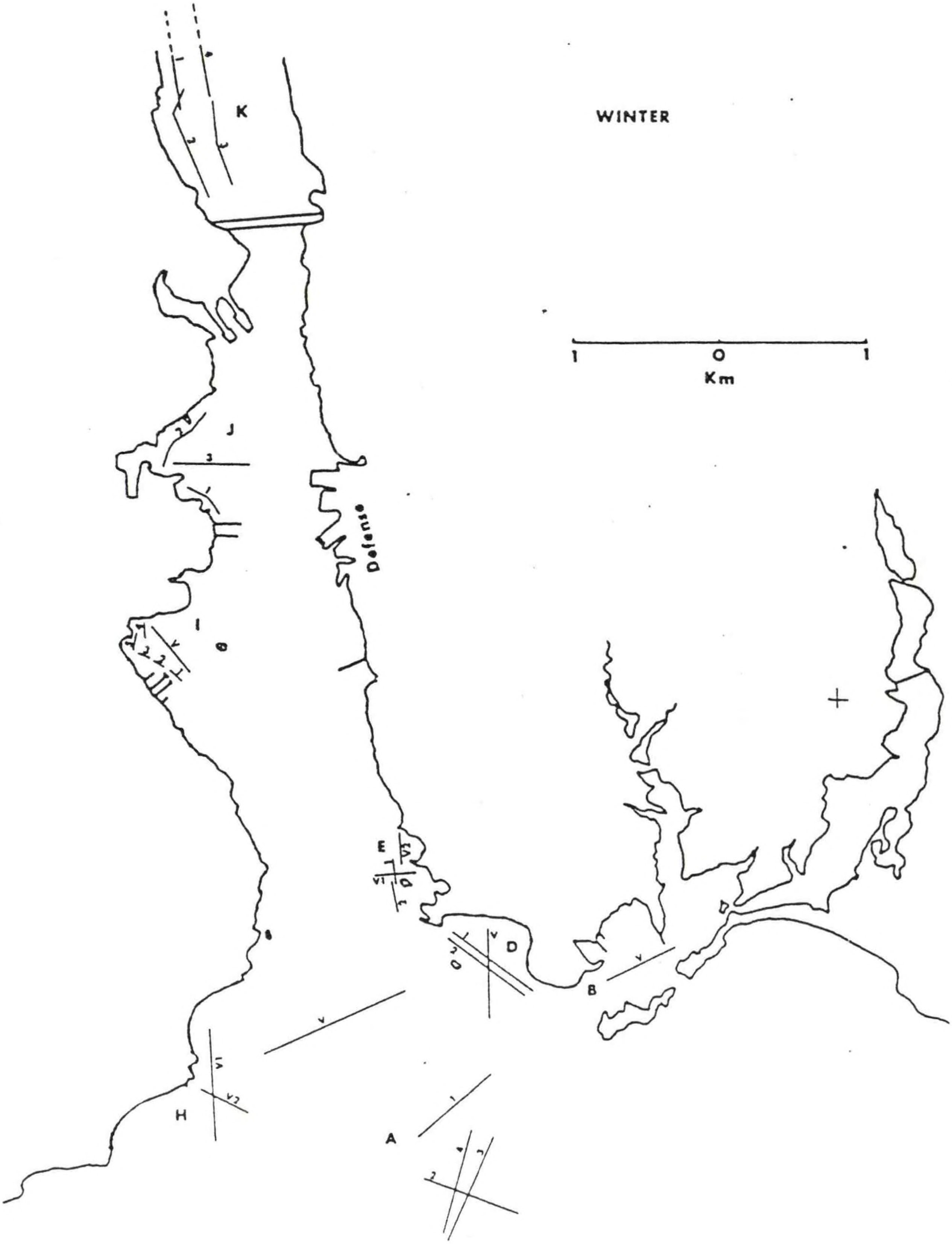


Figure 3-5 Location of video transects and benthic dredge transects during the spring survey. Video transects are identified with a V. Letters are standardized station areas.

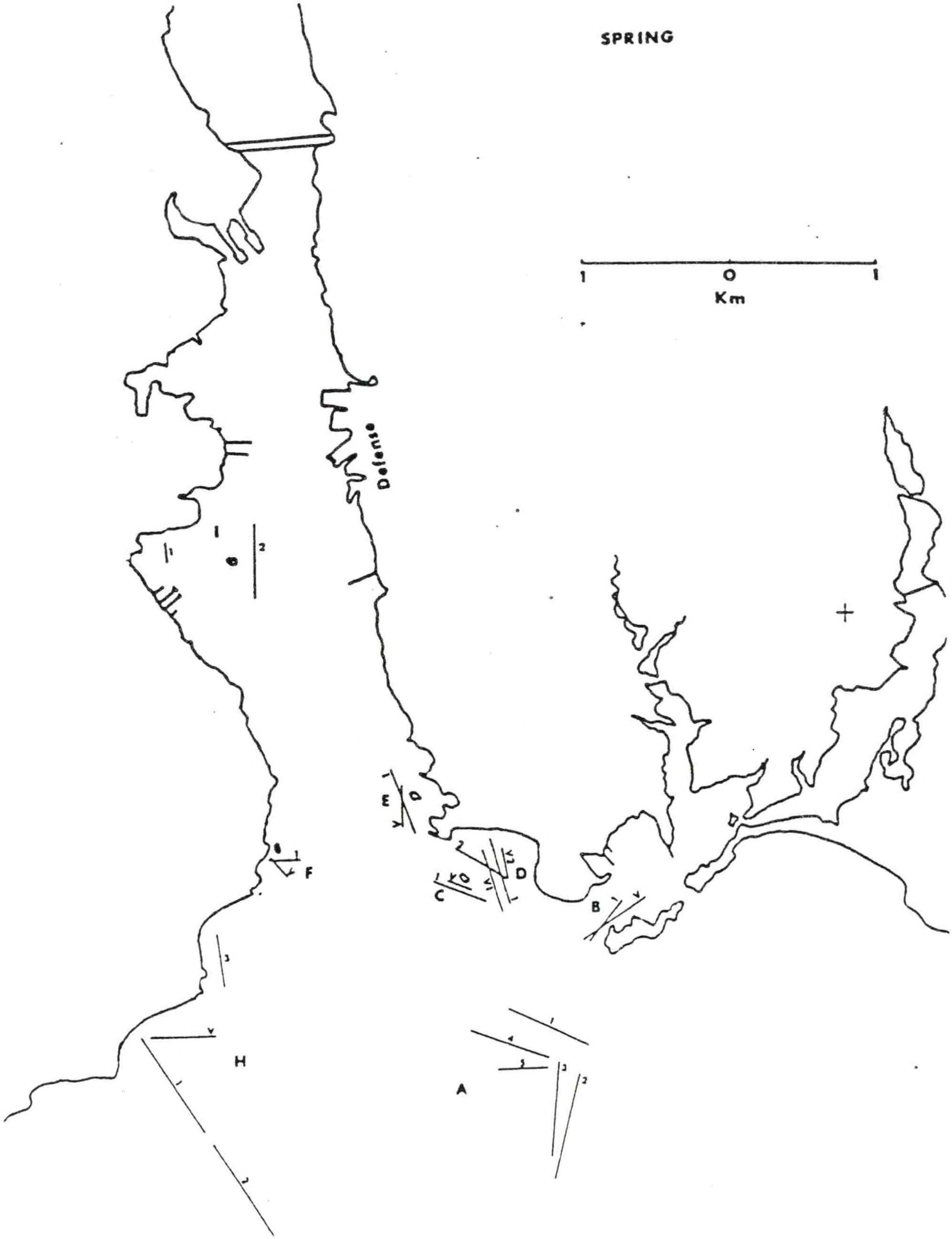


Figure 3-6 Location of video transects during the summer survey. Letters are standardized station areas.

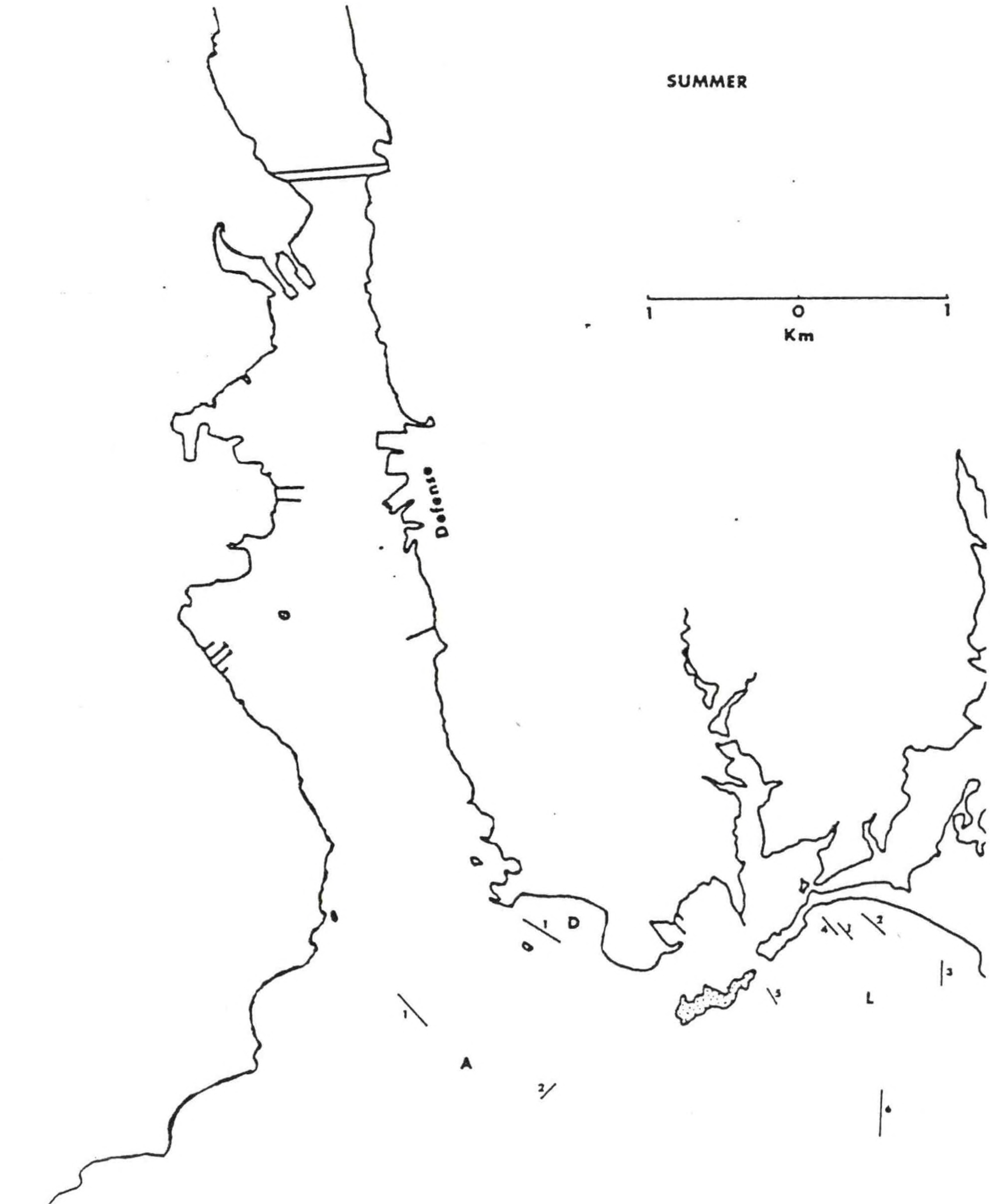


Table 3-2. Distribution of quadrat samples by station and by season. Station letters correspond to locations on Figure 3-6.

STATION	WINTER	SPRING	SUMMER	FALL
BLACK LEDGE (A)	-	6	2	3
AVERY POINT (B)	3	3	2	2
BLACK ROCK OUTSIDE (C)	-	2	2	2
BLACK ROCK INSIDE (D)	-	2	2	2
HOBS ISLAND (E)	-	3	2	2
QUINNIPEAG ROCKS OUTSIDE (F)	2	3	2	2
QUINNIPEAG ROCKS INSIDE (G)	-	-	2	2
LONG ROCK (H)	-	2	2	2
TOTAL:	5	19	16	17

narrow band of subtidal hardrock along the shore.

The stations were chosen close to the traffic lanes (Fig. 3-7) and represented a variety of exposure conditions (Table 3-3). A long fetch in the SW quadrant indicated more exposure in summer when winds and waves were generally moderate; a long fetch in the SE quadrant indicated more exposure in winter when winds and waves tended to be highest.

A set of intertidal/subtidal transects were sampled by quadrat method at Quinnipeag Rocks and Black Rock to compare algal assemblages on exposed and sheltered sides of these islands.

3.2.7 Special studies

A diver reconnaissance survey was made in the Hobs Island Cove area to correlate the benthic vegetative cover determined from the aerial photographs with species types and distributions. A 50-m transect line marked at 1-m intervals was used to locate the underwater observations.

A diver reconnaissance survey was made over Black Ledge to determine the extent of the various habitats making up the Black Ledge area and to try to determine why the results of our dredging and quadrat surveys there differed so markedly from the results of a previous study (28).

A diver reconnaissance survey was made over a benthic tubeworm (*Diopatra cuprea*) community to document the species of algae utilizing the worm tubes as a substrate in a conventional soft-bottom community.

3.2.8 Laboratory processing of plants and animals

Plant materials collected by airlift or by benthic dredge were separated by species. Animals were separated from the plants and preserved in a 6:3:1 water:alcohol:formalin preservative containing Rose Bengal stain. They were later identified and enumerated. The plants were identified in fresh condition, using the keys in Table 3-4. The plants were then dried to constant weight at 60 C. Samples which were too mixed to be separated (ie hopelessly entangled by epiphytic secies), or too large to be resonably dried (ie massive kelps), the plants were subsampled by wet weight and a wet:dry weight ratio subsequently applied. For the kelps, blades, stipes and holdfasts were of such different densities that the three portions were subsampled and recalculated separately.

Data were computerized using an Apple II computer and spreadsheet program. Classification analysis was performed using an IBM computer with SAS statistical package (38).

Figure 3-7 Location of diver quadrat stations during all seasons. Letters are standardized station areas.

Table 3-3. Estimated fetch distances for Quadrat stations by compass direction (to nearest 10 m).

STATION	NORTH 360/0	NE 45	EAST 90	SE 135	SOUTH 180	SW 225	WEST 270	NW 315
	DIRECTION (DEGREES ARE REFERENCED TO TRUE NORTH)							
A. BLACK LEDGE	1450	1310	14100	5380	29660	26170	2240	1760
B. AVERY POINT	50	180	540	250	30530	22680	2260	90
C. BLACK ROCK OUTSIDE	0	0	450	6400	30820	22530	450	0
D. BLACK ROCK INSIDE	290	390	430	0	0	0	1290	1630
E. HOBS ISLAND	360	0	0	0	22970	22610	880	1500
F. QUINNIPEAG ROCKS OUTSIDE	0	0	1600	7270	21080	280	80	90
G. QUINNIPEAG ROCKS INSIDE	390	0	0	0	21080	220	50	110
H. LONG ROCK	50	2260	6400	6980	20430	23190	90	90

Table 3-4. Keys and references for laboratory identifications.

Abbot, I.A. and G.H. Hollenberg. 1976. Marine algae of California. Stanford University Press, Stanford, CA, 827p.

Bigelow, H.B. and W.G. Schroeder. 1953. Fishes of the Gulf of Maine. Fishery Bull 74. US Fish and Wildlife Service Vol 53. US Govt Printing Office. Washington, DC, 577p.

Gosner, K.L. 1971. Guide to the identification of marine and estuarine invertebrates. Wiley-Interscience, NY, 693p.

Project Oceanology. No date. Keys to the identification of the plants and animals of Long Island Sound. Vol 1. Macrofauna. Avery Point, Groton, CT, (unpub).

Rehder, H.A. 1981. The Audobon Society field guide to North American seashells. Alfred A. Knopf Inc, NY, 894p.

Skchneider, C.W., M.M. Suyemoto and C. Yarish. 1979. An annotated checklist of Connecticut seaweeds. CT Geol. Nat. Hist. Survey Bull 108. Hartford, CT, 20p.

Smith, R.I. (ed). 1964. Keys to marine invertebrates of the Woods Hole region. Contrib. 11. Systems Ecology Program. MBL, Woods Hole, MA. 208p.

Taylor, W.R. 1957. Marine algae of the northeastern coast of North America. Univ. Mich. Press, Ann Arbor, Mich. 509p.

Wood, R.D. and J. Lutes. 1967. Guide to the phytoplankton of Narragansett Bay, Rhode Island. Univ. Rhode Island Printing. Kingston, RI, 65p.

Wood, R.D. and M. Villahard-Bohnsack. 1974. Marine algae of Rhode Island. Rhodora 76:399-421.

3.3 Results and Discussion

3.3.1 Plant and Animal Taxa

The study identified 63 seaweed taxa and one vascular plant (Table 3-5). Red algae (Rhodophyta) were by far the most abundant plant division with 40 species. Green algae (Chlorophyta) and brown algae (Phaeophyta) followed with ten taxa each. The one species of vascular plant was eelgrass, *Zostera marina*. All except the two species of *Membranoptera* have been reported in checklists for Long Island Sound (26). Thirty-three of these species were reported in background studies (Section 2.2.2).

One hundred three animal taxa were identified, several of which were grouped at relatively high taxonomic levels (Table 3-6). For crustaceans, groups such as amphipods and isopods probably combined many species and significantly lowered the estimated species richness (number of species) in the habitat. For polychaetes, groups such as Maldanidae and Onuphidae (families) probably contained only one or two species and thus did not seriously alter species richness. The grouping of species into higher-order taxa in this study and the previous studies precludes a realistic comparison of common organisms, but this study contained at least twenty-two taxa which could be legitimately distinguished from those of previous studies (Appendix Table A1, A-D).

3.3.2 Distribution of Macrophyte Habitats

3.3.2.1 Physical characteristics of the study area

The study area covers 8.15 km^2 between Bailey Point on the north to the New London Ledge-Black Ledge area on the south (Fig. 3-1). It includes 46 km of shoreline, including islands. About 60% percent of the area lies above the 5.5-m (18 ft) isobath, which was discussed in Section 2.2 as a conservative estimate of the maximum depth of adequate light penetration for plant growth most of the time. Most of the shoaler areas lie on the west side of the river, where the shoreline is indented with coves and bights. The dredged channel lies close to the east bank of the river, which is relatively steep and straight. Subtidal ledges and boulder (foul) areas as indicated on NOAA (formerly CGS) charts occupy a relatively small proportion of the area.

3.3.2.2 Aerial Photographs

The relative proportions of shoreline as charted from the aerial photos were 17% beach, 46% natural rock and 37% rip-rap (including bulkheads and wharves) based on linear measurement (Fig. 3-8). Most of the industrialized areas of the harbor were bordered by rip-rap, bulkheads and wharves.

The distribution and density of subtidal plant beds could be discerned to about the 1.8-m (6-ft) isobath at the mouth of the river, but visibility decreased rapidly with distance into the harbor (Fig. 3-9). Thus the lack of detection of plants in the inner harbor by this method does not necessarily mean there are no plants there.

Table 3-5. Plant taxa identified from the present study.
* = species previously reported in background studies.

BACILLARIOPHYCEAE

Amphipleura sp
Licomorpha sp

CHLOROPHYCEAE

**Bryopsis plumosa*
**Chaetomorpha linum*
**Cladophora albida*
Cladophora glomerata
**Cladophora sericea*
**Codium fragile*
**Enteromorpha sp*
**Rhizoclonium tortuosum*
**Ulothrix sp*
Ulva lactuca

CHRYSOPHYCEAE

Vaucheria sp

PHAEOPHYCEAE

Ascophylum nodosum
**Desmerestia aculeata*
Desmarestia viridis
**Ectocarpus siliculosus*
Fucus distichus
**Fucus vesiculosus*
Fucus spiralis
Laminaria digitata
**Laminaria saccharina*
Scytosyphon lomentaria

TRACHEOPHYTA

**Zostera marina*

RHODOPHYCEAE

**Ahnfeltia plicata*
**Antithamnion americanum*
**Antithamnion cruciatum*
Antithamnion pylaisaei
**Bangia atropurpura*
**Bonnemaisonia hamifera*
**Callithamnion baileyi*
**Callithamnion byssoides*
**Callithamnion roseum*
Callithamnion tetragonum
**Ceramium rubrum*
**Champia parvula*
**Chondrus crispus*
**Corallina officinalis*
**Cystoclonium purpureum*
**Dasya bailouviana*
Gracilaria tikvahiae
**Grinnellia americana*
**Lomentaria baileyana*
Membranoptera alata
Membranoptera denticulata
Neoagardhiella baileyi
**Palmeria palmata*
Phycodrys rubens
**Phyllophora pseudoceranoides*
**Phyllophora truncata*
**Polyides rotundus*
**Polysiphonia denudata*
Polysiphonia elongata
**Polysiphonia harveyi*
Polysiphonia lanosa
Polysiphonia nigra
**Polysiphonia nigrescens*
Polysiphonia novae-angliae
Polysiphonia subtilissima
**Polysiphonia urceolata*
**Porphyra leucostica*
Rhodomela confervoides
**Spermothamnion repens*

Table 3-6 Master list of animal species collected from the New London harbor area.

TAXON	SPECIES	PHYLUM	SPECIES
MOLLUSCA - BIVALVIA	*Anadora transversa*	ARTHROPODS	*Cancer irroratus*
	Anomia simplex		*Carcinus maenas*
	Argopecten irradians		*Caprella sp*
	Astarte undata		*Crangon septemspinosa*
	Mercenaria mercenaria		*Erichsonella filliformis*
	Mulinia lateralis		*Eurypanope depressus*
	Mytilus edulis		*Gammarus oceanicus*
	Nuculana tenuisulcata		*Idotea baltica*
	Pitar morrhuana		*Idotea phosphorea*
	Solemya velum		*Libinia dubia*
	Bivalve 1 Unid		*Libinia emarginata*
	Bivalve 2 Unid		*Neopanope texana sayi*
			Ovalipes sp
MOLLUSCA - GASTROPODA	*Acmaea testudinalis*		*Pagurus longicarpus*
	Anachis sp		*Pagurus pollicaris*
	Bittium alternatum		*Palaemonetes sp*
	Busycon canaliculatum		*Pelia mutica*
	Cerithiopsis greeni		*Pinnotheres maculatus*
	Crepidula convexa		*Rithropanopeus harrisii*
	Crepidula fornicata		Acarina unid
	Crepidula plana		Amphipod unid
	Epitonium sp		Barnacle unid
	Ilyanassa obsoleta		Isopod unid
	Lacuna sp		
	Littorina littorea	ECHINODERMS	*Arbacia punctulata*
	Littorina obtusata		*Asterias forbesi*
	Lunatia sp		*Axiognathus squamatus*
	Mitrella sp		*Henricia sanguinolenta*
	Nassarius trivittatus		*Pentamera pulcherrima*
	Nudibranch Unid		
	Onchidoris sp	CHORDATES	*Ascidia sp*
	Urosalpinx cinerea		*Myoxocephalus aeneus*
			Pholis gunnellus
ANNELIDS	*Ampharete sp*		*Pseudopleuronectes americanus*
	Amphitrite ornata		*Syngnathus fuscus*
	Cirratulus grandis		*Tautoga onitis*
	Diopatra cuprea		
	Dodecaceria coralii	CNIDARIA	*Campanularia sp*
	Eunice sp		*Diodumene leucolena*
	Lepidonotus squamatus		*Sertularia pumila*
	Lumbrinereis sp		Anemone unid
	Lycastopsis pontica		
	Nephthys sp	PORIFERA	*Haliclona loosanoffi*
	Nereis acuminata		*Microciona prolifera*
	Nereis pelagica		Unid 1
	Nereis sp		Unid 2
	Odontosyllis fulgunanus		
	Oligochaeta unid	BRYOZOA	*Crisia sp*
	Pista palmata		Bryozoan unid
	Polydora ligni		
	Potamilla sp	PLATYHELMINTHES	Flatworm unid
	Spirorbis sp		
	Maldanidae or Owenidiidae		
	Onuphidae unid		
	Phyllodocidae unid		
	Sabellidae unid		
	Terebellidae unid		
	Polychaeta unid		

Figure 3-8 Distribution of shoreline types within the study area. Rip-rap includes both wharfage and bulkheading.

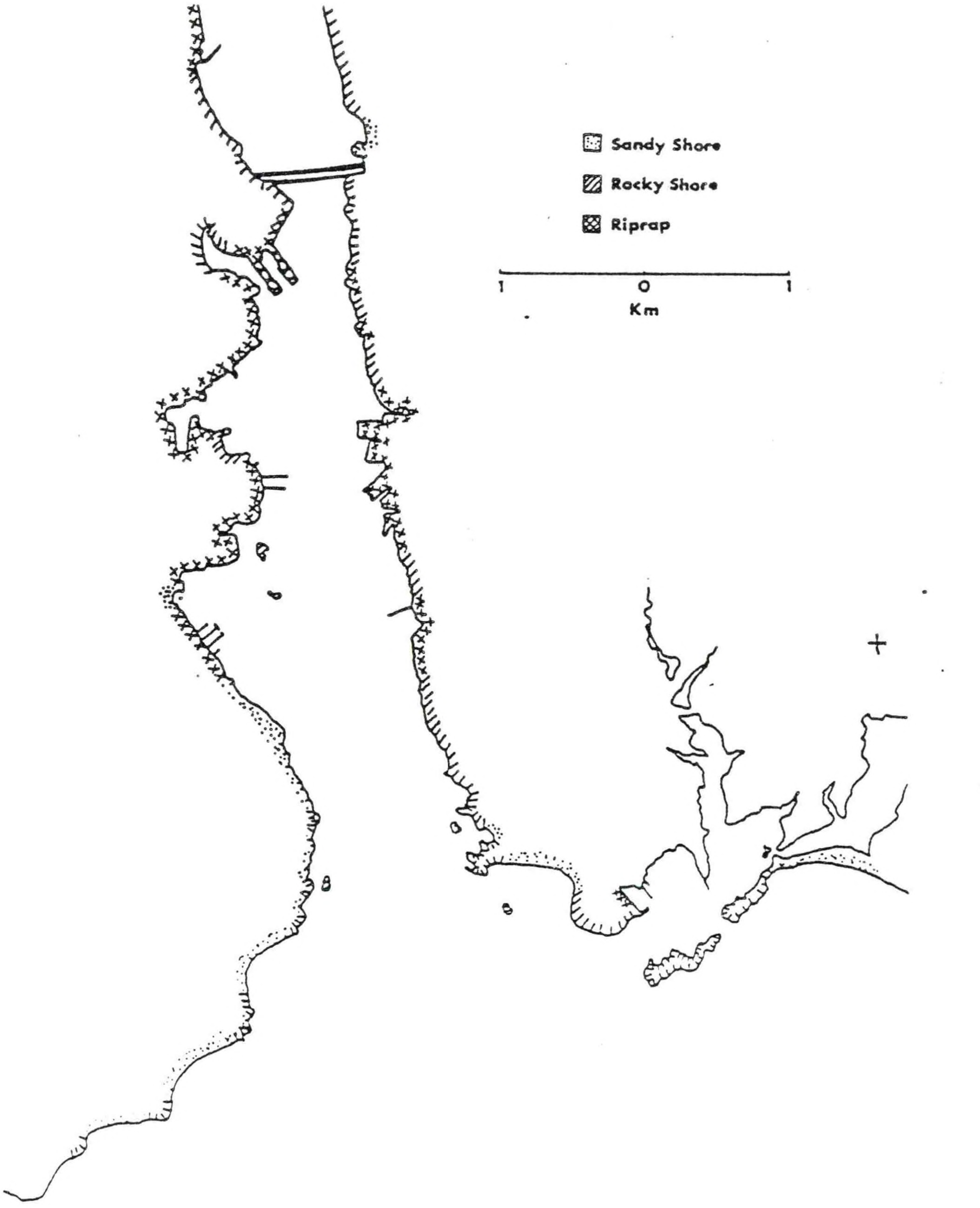
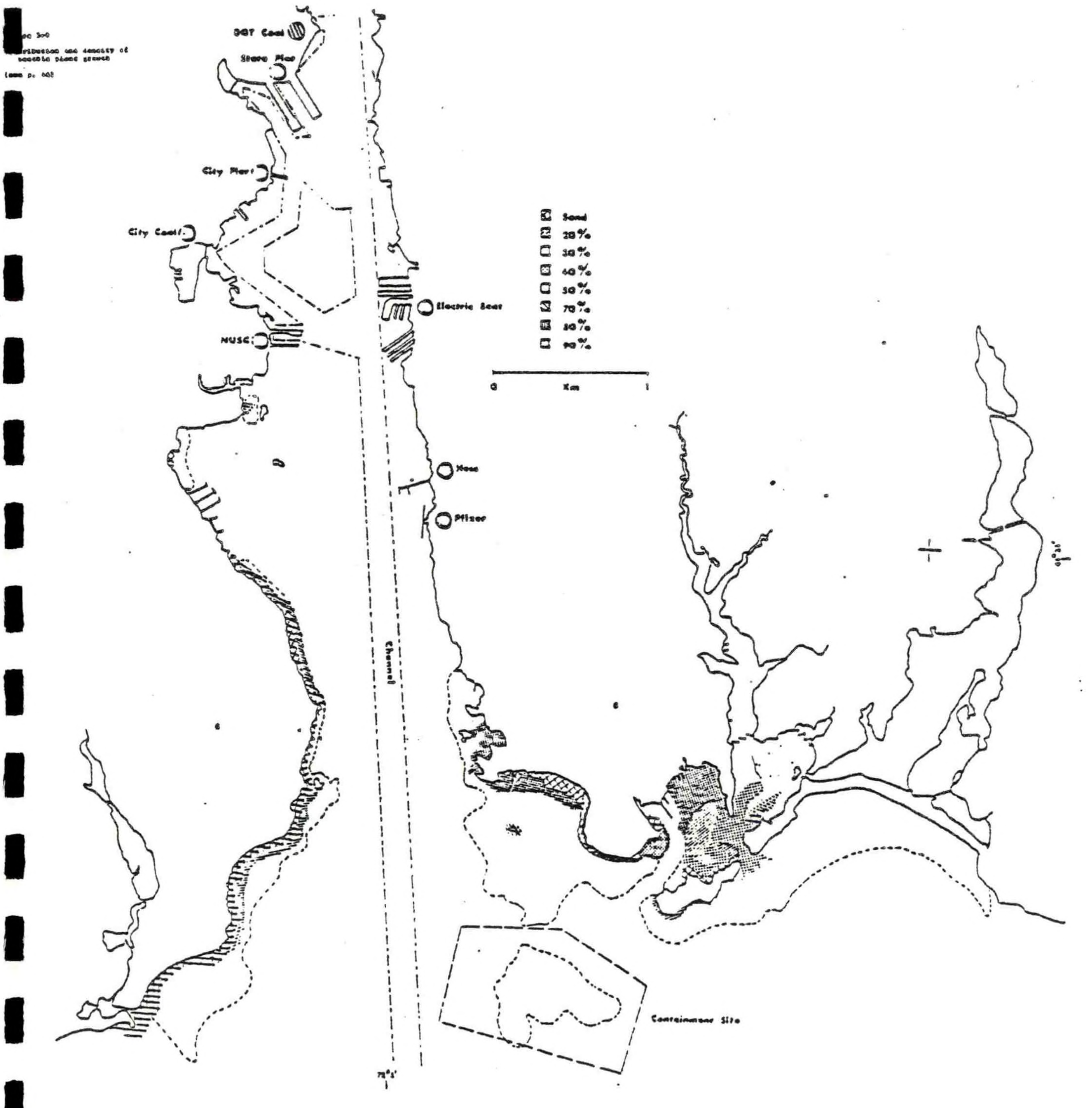


Figure 3-9   Distribution and density of benthic plant growth as discerned from aerial photographs.

(Submitted as a large figure)



On rocky substrate, the heaviest plant cover was along exposed shorelines. On soft substrate, cover was heaviest in protected bays such as behind Pine Island (near Sta B) and behind Hobs Island (near Sta E). Along exposed beaches, there was typically a strip of sand between the beach and any offshore plant beds, which presumably corresponded to the swath of high wave energies.

With respect to subtidal plant distributions, we considered the information obtainable from aerial photos to be limited even under the best conditions, but their geomorphological information was useful. They showed, for instance, that for the Poquonnock River system, which lies immediately adjacent to the harbor on the east, there is a net inward transport of sediment. This situation indicates that drifting benthic algae from the Thames River would also be carried into the Poquonnock River system.

3.3.2.3 Shoreline surveys and intertidal transect studies.

The shoreline observations confirmed the distribution of beaches, natural rocks and rip rap and bulkhead zones charted from the aerial photographs. Most riprap and bulkheaded margins were steep, narrow and bordered by deep water, thus providing only a narrow zone for attached plant growth. Natural rock margins were highly variable. At one extreme there was a near-vertical cliff bordering the channel on the western flank of Hobs Island (Sta E). At the other extreme there were broad subtidal ledges strewn with boulders such as the southern exposures of Pine Island and Black Rock (Sta C) and skirting the promontories to the east and west of the harbor mouth. These rockstrewn ledges along with extended areas of boulders and ledges interspersed with sand substrate, generally corresponded to the nearshore zones designated as "foul" on NOAA (CGS) charts (Fig. 3-1). In contrast to smooth ledges, rip-rap and bulkheads, these boulder-strewn areas provided highly irregular, 3-dimensional habitats which greatly increased both the diversity of conditions and the surface area available for algal growth. Thus their importance as a habitat within the system is substantially underestimated from a simple planimetric measurement of the relative amount of area they occupy.

Most of the shallow subtidal zones consisted of cobble, gravel or coarse sand with boulders, rather than the fine sands and soft muds reported for the deeper area (Section 2.2). The water was extremely turbid along the rip-rap and bulkheads of the wharf areas and industrialized zones of both sides of the river.

Nineteen seaweed taxa were identified in the intertidal and shallow subtidal zones, 10 in early spring, 16 in summer, and 7 overlapping both seasons (Table 3-7). Along the beaches, the algae were mostly confined to subtidal cobbles and boulders. On natural rock shorelines, and rip-rap and bulkheads (including wharf pilings), they occupied intertidal and subtidal areas and were distributed in classical patterns of vertical zonation. Intertidal zones were narrower and more well-defined than subtidal zones. The algal assemblages occupying each particular zone are controlled by degree of tidal exposure, by wave energy regimes, and by light penetration as determined by depth and turbidity, producing a general pattern in which the gentler the slope of the substrate and the clearer the

Table 3-7. Species identified in intertidal surveys. Coded to Figures 3-10 and 3-11.

Species	Code	March Survey	June-July Survey
Ascophylum nodosum	An	X	X
Bangia atropurpura	Ba	X	
Chaetomorpha linum	Cl		X
Champia parvula	Cp		X
Chondrus crispus	Cc	X	X
Ectocarpus siliciosus	Es		X
Enteromorpha sp	Esp	X	X
Fucus vesiculosus	Fv	X	X
Laminaria saccharina	Ls	X	X
Neoagardhiella baileyi	Nb		X
Polysiphonia sp	Psp		X
Porphyra leucosticta	Pl	X	
Scytosiphon lomentaria	Sl	X	
Spermothamnion repens	Sr		X
Ulva lactuca	Ul	X	X
Vaucheria sp	Vsp		X
Zostera marina	Zm	X	X
	Total:	10	14

water, the wider the zone will be and the more abundant the algal assemblages will be per linear unit of shoreline. Thus in the study area algae were most abundant along natural rock shorelines of the lower harbor and least abundant along the rip-rap and bulkheads of the industrialized shorelines with their murky waters.

The species distributions for the surveys (Figs. 3-10, 3-11) exhibited qualitative changes associated with the gradient into the estuary and with season. *Fucus vesiculosis* was the most ubiquitous species. It inhabited the mid-tidal zone throughout area in both winter and summer. *Fucus* is a perennial brown alga well-adapted to tidal exposure in low to moderate wave regimes. It is also tolerant of a broad range of salinity and temperature.

At the mouth of the river, the *Fucus* zone graded into *Chondrus crispus* at low intertidal or upper subtidal depths. Deeper in the subtidal, *Chondrus* became mingled with *Laminaria saccharina,* which took over as zone dominant if the rock substrate continued into deeper water. *Chondrus,* a tough red alga, and *Laminaria,* a brown kelp with strong hold-fasts, are well adapted to the hardrock substrates and high wave energies of exposed coastlines. *Laminaria* can inhabit fairly deep waters because its strap-like thalli can extend upward into better lighted zones. The thalli of *Chondrus* are relatively short. Both *Chondrus* and *Laminaria* are boreal and sub-boreal in distribution, with Long Island Sound lying near the southern limits of their geographic range. Neither was found north of Trumbull Point (NUSC, Fig.2-2) in summer, probably because river temperatures exceeded their tolerance levels. Moreover, there were few deepwater hardrock substrates within the river, so that where *Laminaria* did occur, its blades were short and narrow and its biomass was correspondingly diminished.

In more protected areas, *Ascophyllum nodosum* occupied the lower intertidal area below the *Fucus* zone. *Ascophyllum* is a brown alga which, like *Fucus,* is tolerant of tidal exposure and a relatively broad range of salinity and temperature, but less tolerant of wave exposure.

Several green algae, *Ulva lactuca, Enteromorpha sp* and *Cladophora linum,* and a chrysophyte, *Vaucheria sp,* proliferated throughout the study area in both late spring and summer and probably reflected nutrient loadings from the two sewage outfalls in the harbor. These ubiquitous taxa can also grow unattached over soft substrates and are found in shallow areas with low current regimes. If nutrients are plentiful, they become very dense.

Two distinctly seasonal species were found, *Porphyra leucosticta* (winter) and *Neoagardhiella baileyi* (summer). They were only present at stations outside the river.

The remaining species were primarily epiphytes, mostly red algae. Their biomass was generally negligible relative to the dominants and their occurrences were less predictable.

The shoreline surveys indicated that the distribution of algae in intertidal and shallow subtidal areas was qualitatively typical of northeastern rocky coastlines, exhibiting a common zonation pattern of *Enteromorpha-Fucus-Chondrus-Laminaria* with minor variations of that

Figure 3-10 Distribution of intertidal and shallow subtidal algae as determined from the shoreline survey conducted on 30 March 1983.

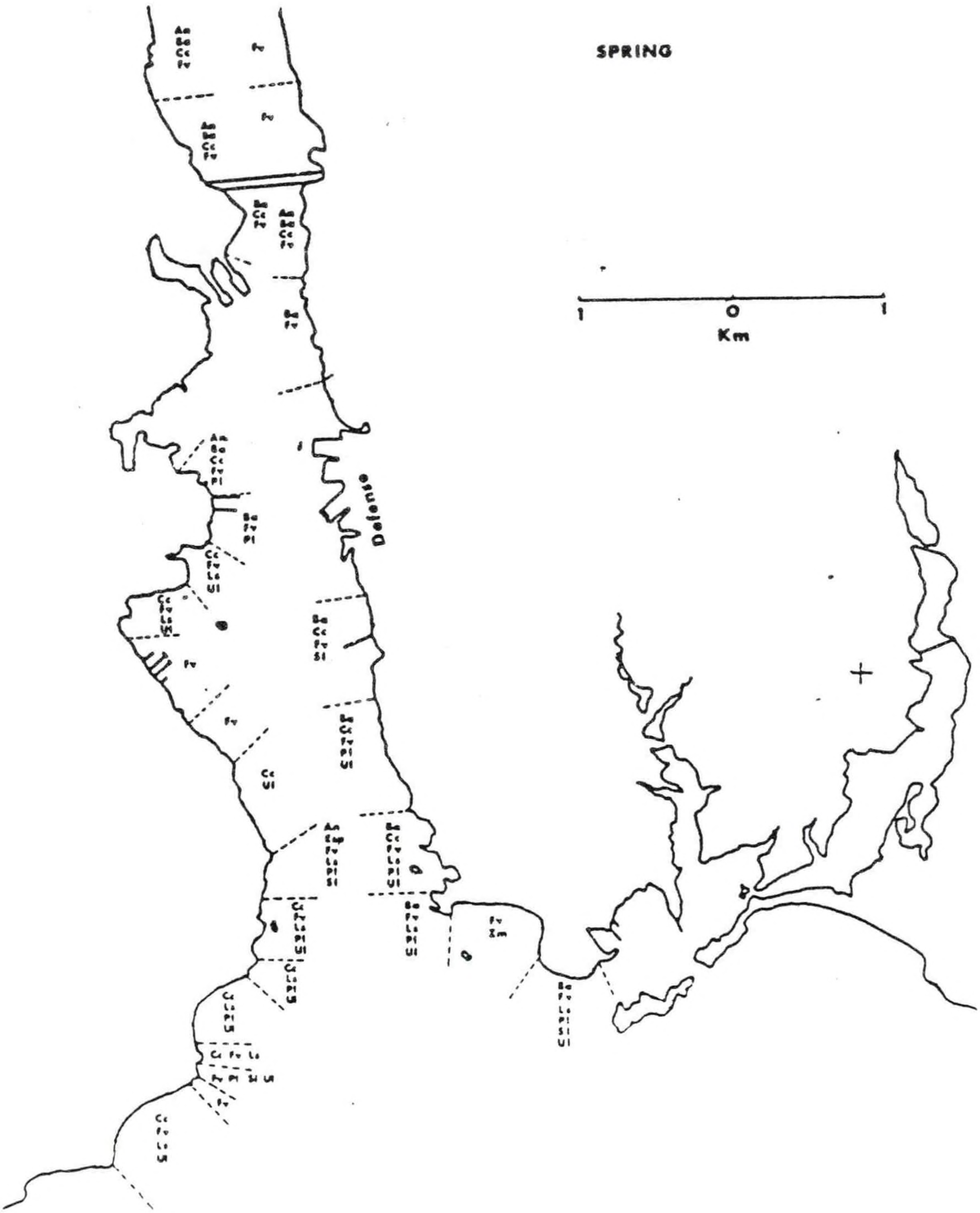
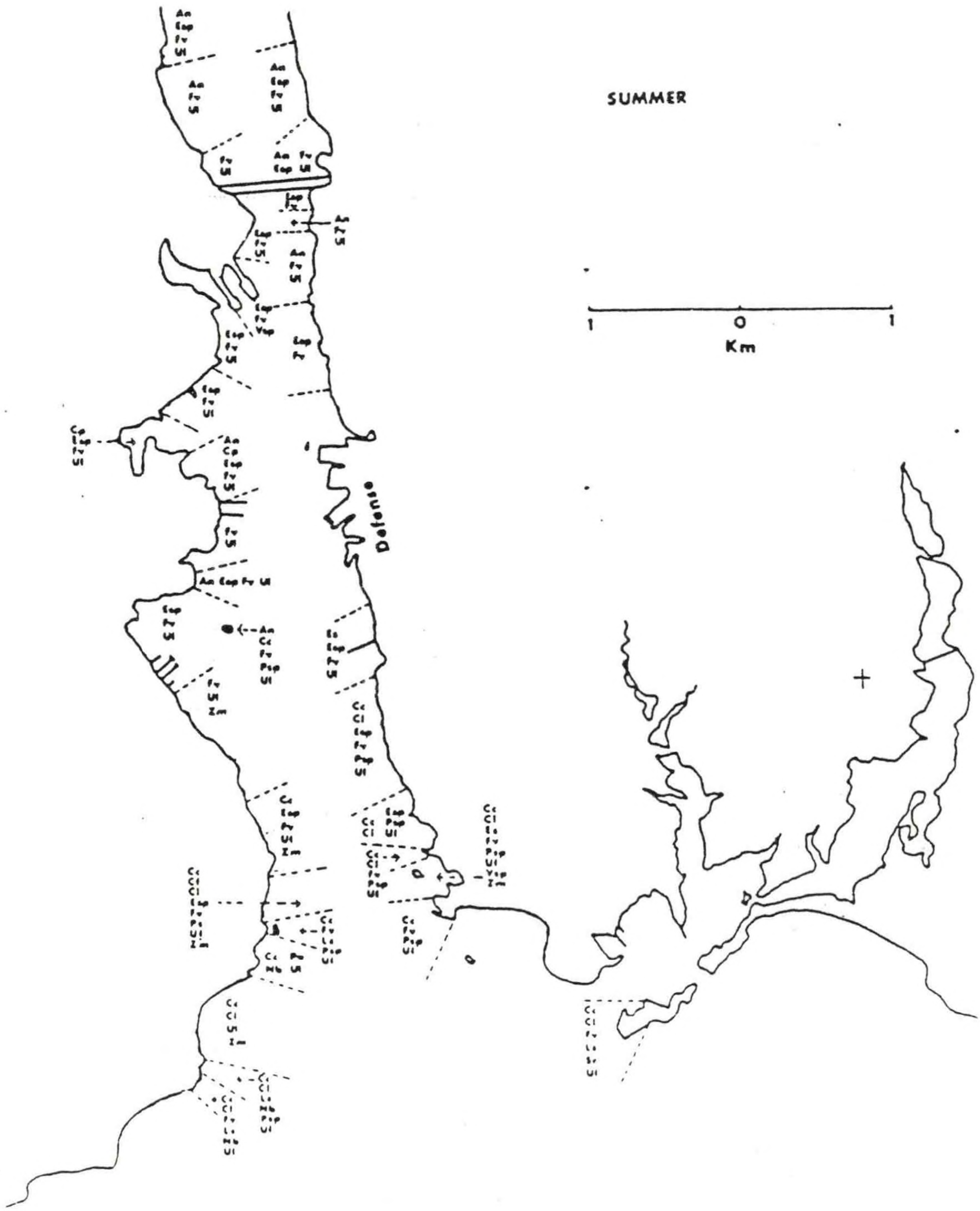


Figure 3-11 Distribution of intertidal and shallow subtidal algae as determined from the shoreline survey conducted on 30 June and 1 July 1983.



pattern in response to wave exposure, depth and nutrient regimes. These patterns were most recognizable along shorelines with extensive rocky substrate. Along industrialized shorelines, the pattern was aberrant. The community usually occupied a very narrow zone due to the murky water. It was either very sparse and grew as small mucoid balls or, if abundant, was dominated by pollution-tolerant species such as *Ulva, Cladophora, Enteromorpha* and *Vaucheria.* In either case, the mucoid balls or fronds tended to be laden with silt.

Except for the industrialized shorelines, the zonation patterns and their variations were similar to those found at exposed and sheltered stations in the Millstone Point area (15,16,17,18,19). In the latter studies, which have been conducted continuously for more than ten years over all seasons, the dominant species and their distributions remained relatively stable from year to year. We would expect, therefore, that the patterns in the Thames River are similarly stable.

3.3.2.4 Video Transects

Qualitative descriptions of the substrate type and softbottom plant distributions along the video transects are given in Table 3-8. The transects revealed that subtidal bottoms are a spatial mosaic of substrate types, which we have identified as soft silt, mud, mud consolidated with amphipod tubes, fine sand, sand, sand with gravel, sand with cobble, shifting sand over cobble, cobble, cobble with sand, ledge, and shifting sand over ledge. They are distributed in complex, relatively small-scale (tens of meters) patterns which appear to reflect interacts between depth, exposure and current regimes (Fig. 3-12).

The plants were classified as rooted (eelgrass), attached algae, drift algae, trapped drift algae, and lentic algae. "Lentic" is a term used to describe quiescent pools in streams, and it appropriately describes communities of lightly attached or unattached algae which develop in shallow, protected areas where there is negligible current flow.

Eelgrass beds were relatively localized in distribution, which would be expected from their growth form in which individual turgeons (leaf groupings) arise from a network of rhizomes (horizontal roots) lying beneath the substrate. The densest beds were located in protected areas where there was good current flow. They were all subtidal, extending from just beyond extreme low water (LLW) to depths which varied from location to location. Off Shennecossett Beach (Sta D) and Bluff Point (Sta L), the beds were found to nearly 5 meters, and blades were correspondingly very long. Within the river, maximum depths were about 2 m, and blades were shorter. The beds terminated relatively abruptly, preceded by a short transition zone of rapidly thinning blade densities.

In contrast, the macroalgal distributions beyond the hardrock areas were extensive. Attached and presumably growing algae were found from the intertidal zone to depths of 10.2 m, utilizing cobble, gravel, wharves, shell, worm tubes, eelgrass and debris for substrate. Considering the size of algae attached to pebbles and kelp blades attached to relatively small boulders, there must be considerable

Table 3-8. Results of Video Transects. ( ) refer to transects in Figures 3-3, 3-4 and 3-5.

Station A
July transect (A1).
depth: 28-30 ft
substrate: soft silt, flat, featureless except patches of amphipod tubes
flora: none seen
fauna: none seen

July transect (A2).
depth: 5 ft - 10 ft
substrate: shifting sand, exposed bedrock and large boulders in about equal proportions
flora: forest of large kelps (*Laminaria saccharina*) about 5 m long rising 1-2 m off bottom then trailing in direction of prevailing current. Understory primarily filimentous reds and *Chondrus crispus*.
fauna: none noted.

B. Avery Point
May transect (Bv)
depth: 19 ft -> 8 ft
substrate: sand -> sandy silt
flora: sparse attached algae (*Laminaria saccharina*, *Palmeria palmata*, *Chondrus crispus*, filamentous reds and browns at 19 ft outside bay at 2 plants/ sq m, relatively homogeneously distributed. In Bay channel, patchy eelgrass beds on sandy/silt. Within Bay, dense eelgrass with occasional *Laminaria* blade. Lower density patches of eelgrass with thick deposits of heavily epiphitized drift *Laminaria*. Appears to be a trapping area.
fauna: none noted.

C. Black Rock
May transect (Cv).
depth: 21 ft
substrate: silty sand
flora: attached *Laminaria saccharina* fronds > 3 m long @ 4-8/sq m, *Chondrus crispus*, filamentous red algae.
fauna: none seen

D. Shennecossett Beach
January transect (Dv)
depth: 9 ft -> 16 ft
substrate: cobble/sand -> pebbles -> sand ->hard rock
flora: heavy eelgrass (6 shoots/.25 sq m) -> sparse eelgrass (1-2 shoots/.25 sq m) with drifting macrophytes (*Ulva*, *Porphyra*, *Polysiphonia*, *Chondrus*) -> no eelgrass at pebble-sand transition -> *Laminaria saccharina* and *Chondrus crispus* attached to hardrock.
fauna: hermit crabs (*Pagurus* sp), starfish (*Asterias* sp).

May transect (Dv 1,2)
depth: 6 ft -> 15 ft
substrate: sand/cobble (6-10 ft) -> cobble/sand (10-15 ft)
flora: medium density *Zostera* with *Ulva lactuca* and *Laminaria saccharina* (6-10 ft) *Ulva lactuca*, *Laminaria saccharina* with filamentous reds and browns (>10 ft) distribution patchy.
fauna: none seen

July transect (D1)
depth: 11 ft -> 16 ft
substrate: sand
flora: dense eelgrass (6 shoots/.25 sq m) with drift *Laminaria saccharina* and *Ulva lactuca*. 80%- 100% coverage. Transition at 14 ft where eelgrass ends and Laminaria and *Ulva* cover about 20% of bottom. Zone of attached algae, no eelgrass. *Laminaria* blades exceed 2 m and *Ulva* thalli about .25 sq m, with bottom coverage about 90%. No other algae.
fauna: none noted.

E. Hobs Island
May transect (Ev)
depth: 23 ft
substrate: sandy sediment, smooth bottom
flora: Drifting patches of *Laminaria saccharina* and *Chondrus crispus*, filamentous types.
fauna: none seen

F. Quinnipeag Rocks
May transect (Fv)
depth: 13 ft -> 21
substrate: fine sand
flora: drift community (*Laminaria saccharina*, *Ulva lactuca*, filamentous reds and browns).
fauna: swarms of zooplankton throughout transect, densities to 40/.25 sq m.

H. Long Rock
January transect (Sta H -> Sta D)
depth: 30 ft -> 42 ft
substrate: soft silt, flat, 1 crab burrow

H. Long Rock (cont)
flora: drift algae, *Laminaria, Agardhiella, Chondrus*
fauna: 3 *Cancer* crabs

January transects (Hv)
depth: 23 ft -> 30 ft
substrate: sand -> sand/cobble with worm tubes (*Clymenella*)
flora: thin *Zostera* inshore -> attached and drifting algae offshore (*Laminaria, Chondrus, Ulva*)
fauna: bivalves (*Pitar morhuana, Mercenaria mercenaria, Crassostrea virginica*), crustaceans (*Cancer sp, Pagurus sp, Crangon septemspinosa*, mysids), starfish, fish (blennie, sand dab, eel). Most of fauna associated with offshore algal community.

May transect (Hv)
depth: 16 ft -> 20 ft
substrate: sand -> sand-gravel-rock
flora: drift algae onshore -> drift and attached algae offshore (*minaria saccharina, Chondrus crispus, Codium fragile, Rhodomenia palmata*). 0 -> 100% cover.
fauna: none seen

I. Green's Harbor
January transect (Iv)
depth: 8-12 ft
substrate: soft silt bound by amphipod tubes over about 80%
flora: drift algae in dense windrows (*Laminaria saccharina, Ulva lactuca*).
fauna: amphipods, *Cancer* sp.

K. Above I-95 Bridge.
January transect (K1).
depth: 6-14 ft.
substrate: fine sand and mud with abundant clam shell (*Mya arenaria*)
flora: none
fauna: none

January transect (K2)
depth: 22-10 ft
substrate: light brown silty mud with patches of shell
flora: none observed
fauna: two small fish, one starfish (*Asterias forbesi*), light yellow sponges.

L. Bluff Point-Bushy Point
July calibration area (L1)
depth: 15 ft
substrate: sand/cobble
flora: attached algae (*ondrus crispus, Laminaria saccharina* and filimentous reds on boulders > 10 cm. About 25% cover. *Laminaria* fronds about 50 cm, *Chondrus* and filimentous reds 5-30 cm.
fauna: none noted

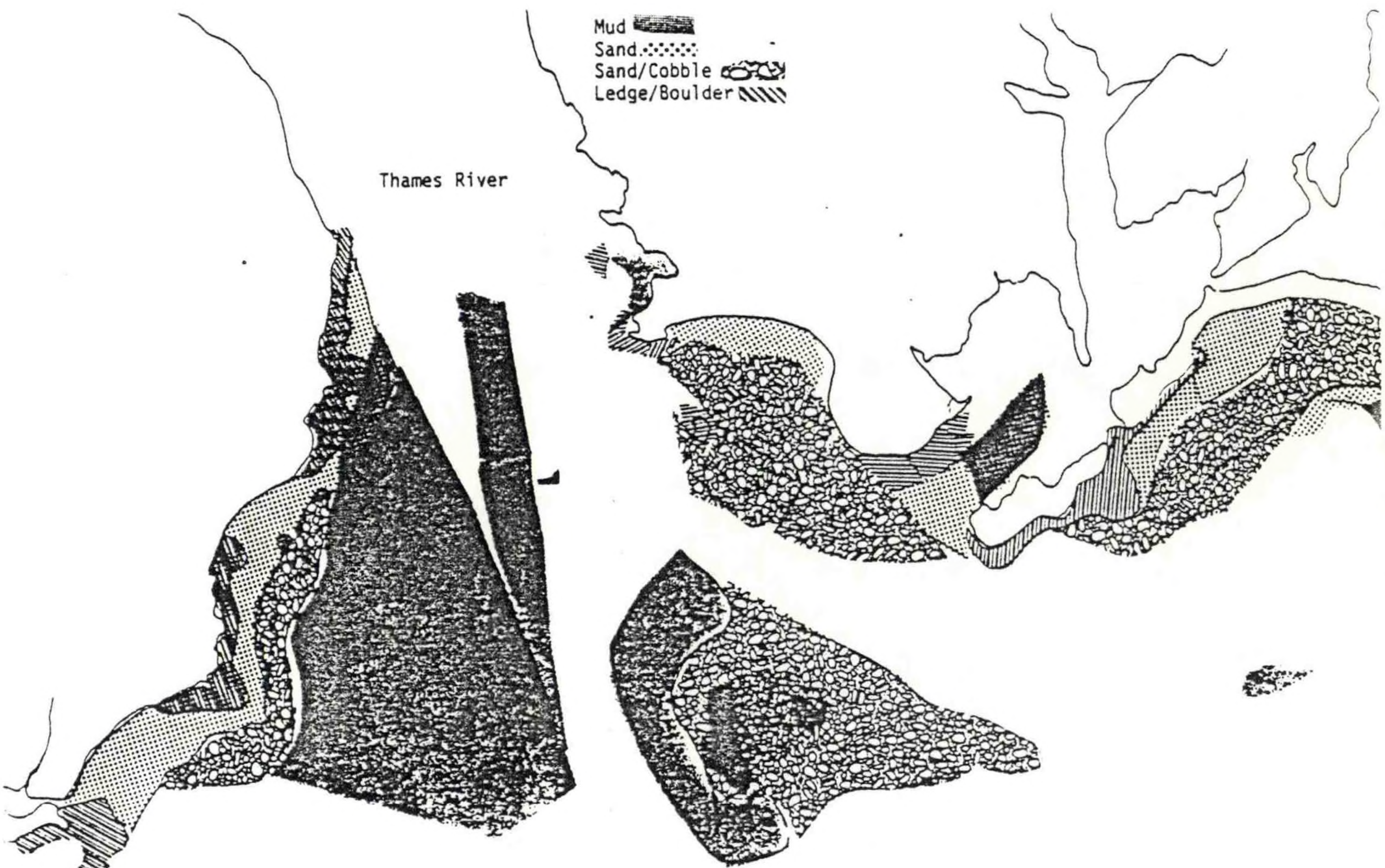
July transect (L2)
depth: 8 ft -> 15 ft (starting about 15 m off surf zone)
substrate: shifting sand presumeably overlying cobble
flora: algae attached below layer of shifting sand (*Ulva lactuca, Laminaria saccharina*, tufted and filimentous reds and browns). Coverage up to 90% onshore. Offshore, distributions becase patchier and individual fronds larger. Coverage decreased to about 50%.
fauna: numerous large crabs (*Callinectes sapidus* and *Libinia* sp) and small fish in areas with thick algal cover.

July transect (L3)
depth: 8-14 ft
substrate: cobble onshore -> fine sand offshore (transition at about 9 ft)
flora: Attached algae in cobble area (*Ulva lactuca* fronds 0.5 m diam) with *Laminaria saccharina*, red and brown filimentous types and detrital eelgrass. About 80% coverage. Offshore sand area had less densed attached community with more drift algae. Coverage about 30%.

July transect (L5)
depth: 6 -> 15 ft
substrate: sand -> cobble/sand at 250 m offshore (10-15 ft deep)
flora: inshore dense eelgrass, leaves > 1 m and 100% cover. transition area thinner eelgrass with algae (*Laminaria saccharina, Chondrus crispus*, filimentous reds and browns), about 20% cover. offshore algae attached to cobbles (*Laminaria saccharina* with blades to 3 m, *Chondrus crispus*, red and brown filimentous types. 50%-80% cover.
fauna: dense populations of grazing snails on eelgrass.

July transect (L6)
depth: 32-34 ft
substrate: silt consolidated uniformly with amphipod tubes.
flora: sparse clumps of attached filimentous red algae and sparse clumps of drift algae (*Laminaria saccharina, Ulva lactuca*).
fauna: amphipod swarms, large crabs (*Cancer sp, Libinia sp*), squid.

Figure 3-3 Video camera mounted on benthic sled. The camera mounted in the central housing connects to an onboard monitor and VCR recorder on the towing vessel. Two photo floodlamps provide lighting for the camera.



rafting or "weighing" of these anchor systems during the growing season. These same species also occurred as unattached clumps trapped within the eelgrass beds, rock crevices and other quiescent zones, and as drifting clumps over level bottoms, and most of these plants appeared to be in a healthy and growing state. Thus any assignment of unattached algae to a living or detrital state was far from clearcut.

Thus the most revealing results of the video transects was the mosaic nature of the distribution of substrate in the area and the resulting mosaic of macrophyte habitats. In particular, they showed that algal growth zones are far more extensive than conventionally recognized, and that the algae are relatively mobile even during their growth periods. This mobility may partially account for the presence of attached algal communities at depths up to 34 feet. In Figure 3-13, the results of the video transects and aerial photographs have been combined to identify and chart these macrophyte habitats.

3.3.3 Characterization of macrophyte communities

3.3.3.1 Transect sampling of intertidal algae and animals

Two quantitative intertidal transect studies were conducted at Quinnipeag Rocks and Black Rock. They confirmed the generalizations drawn from the shoreline surveys. At Quinnipeag Rocks, the outside transect was exposed to the east and hence to the severest storms, and *Fucus* spp were not found there (Table 3-9). *Fucus* was found on the inside transect. At Black Rock, where the exposed side faces southwest (a longer fetch but milder weather), *Fucus* spp were found on both sides of the rock. We do not know whether various species of *Fucus* (i.e. *F. vesiculosus* vs *F. spiralis* vs *F. distichus*) have any significance with respect to exposure.

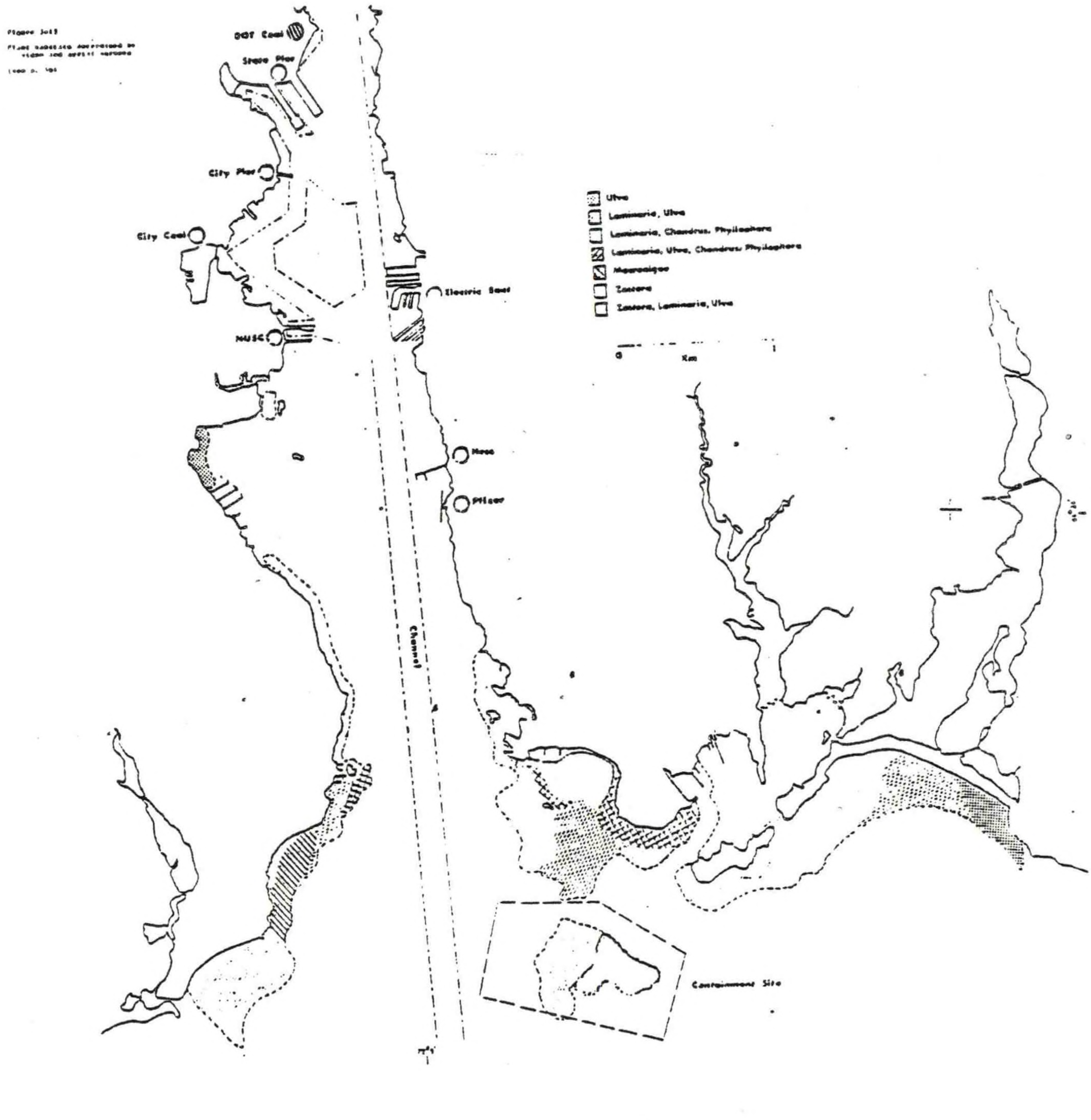
In all four transects, the lower intertidal/upper subtidal zone supported heavy growths of the green algae cited above as indicative of nutrient loading. Both rocks were heavily utilized by seabirds, mostly cormorants and seagulls. The rocks were well spattered with guano and water in the tidepools was bright green with algal growth, indicating that any eutrophication responsible for local green algal zones must be considered at least partially natural.

The red alga, *Chondrus crispus,* either dominated the zone below the green algae, or shared the green algal zone, in all four transects. On the channel side of Quinnipeag Rocks, *Chondrus* also dominated the mid-intertidal zone, invading space occupied by *Fucus* in the other transects, probably as a result of the high-energy regime there. *Laminaria* occupied the zone below *Chondrus,* except on the sheltered side of Quinnipeag Rocks, where the ledge dipped beneath sandy substrate at a fairly shallow depth.

Total biomass for the intertidal transects ranged from 313 gdw/m^2 to 5426 gdw/m^2 with a median of 983 gdw/m^2 (Table 3-9). Biomass tended to be higher on the easterly transects. The sample size was too small to detect other biomass trends such as possible correlations with dominant species type, vertical position, or exposure.

Figure 3-13 Plant habitats as determined from results of the aerial survey and video transects.

(Submitted as a large figure)



Twenty animal taxa were identified from the intertidal transects (Table 3-10). Gastropods and crustacean groups dominated the assemblage with seven taxa each. The blue mussel, *Mytilus edulus*, reached enormous densities. Most individuals were < 2 mm long and represented the new year class which had recently settled from the plankton. They formed a thick, continuous matrix of shell, byssus and attached seaweed and detritus which harbored high densities of early stage juveniles of several species of rock crab (*Cancer irroratus*), mud crab (*Neopanope* sp), and pea crab (*Pinnotheres* sp).

3.3.3.2 Quadrat sampling of subtidal algae and animals.

(A complete data base for the quadrat samples is provided in Appendix Tables A2,A-F; A3,A-F)

Forty-nine species of algae were identified from the quadrat samples (Table 3-11). The number of species did not vary greatly from season to season except for the winter survey when only 5 quadrats were sampled representing two stations. We infer from these results that the number of species for the area as a whole does not change radically in the course of a year, but that seasonal changes within the assemblages do occur, corresponding to the growth patterns of individual species. Only 8 species were found in every season.

Sixteen species qualified as community dominants based on the criterion that they comprised 20% or more of the total biomass for the quadrat (Table 3-12). Ten species occurred as primary dominants (highest % of total biomass for the quadrat) in at least one sample,. but three species occurred as primary dominant in the majority of samples. These were *Chondrus crispus* (15 quads), *Laminaria sacchrina* (15 quads) and *Phyllophora pseudoceranoides* (12 quads). At least one of these three species occurred as primary dominant at every station in some season and in every season at some stations. Two of these, *Chondrus* and *Phyllophora*, comprised the dominants of the two zones in the Read (19) study cited earlier.

Based on this characterization by dominants, the subtidal algal communities were strikingly heterogeneous within stations, within seasons and/or between seasons. Avery Point (Sta B) offers an example of within-station heterogeneity both within seasons and between seasons. Black Rock Outside (Sta C) offers an example of within-season homogeneity and between-season heterogeneity. The detection of heterogeneity was a goal of the sampling procedure, in which divers consciously selected a second community, if one were present, for their second quadrat and even added a third quadrat if a third community was evident. The homogeneity at Black Rock implied that there was no obvious second assemblage in the dive area within the depth range sampled.

We have defined this recurrence of assemblages from station to station and season to season as "repetitive heterogeneity". When the quadrats were lumped by station this characteristic was masked, resulting in similarity indices which were much higher than those between individual quadrats.

Cluster analysis was performed to further characterize the algal communities using whole assemblages rather than just by dominant

Table 3-9. Intertidal macrophytes. Lower=lower intertidal, Middle=middle intertidal, Upper=upper intertidal, Subtide=upper subtidal zone. Values are gdw/m².

	QUINNIPEAG ROCKS INTERTIDAL					BLACK ROCK INTERTIDAL				
	OUTSIDE TRANSECT			INSIDE TRANSECT		INSIDE TRANSECT			OUTSIDE TRANSECT	
SPECIES	LOWER	MIDDLE	UPPER	LOWER	UPPER	SUBTIDE	LOWER	MIDDLE	LOWER	MIDDLE
Ahnfeltia plicata	1700					6				
Ceramium rubrum				1						
Chaetomorpha linum	2702	211		12	10	654	20	7	62	10
Chondrus crispus	1023	806		1		353	127	3	213	2
Enteromorpha sp				11						
Fucus distichus					33	5	1077	1257		
Fucus vesiculosus				575	873		188	119		
Fucus spiralis										430
Gracilaria tikvahiae						6	0.4			
Polysiphonia denudata		278								
Polysiphonia harveyi						3	11			
Polysiphonia urceolata				2		0.3				
Ulva lactuca		113	346	101	4	14	24		39	1
Zostera marina (det)						6	1	1		
TOTAL:	5426	1408	346	704	920	1047	1449	1387	314	443
NUMBER OF SPECIES:	3	4	1	7	4	9	8	5	3	4
MAXIMUM VALUE:	2702	806	346 0	575	873 0	654	1077	1257 0	213	430

Table 3-10. Animals from intertidal zones at Quinnipeag Rocks and Black Rock. Outside= exposed transect, Inside=sheltered transect, Subtide=upper subtidal transect, Lower, Middle and Upper= intertidal position relative to low water. NA =not practical to enumerate.

	QUINNIPAG ROCKS INTERTIDAL					BLACK ROCK INTERTIDAL				
	OUTSIDE			INSIDE		INSIDE			OUTSIDE	
SPECIES	LOWER	MIDDLE	UPPER	LOWER	UPPER	SUBTIDE	LOWER	MIDDLE	LOWER	MIDDLE
CNIDARIA										
Haliclona loosanoffi	0	0	0	NA	0	0	0	0	0	0
Anemones unid	0	0	0	0	0	40	0	0	0	0
MOLLUSCA - BIVALVES										
Argopecten irradians	0	0	0	0	0	0	4	0	0	0
Mytilus edulis	126672	345664	0	1776	880	596	0	1408	67492	268
MOLLUSCA - GASTROPODS										
Crepidula fornicata	0	0	0	0	0	0	4	0	0	0
Ilyanassa obsoleta	0	0	0	4	0	0	0	0	0	0
Lacuna sp	5112	0	0	380	36	400	16	52	732	4
Littorina littorea	0	1856	0	200	780	200	636	216	184	956
Littorina obtosata	0	0	0	12	20	0	8	176	0	0
Mitrella sp	0	0	0	0	0	160	0	0	0	0
Urosalpinx cinerea	0	0	0	116	8	320	20	0	0	0
ANNELIDA - POLYCHAETES										
Lepidonotus squamatus	184	0	0	0	0	400	0	0	0	0
Sabellidae unid	0	0	0	0	0	80	0	0	0	0
ARTHROPODA - CRUSTACEANS										
Barnacle spp	0	0	0	20	40	0	0	0	184	NA
Amphipod spp	0	4672	0	0	0	360	0	36	184	8
Isopod spp	732	0	0	0	0	120	16	4	0	0
Cancer irroratus	0	0	0	12	0	0	0	0	0	0
Neopanope sayi	0	19648	0	0	0	280	4	24	0	4
Pagurus longicarpus	0	0	0	44	0	0	0	0	0	0
Pinnotheres maculatus	548	0	0	4	0	0	0	0	0	0
NUMBER OF TAXA:	5	4	0	11	6	11	9	7	5	6

Table 3-11. Algal biomass as % of all algae collected by season for quadrats and dredge Rank signifies ranked relative abundance by species. Abbreviations may be interpreted from Table 3-5.

RANK	WINTER QUADRAT		SPRING GQUADRAT		SUMMER QUADRAT		FALL QUADRAT		WINTER DREDGE		SPRING DREDGE	
1	P TURNCA	30.63	L.SACCHA	57.69	C CRISPU	41.52	C CRISPU	37.24	L SACCAR	85.70	L SACCH	83.18
2	N BAILE	22.06	N BAILE	8.66	L SACCHA	34.56	P PSEUDO	32.84	U LACTUC	3.88	N BAILE	7.14
3	L SACCAR	19.45	C CRISPU	8.24	C LINUM	5.57	C FRAGIL	12.24	P PALMAT	1.97	U LACTU	3.26
4	P PSEUDO	13.37	P TRUNCA	6.00	U LACTUC	5.13	L SACCHA	5.49	C CRISPU	1.65	L DIGIT	1.13
5	G TIKVAH	5.98	U LACTUC	5.46	C PARVUL	4.69	U LACTUC	3.78	G TIKVAH	1.28	P PSEUD	.79
6	P ROTUND	5.15	C OFFICI	3.74	P TRUNCA	3.67	C OFFICI	.99	Z MARINA	1.16	D VIRID	.72
7	P RUBENS	.90	P PSEUDO	3.50	P PSEUDO	.80	C PARVUL	.85	A NODOSU	.86	P LANOS	.50
8	C PARVUL	.75	L DIGITA	2.71	CLADOPHO	.68	P ROTUND	.70	N BAILEY	.84	C CRISP	.45
9	U LACTUC	.62	D VIRIDI	1.16	P PALMAT	.52	P TRUNCA	.50	P TRUNCA	.37	P PALMA	.39
10	C BYSSOI	.56	A PLICAT	.67	C FRAGIL	.41	P NOVAE-	.49	P RUBENS	.17	P TRUNC	.38
11	F VESICU	.33	C RUBRUM	.56	C OFFICI	.41	A PLICAT	.31	P HARVEY	.09	D ACULE	.34
12	AMPHIPLE	.10	P ROTUND	.43	P DENUDA	.35	F VISICU	.16	M ALATA	.08	P NIGRE	.32
13	M DENTIC	.06	D ACULEA	.40	P URCEOL	.27	P URCEOL	.14	F VESICU	.08	P NIGRA	.25
14	B HAMIFE	.03	C BYSSOI	.15	P ROTUND	.26	Z MARINA	.14	C BAILEY	.04	C RUBRU	.18
15	Z MARINA	.01	B HAMIFE	.12	A PLICAT	.21	C LINUM	.12	C RUBRUM	.03	Z MARIN	.17
16	P NIGRES	<.01	P PALMAT	.12	ANTITHAM	.20	C ROSEUM	.08	E SILICU	.03	E SILIC	.13
17	C FRAGIL	<.01	P RUBENS	.12	P NIGRES	.18	S REPENS	.05	C LINUM	.02	M DENTI	.13
18	C LINUM	<.01	P NIGRES	.05	F DISTIC	.09	P RUBENS	.05	A PLICAT	.01	F DISTI	.09
19			VAUCHERI	.04	B HAMIFE	.08	C RUBRUM	.04	ANTITHAM	.01	G TIKVA	.10
20			F DISTIC	.04	G TIKVAH	.06	P NIGRES	.04	G AMERIC	.01	P-ROTUN	.09
21			Z MARINA	.02	E SILICU	.05	P LANOSA	.03	B HAMIFE	.001	A NODOS	.07
22			P NIGRA	.02	P SUBTIL	.05	P ELONGA	.03	C FRAGIL	.001	P RUBEN	.07
23			G TIKVAH	.02	VAUCHERI	.05	CALLITHA	.02	D BAILLO	.001	B HAMIF	.04
24			E SILICU	.02	Z MARINA	.03	P PALMAT	.01	LOMENTAR	.001	ULOTHRI	.03
25			C. ROSEU	.01	B PLUMOS	.03	A AMERIC	<.01	P ROTUND	.001	ANTITHA	.01
26			C PURPUR	.01	P ELONGA	.03	D BAILLO	<.01	R CONFER	.001	A PLICA	.01
27			P LANOSA	.01	A PHYAIS	.02	A CRUCIA	<.01			C OFFIC	.01
28			P URCEOL	.01	S REPREN	.02	E SILICU	<.01			P HARVE	.01
29			ULOTHRIX	<.01	A CRUCIA	.01	LICMORPH	<.01			P URCEO	.01
30			CODIUM F	<.01	C GLOMER	.01	S REPENS	<.01			VAUCHER	.01
31			CLADOPHO	<.01	C RUBRUM	.01	VAUCHERI	<.01			C FRAGI	<.01
32			CHAETOMO	<.01	C ALBIDA	.01	G AMERIC	<.01			P ELONG	<.01
33			C. TETRA	<.01	D.ACULEA	.01						
34			ANTITHAM	<.01	C SERICE	<.01						
35					R TORTUO	<.01						

Table 3-12. Algal assemblages characterized by dominant species (> 20% of total biomass) for the sample. Order corresponds to biomass given in Table 3-14.

STATION	WINTER	SPRING	SUMMER	FALL
AVERY	PP(63)LS(31)	CC(60)CO(21)	CP(60)	CF(90)
POINT	NB(36)LS(27)PT(22)	NB(53)PP(37)	PT(46)CP(26)CS(21)	PP(60)CC(26)
(B)	PT(62)NB(18)PR(16)	NB(54)PP(20)		
QUINNIPEAG	PT(46)NB(38)	CO(81)	CC(43)	CC(83)
ROCK OUTISDE	GT(40)LS(36)PT(24)	CO(38)NB(29)PP(21)	LS(37)CC(29)UL(28)	CC(87)
(F)		CC(73)		
QUINNIPEAG			CC(50)CL(36)	CC(67)
ROCK INSIDE			UL(83)	PP(35)NB(27)CC(22)
(G)				
LONG ROCK		UL(59)CC(27)	CC(88)	CF(38)AP(22)
(H)		CC(67)AP(22)	LS(63)	CC(47)AP(40)
BLACK LEDGE		PT(66)DA(22)	LS(57)	PP(41)LS(37)
(A)		LS(92)	LS(92)	PP(72)LS(27)
		LS(46)LD(30)		PP(74)
		LS(99)		
		LS(73)		
		LS(79)		
BLACK ROCK		LS(92)	CC(79)	PP(92)
OUTSIDE		LS(90)	CC(89)	PP(96)
(C)				
BLACK ROCK		NB(53)	CC(90)	PP(59)UL(24)
INSIDE		NB(68)PT(19)	CC(26)LS(21)PT(21)	CC(48)PP(46)
(D)				
HOBBS ISLAND		PP(82)	LS(83)	PP(90)
(E)		LS(85)	LS(99)	PP(63)CC(28)
		LS(69)PP(23)		

KEY

PRIMARY DOMINANTS

CODE	SPECIES
CC	*Chondrus crispus*
CF	*Codium fragile*
CO	*Corallina officinalis*
CP	*Champia parvula*
GT	*Gracillaria tikvahiae*
LS	*Laminaria saccharina*
NB	*Neoagardhiella baileyi*
PP	*Phyllophora pseudoceranoides*
PT	*Phyllophora truncata*
UL	*Ulva lactuca*

SECONDARY DOMINANTS

CODE	SPECIES
AP	*Ahnfeltia plicata*
CL	*Chaetomorpha linum*
CS	*Cladophora sericea*
DA	*Desmerestia aculeata*
LD	*Laminaria digitata*
PR	*Phycodrys rubens*

species. The smallest number of identifiably separate assemblages (Groups) in this analysis was four (Fig. 3-14, Table 3-13). In order of decreasing intragroup coherence they are:

- III the most homogeneous group, comprised of 12 quadrats dominated by *Chondrus crispus.* This assemblage was highly ubiquitous with respect to station and season. The only season not represented was winter, probably because the sampling size was small.

- I the next most uniform group, again consisted of 12 quadrats. All except one were dominated by *Phyllophora pseudoceranoides.* This group is highly seasonal (10 fall quads) and is localized on the east side of the river, which is more protected during the fall.

- IV consisting of 16 quadrats, primarily composed of *Laminaria saccharina* assemblages. It was dominated by 14 spring and summer quadrats which were found mostly at the deeper, more exposed stations A, C, and E.

- II a highly heterogeneous assortment of 19 quadrats. It is probably more realisitc to consider this group in terms of four subgroups:

    - IIB the strongest subgroup, a 4-quadrat assemblage dominated by *Phyllophora truncata.*

    - *IID a 2-quadrat fall assemblage dominated by Codium fragile.*

    - IIA a heterogeneous group of spring *Neoagardhiella* assemblages.

    - IIC an even more heterogeneous grouping of mixed spring and summer assemblages.

One clue to the heterogeneity within Group II may be that it contained over half of the quadrats from the relatively protected shallow-water stations, B, D, and G. In general, habitats which are less physically stressed tend to be more diverse.

The patterns suggest that the distributions are controlled by recurrence of gradients such as degree of wave exposure and/or seasonality. *Laminaria,* for instance tends to dominate at exposed stations of the outer harbor, but only in spring and summer. It was not present on Black Ledge during an earlier fall study (28), and it disappeared between summer and fall in this study. In the shoreline survey, we noted that *Laminaria* was observed within the river in the late spring survey, but not in summer. Thus although *Laminaria* is a perennial species in the area as a whole, its occurence at a particular station may be highly seasonal.

The results of clustering supported the concepts of spatial and temporal hetergeneity inferred from the analysis of dominants. They demonstrated that: 1) the river supports a year-round attached macroalgal community; 2) on a broad scale, the algae occur as about

Figure 3-14. Dendrogram depicting station groupings for the quadrat samples as determined by cluster analysis. Roman numerals signify groups and arabic numbers signify stations as keyed in Table 3-13.

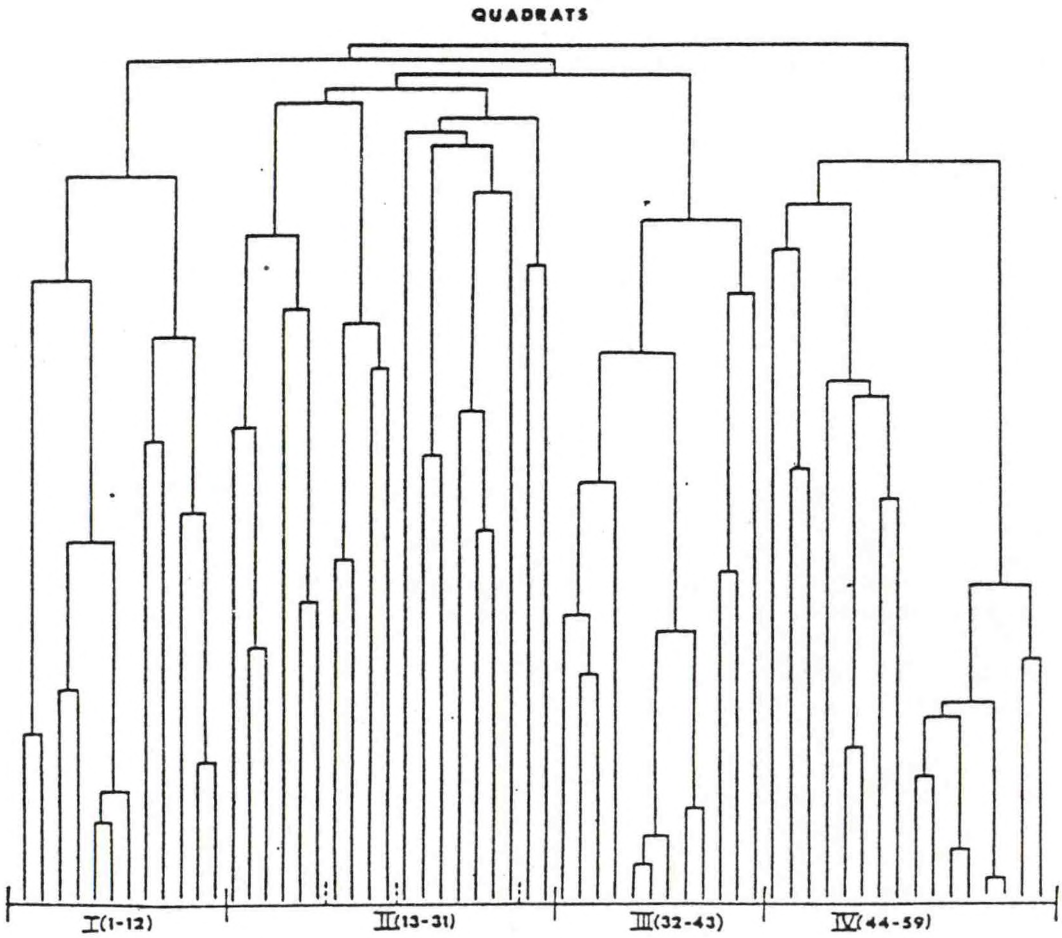


Table 3-13. Quadrat algal assemblages identified by cluster analysis. Quads (quadrat) identifications are keyed as follows: W=winter, V=spring (vernal), S=summer, F=fall for first letter. Q signifies quadrat. Third letter is station, final digit is replicate number, i.e. WQD1= Winter Quadrat, Station D, Replicate 1.

QUAD	DOMINANT SPECIES (% TOTAL BIOMASS)	QUAD	DOMINANT SPECIES (% TOTAL BIOMASS)
	GROUP I		
WQB1	*P. pseudoceranoides*(63) *L. saccharina*(31)	FQC2	*P. pseudoceranoides*(96)
FQA2	*P. pseudoceranoides*(72) *L. saccharina*(27)	FQD1	*P.pseudoceranoides*(59) *U.lactuca*(24)
VQE1	*P. pseudoceranoides*(82)	FQG2	*P.pseudoceranoides*(35) *N.baileyi*(27) *C.crispus*(22)
FQA3	*P. pseudoceranoides*(74)	FQD2	*C.crispus*(48) *P.pseudoceranoides*(46)
FQC1	*P. pseudoceranoides*(92)	FQE2	*P.pseudoceranoides*(63) *C.crispus*(28)
FQE1	*P. pseudoceranoides*(90)	FQB2	*P.pseudoceranoides*(60) *C.crispus*(26)
	GROUP II-A		
WQB2	*N.baileyi*(36) *L.saccharina*(27) *P.truncata*(22)	VQF2	*C.officinalis*(38) *N.baileyi*(29) *P.pseudoceranoides*(21)
VQD1	*N.baileyi*(53)	VQB2	*N.baileyi*(53) *P.pseudoceranoides*(37)
VQD2	*N.baileyi*(68) *P.truncata*(19)	VQB3	*N.baileyi*(54) *P.pseudoceranoides*(20)
	GROUP II-B		
WQB3	*P.truncata*(62) *N.baileyi*(18) *P.rubenis*(16)	VQA1	*P.truncata*(66) *D.aculeata*(22)
WQF1	*P.truncata*(46) *N.baileyi*(38)	SQB2	*P.truncata*(46) *C.parvula*(26) *Cladophora sp*(21)
	GROUP II-C		
VQF1	*C.officinalis*(81)	SQF1	*C.crispus*(43)
VQH1	*U.lactuca*(59) *C.crispus*(27)	SQF2	*L.saccharina*(37) *C.crispus*(29) *U.lactuca*(28)
SQG2	*U.lactuca*(83)	SQB1	*C.parvula*(60)
SQD2	*C.crispus*(26) *L.saccharina*(21) *P.truncata*(21)		
	GROUP II-D		
FQB1	*C.fragile*(90)	FQH1	*C.fragile*(38) *A.plicata*(22)
	GROUP III		
VQF3	*C.crispus*(73)	SQC2	*C.crispus*(89)
SQC1	*C.crispus*(79)	FQF1	*C.crispus*(83)
FQG1	*C.crispus*(67)	FQF2	*C.crispus*(87)
VQB1	*C.crispus*(69) *C.officinalis*(21)	VQH2	*C.crispus*(67) *A.plicata*(22)
SQD1	*C.crispus*(90)	FQH2	*C.crispus*(47) *A.plicata*(40)
SQH1	*C.crispus*(88)	SQG1	*C.crispus*(59) *C.linum*(36)
	GROUP IV		
WQF2	*B.tikvahiae*(40) *L.saccharina*(36) *P.truncata*(24)	VQA2	*L.saccharina*(92)
VQE3	*L.saccharina*(60) *P.pseudoceranoides*(23)	SQA2	*L.saccharina*(92)
FQA1	*P.pseudoceranoides*(41) *L.saccharina*(37)	VQC1	*L.saccharina*(92)
VQA3	*L.saccharina*(40) *L.digitata*(30)	VQC2	*L.saccharina*(90)
VQA5	*L.saccharina*(73)	VQA4	*L.saccharina*(99)
VQA6	*L.saccharina*(79)	SQE2	*L.saccharina*(99)
SQA1	*L.saccharina*(57)	VQE2	*L.saccharina*(85)
SQH2	*L.saccharina*(63)	SQE1	*L.saccharina*(83)

seven relatively common, identifiable assemblages; 3) their pattern of occurrence may be described as "repetitively heterogeneous" throughout the harbor area and throughout the year, and 4) while some of these assemblages are ubiquitous, others respond to season and degree of exposure, although it must be recognized that these two physical factors cannot be entirely separated in the study area.

Biomass for individual quadrats ranged from 19 gdw/m^2 to 3014 gdw/m^2 (Table 3-14). Spring and summer biomass was roughly double that of fall and winter. The patterns reflected those of their dominant species. *Laminaria* reached the greatest density of any species (max=2708 gdw/m^2), followed by *Chondrus* (1616 gdw/m^2), Ulva (773 gdw/m^2) and *Codium* (685 gdw/m^2). The other dominants reached densities of 100-500 gdw/m^2. While *Laminaria* was present year-round, its biomass dropped sharply in winter and its distribution changed. Thus the Black Ledge quadrats, dominated by *Laminaria,* yielded the greatest spring-summer biomass and also the lowest fall-winter biomass. Stations B, C, F and G, which were dominated by *Chondrus, Codium* or *Phyllophora,* tended to have more evenly distributed seasonal patterns. Stations B, F and G reached their maximum biomass in the fall.

Our summer measurements (171-1842 gdw/m^2) were consistent with the range measured by Read (22). Her highest biomass for an individual species was 1354 gdw/m^2 (*Chondrus*) and 620 gdw/m^2 (*Phyllophora*). We measured a maximum of 1616 gdw/m^2 for *Chondrus* and 376 gdw/m2 for *Phyllophora.* Our data do not compare well with the earlier study at Black Ledge (28). The range of biomass in the earlier study was 4.3-152 gdw/m^2. Our fall biomass on Black Ledge proper was 410-522 gdw/m^2. On boulders there, *Laminaria* which had been found in spring and summer had been torn loose, and the biomass was only 31 gdw/m^2. Our spring-summer measurements were 50-1830 gdw/m^2 (median = 498). These results strongly contradict the conclusions of the earlier study that the biomass of the seaweed community of Black Ledge was relatively insignificant.

Seventy-four animal taxa were identified from the quadrat samples (Appendix Tables A4,A-D). Colonial and encrusting organisms were recorded as present but not quantified. It was not always feasible to enumerate very tiny animals such as the gastropods *Anachis, Mitrella* and *Lacuna,* new sets of the blue mussel (*Mytilus*) and amphipods. Under these circumstances, they were designated by *** or NA.

The number of taxa did not vary significantly from season to season, despite the large differences in the number of quadrats sampled (Table 3-15). The dominant groups were crustaceans, gastropods and polychaetes. The magnitude of community dominance by crustaceans was considerably masked because most of the amphipods, which constituted a large and diverse assemblage, were lumped as a single taxon. Although some of the polychaetes were also lumped, they were less numerous and less diverse than the amphipods, so that lumping did not appreciably affect their assemblage characteristics.

Crustaceans were represented by several groups, amphipods, which were the most ubiquitous and most numerous catagory, followed by

Table 3-14 Biomass for individual quadrats in gdw/m². Values correspond to assemblages in Table 3-12.

STATION	WINTER	SPRING	SUMMER	FALL	RANGE
BLACK LEDGE (A)		281	211	410	31-1830
		50	1830	522	
		484		31	
		999			
		1215			
		511			
AVERY POINT (B)	299	148	560	760	76-760
	332	199	329	76	
	206	392			
BLACK ROCK OUTSIDE (C)		2811	1043	73	73-3014
		3014	1322	143	
BLACK ROCK INSIDE (D)		766	1460	279	279-1460
		542	671	773	
HOBS ISLAND (E)		208	523	123	123-1344
		1279	1344	276	
		442			
QUINNIPEAG ROCKS OUTSIDE (F)	454	562	428	920	218-920
	228	218	463	484	
		468			
QUINNIPEAG ROCKS INSIDE (G)			341	437	176-437
			176	413	
LONG ROCK (H)		1316	1842	19	19-1843
		396	533	32	
MEAN BY SEASON		319.8	776.2	817.2	339
COEFFICIENT OF VARIATION		28%	103%	70%	114%
MEDIAN		299	484	540	276
RANGE		206-454	50-3014	176-1842	19-920

Table 3-15. Number of animal taxa in major phyletic groups.

TAXON	QUADRATS WINTER	QUADRATS SPRING	QUADRATS SUMMER	QUADRATS FALL	DREDGES WINTER	DREDGES SPRING
PORIFERA	2	2	1	1	5	3
CNIDARIA	1	2	1	2	1	0
PLATYHELMINTHES	0	1	0	0	0	0
BRYOZOA	1	1	1	1	2	0
MOLLUSCA-BIVALVIA	2	4	2	3	5	4
MOLLUSCA-GASTROPODA	9	9	12	10	10	7
ANNELIDA-POLYCHAETA	9	9	5	4	12	5
ARTHROPODA-CRUSTACEA	7	9	10	11	12	9
ARTHROPODA-OTHER	1	0	0	0	0	0
ECHINODERMATA	4	3	2	5	3	2
CHORDATA	1	1	2	3	4	0
TOTAL SPECIES	37	41	36	40	53	30

isopods, juveniles of several large crabs, small pea and mud crabs, and hermit crabs. The juvenile crab group, which was especially prominant in the seaweed in winter, included 3 species of spider crabs, *Libinia dubia, L. emarginata* and *Pelia mutica,* and the green crab, *Carcinus maenus.*

Gastropods were characterized by a group of very small (several mm) grazing snails (*Anachis, Bittium, Ceriopsis, Epitonium, Lacuna, Mitrella*), larger grazers (Littorinids, *Nassarius, Crepidula,* nudibranchs), and the predators *Busycon* and *Urosalpinx.*

Polychaetes consisted mainly of the scale worm, *Lepidonotus,* a group of terebellids and the calcarious tube-builder, *Spirorbis.*

Members of other groups which reached significant densities were the blue mussel (*Mytilus edulis*), starfish (*Asterias* and *Henricia*), and brittle stars (*Axiothella*).

Table 3-16 contains species richness by quadrat and by season in a format comparable with the algal data in Tables 3-12 and 3-14. Based on median scores, animal communities were richer in fall and winter than in spring and summer. There appeared to be no relationship between number of animal species and biomass of the algae. Based on the algal assemblages developed by cluster analysis, the richest animal communities were associated with algal communities I and II, *Phyllophora* sp, and the sparsest communities were associated with *Neoagardhiella,Laminaria* (Table 3-17). Our subjective impression was that the morphology of *Phyllophora* sp, which consisted of a dense cluster of small flat leaves provided a more diverse and protective substrate than either the flat, slick fronds of *Laminaria* which were adapted to current flow or the wirey filiments of *Neoagardhiella.*

The patterns suggest that the distributions of animals are affected by the physical morphology of the plants and are thereby secondarily influenced by the physical recurrence of gradients such as degree of wave exposure and seasonality.

3.3.3.3 Dredge sampling of algae and animals

(A complete data base for the dredge samples is provided in Appendix Tables A5,A-D).

Thirty-nine plant species were identified in the dredge hauls. Twenty-six species were collected in winter and 32 in summer (Table 3-11). Twenty species were common to both seasons. Only 2 species were found in the dredge hauls which were not found in either the intertidal or the subtidal quadrat samples. These were *Callithamnion baileyi* and *Lomentaria baileyana.* They were found only in the winter dredges and neither constituted more than 0.04% of dredged winter biomass. Twenty-two species found in the quadrat samples were not found in dredge samples, but only one, *Champia parvula,* was a dominant species. Nineteen of the "missing" species were red or green algae, which have a faster decomposition rate than brown algae. Most were also components of summer and fall quadrats. Dredging during winter and late spring may have missed minor components of the summer

Table 3-16. Species richness of animal communities by quadrat. Values are numbers of species, and correspond to algal data in Tables 3-12 and 3-14.

STATION	WINTER	SPRING	SUMMER	FALL	STATION RANGE	MEDIAN
BLACK LEDGE (A)		4	14	17	2-17	8
		2	12	15		
		8		17		
		4				
		4				
		7				
AVERY POINT (B)	19	8	13	2	2-20	5
	20	9	11	12		
	18	12				
BLACK ROCK		17	15	21	12-21	15
OUTSIDE (C)		12	12	19		
BLACK ROCK		10	11	8	20	10
INSIDE (D)		8	15	20		
HOBS ISLAND		7	10	19	7-19	9
(E)		6	6	16		
		9				
QUINNIPEAG ROCKS	17	10	12	26	6-26	11
OUTSIDE	6	8	11	14		
(F)		10				
QUINNIPEAG ROCKS			13	8	8-13	10.5
INSIDE			9	12		
(G)						
LONG ROCK (H)		12	17	20	2-20	14
		10	11	16		
SEASONAL MEDIAN	18	10	12	16		11
RANGE	6-20	2-17	6-17	2-26	2-26	

and fall flora, especially those with rapid decompositions times. *Laminaria saccharina* constituted over 80% of the dredged biomass, reflecting its slow rate of decomposition as well as its abundance in the area.

Cluster analysis identified four dredge assemblages (Fig. 3-15, Table 3-18). In order of decreasing intragroup coherence they were:

II — the most homogeneous group consisting of 11 hauls strongly dominated by *Laminaria saccharina* (>92% of total biomass). It includes stations C, I-2 and E from the channel and near-channel areas of the lower harbor, and station A at Black Ledge.

I — the largest group, consisting of 15 hauls moderately dominated by *Laminaria saccharina* (64%-87%). All stations except K (above the I-95 bridge) and C (outside Black Rock) were represented.

III & IV — a small, highly heterogeneous group of hauls with at most about 50% *Laminaria saccharina*. The transects were all in non-channel areas on the west side of the river and spread from station H, located outside the harbor mouth, to station K, located above the I-95 bridge.

None of the dredge groups could be considered seasonal. Qualitatively, the dredge hauls appeared to be a relatively homogeneous mixture of the attached algal communities. While there was a trend for *Laminaria saccharina* to become less dominant in the upstream direct, it was found at all stations in fair abundance. The presence of *L. saccharina, Neoagardhiella baileyi* and *Palmeria palmata* at the inner stations indicates a considerable degree of drift transport into the harbor from growing areas near the mouth.

Comparison of algal biomass and species richness for individual dredge hauls is given in Table 3-19. Despite the inherent problems with obtaining quantitative hauls, there are trends in the data which are strong enough to be considered realistic. Biomass diminished along a gradient from the mouth to Station K above the bridge. Biomass also diminished in an offshore direction except in the Black Ledge area. The largest hauls were obtained in or near the river channel.

The species assemblages found in the dredge hauls for winter and spring were compared with the species collected from quadrats during those seasons to determine to what degree the drift community could be considered a homogenate of the attached communities. Despite the differences in numbers of dredge hauls, areas dredged, numbers of quadrats and areas sampled between winter and spring, there was a general uniformity in characteristics when the samples were composited (Table 3-11). For instance, number of taxa increased from winter to spring in both dredges and quadrats, and total number of taxa were 39 and 38 respectively, with 8 taxa found only in dredges and 8 found only in quadrats. Based on percent composition, similarity indices between seasons were low and fairly similar, i.e. the data were relatively uninformative.

Appendix Tables A6-A and A6-B present the data base for animals collected in the benthic dredge samples. The sampling regimes differed between seasons. Twenty-two hauls were collected from 6 stations in winter, while 12 hauls were collected from 8 stations in summer, the changes being dictated by field conditions. As for the quadrat samples, it was not feasible to enumerate encrusting species and very small organisms. Moreover, the mesh size of the dredge bag was much larger than the airlift bag, so that small animals were retained in the dredge only when they were trapped there by the seaweed.

Sixty-four taxa were identified, 53 in the winter dredges and 30 in the spring dredges. Nineteen taxa were common to both seasons. As in the quadrat samples, crustaceans dominated the assemblages (Table 3-15), and their true dominance was underestimated because amphipods and isopods were lumped as a single group. More large crabs (*Cancer irroratus, Carcinus maenas, Libinia* spp) were collected in the winter dredges, presumably because the cold water slowed them down and made them more catchable. The dredged animals appeared to be a mixture of those collected in the quadrats and species normally associated with softbottom habitats. Polychaetes and bivalves were more numerous in the dredges, which is reasonable for samples from softbottom habitats.

Species richness per dredge haul ranged from 2 to 19 in winter, with a median of 9 species. In spring, the range was 1 to 21 species, with a median of only 5. There was no consistency between seasons for those stations which were sampled during both surveys. There also appeared to be no consistent relationship between animal species richness and algal biomass.

The most ubiquitous species in winter were the scale worm, *Lepidonotus squamatus* and the rock crab, *Cancer irroratus,* which were found at all dredge stations. *Lepidonotus* and the small gastropod, *Anachis* sp, were the most ubiquitous species in the spring samples, occupying 80% and 70% of the stations respectively.

Table 3-17. Relationship between animal species richness and algal group as determined by cluster analysis (Table 3-13).

ALGAL GROUP	ANIMALS (NO. SPECIES) RANGE	MEDIAN	RANK	ALGAE DOMINANT SPECIES
I	7 - 20	16.5	2	*Phyllophora pseudoceranoides*
II-A	6 - 12	8.5	6	*Neoagardhiella*, mixed
II-B	19 - 22	21	1	*Phyllophora truncata*
II-C	9 - 15	12	3	Mixed
II-D	2 - 19	10.5	5	*Codium fragile*
III	7 - 26	11.5	4	*Chondrus crispus*
IV	2 - 17	7	7	*Laminaria saccharina*
TOTAL	2 - 26	11		

Figure 3-15 Dendrogram depicting the groupings for the dredge samples as determined by cluster analysis. Roman numerals signify groups and arabic numbers signify stations as keyed in Table 3-18.

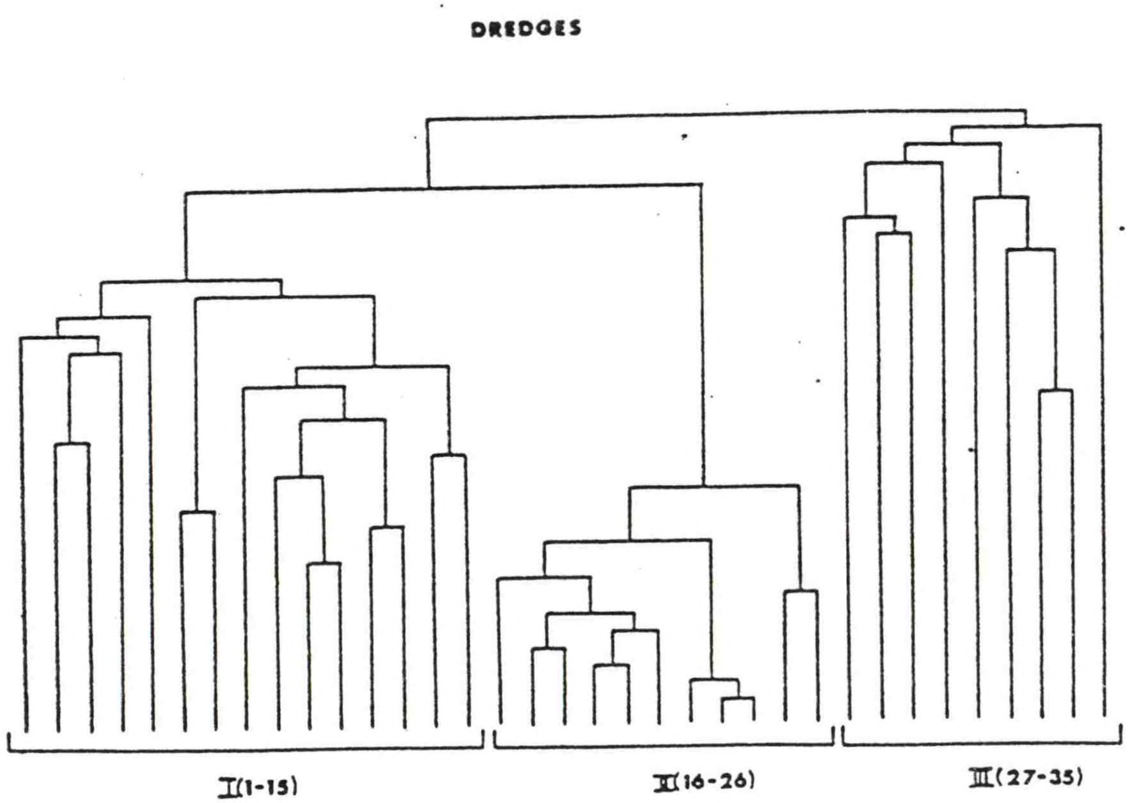


Table 3-18. Dredge algal assemblages identified by cluster analysis. Numbers in () are % of total dry weight for sample. ID's coded as follows: W=Winter, V=Spring (vernal), D=Dredge. Third digit is station and fourth is replicate number. Example: WDA1=Winter, Dredge, Station A, Replicate 1.

Group	ID	Dominant Species (% of total biomass)
I	VDA1	*L.saccharina(64) L.digitata(16)*
	VDB1	*L.saccharina(67)*
	VDJ1	*L.saccharina(67) U.lactuca(11)*
	WDI3	*L.saccharina(72) A.nodosum(18)*
	WDI1	*L.saccharina(54) U.lactuca(15) G.tikvahiae(13)*
	VDD1	*L.saccharina(73) U.lactuca(17)*
	VDD2	*L.saccharina(79) U.lactuca(19)*
	VDH1	*L.saccharina(76) P.lanosa(11)*
	VDF1	*L.saccharina(81)*
	WDA4	*L.saccharina(87)*
	WDD2	*L.saccharina(84)*
	WDE1	*L.saccharina(80)*
	WDE2	*L.saccharina(79)*
	VDI1	*L.saccharina(84) Z.marina(14)*
	WDD1	*L.saccharina(76)*
II	VDA2	*L.saccharina(94)*
	VDA5	*L.saccharina(95)*
	WDA2	*L.saccharina(95)*
	VDC1	*L.saccharina(97)*
	VDI2	*L.saccharina(97)*
	WDA3	*L.saccharina(97)*
	VDA3	*L.saccharina(99)*
	VDE1	*L.SACCHARINA(99)*
	WDA1	*L.saccharina(99.9)*
	VDA4	*L.saccharina(94)*
	WDI5	*L.saccharina(92)*
III	VDH2	*P.truncata(52) D.aculeata(29)*
	WDI2	*P.palmata(48) N.baileyi(17)*
*	WDK4	Leaves(100)
*	WDK2	*Z. marina(57) F.vesiculosus(24)*
IV	VDH3	*N.baileyi(48) L.saccharina(39)*
	WDI4	*U.lactuca(49) L.saccharina(39) G.tikvahiae(26)*
	WDJ2	*L.saccharina(44) U.lactuca(27)*
	WDK1	*L.saccharina(52)*Leaves*U.lactuca(19)*
*	WDK3	Leaves(88)

* singletons with low biomass and high terrestrial detritus.

Table 3-19. Algal biomass and number of species for algae and animals per dredge haul. Biomass (Biom) values are gdw/m². Station codes are as in Table 3-18.

WINTER DREDGES

Haul	Algae Biom	Algae # spp	Anim # spp	Mean Alga Biom	Median # species Algae	Median # species Anim
WDA1	411	4	11			
WDA2	258	10	2			
WDA3	785	6	13			
WDA4	83	7	5	384	6.5	8
WDD1	253	7	13			
WDD2	186	7	19	220	7	16
WDE1	271	12	9			
WDE2	284	10	15	278	11	12
WDI1	46	7	6			
WDI2	9	7	8			
WDI3	119	8	13			
WDI4	109	6	14			
WDI5	48	8	7	28	7	8
WDJ1	35	8	7			
WDJ2	14	5	5			
WDJ3	0	0	3	16	5	5
WDK1	5	3	15			
WDK2	.2	3	9			
WDK3	.7	3	7			
WDK4	0	0	12	2	3	10.5
TOTAL	2633					
N:	20	20	20	6		
Mean:	146	6	10	154		
Max:	785	12	19	384		
Min:	0	0	3	2		

SPRING DREDGES

Haul	Alga Biom	Alga # spp	Anim # spp	Mean Alga Biom	Median # species Algae	Median # species Anim
VDA1	353	15	4			
VDA2	84	4	0			
VDA3	440	3	0			
VDA4	520	9	1			
VDA5	75	7	0	349	7	0
VDB1	463	17	11	463	17	11
VDC1	922	9	5	922	9	5
VDD1	277	10	0			
VDD2	365	11	9	321	10.5	4.5
VDE1	834	8	4	834	8	4
VDF1	348	15	6	348	15	6
VDH1	221	11	3			
VDH2	1	6	2			
VDH3	695	14	5	306	11	2
VDI1	19	3	1			
VDI2	733	12	21	376	7.5	11
Total	6330					
N:	16	16	16	8		
Mean:	397	10	5	490		
Max:	922	17	21	922		
Min:	1	3	1	306		

Missing p.75

4.0 Integration of Studies and Development of an Ecosystem Framework

4.1 Ecological characteristics of the Thames River macrophyte community

The Thames River currently supports a well-developed and relatively healthy ecosystem despite its moderately heavy use as an industrial and military port. A major characteristic of this system is the diverse nature of its spatial and temporal structure. This diversity undoubtedly plays a major role in the persistence of ths system and its robust quality. At its base lie three categories of producers, phytoplankton, eelgrass and macroalgae, which display markedly different functional characteristics within the system.

Phytoplankton are a highly nutritional food source because their protoplasm contains carbon:nitrogen:phosphorus ratios similar to those of animal tissue, but phytoplankton production in the river is highly variable. Some of the variability is predictable, but much of it is not. The small size and waterbourne nature of phytoplankton make them a primary food source for filter-feeding consumers such as zooplankton and bivalve molluscs (oysters, clams, scallops mussels, etc). In systems such as the open ocean where there is no alternate food base, large harbivores (i.e. filter-feeding fishes) must migrate out of the area when the phytoplankton population crashes. Small filter-feeders (i.e. herbivorous zooplankton) experience substantial population crashes in response to the instabilities of the phytoplankton. The New London Harbor area supports substantial populations of filter-feeding zooplankton and bivalves which utilize phytoplankton, but they are species which also utilize small-sized detrital particles to supplement their diets. These detrital particles must be supplied from a source other than phytoplankton. Dead phytoplankton decay within days, or at most a few weeks, so that even heavy blooms cannot provide a basis for year-round support. Detrital phytoplankton from the dense seasonal blooms in the upper river apparently sink to the bottom where they are rapidly consumed by bacteria. These phytoplankton are thus believed to be a major cause of the deleterious summertime anoxia in the bottom water of the upper river, which would exclude benthic filter-feeders from taking advantage of the areas of highest phytoplankton production. Thus there are serious limitations to the usefulness of phytoplankton alone as a food base to the system.

Eelgrass production in the area is also substantial, but it is highly localized. Eelgrass is a rooted vascular plant which requires soft substrate of sand or mud, some protection from heavy wave-stress, and sufficient light. It grows from shallow subtidal areas beyond the wave-surge zone to depths of about 6 meters in clear water. It does not tolerate high turbidity over extended periods. Like phytoplankton, its production is seasonal, but its season is longer, and unlike phytoplankton living eelgrass is not heavily grazed by consumers in the system. It maintains a high standing biomass until fall when it dehisces (loses its leaves naturally by abscission). As a result, most of its annual production enters the system as a single seasonal pulse. After dehiscence (or after being torn loose by storms), eelgrass leaves enter the food chain as detritus which can then be transported throughout the system. These leaves are not as nutritional a food source as phytoplankton. Their nitrogen content is low compared to that of animal tissues and their structural material is cellulose which most animals cannot digest. Moreover, the most valuable nutrients leach away as dissolved materials soon after dehiscence. A period of aging is required during which bacterial colonization of the detrital fragments breaks down their tough cellulose components and raises their nitrogen levels thus restoring their nutritional value to animal consumers. The aging process for various fractions of the leaves takes from months to years and thus, unlike phytoplankton, detrital eelgrass provides a long-term food supply for consumers. Most of the benthic invertebrates reported in the background literature and the research section of this study utilize detritus as a major dietary component. Most of the fish reported for this region utilize detritus directly or feed on the invertebrates which utilize detritus. If small-sized, aged particles of eelgrass are swept into the water column, they may be utilized by filter-feeders.

During its growth period, eelgrass serves as a substrate for attachment of epiphytic plants and animals and for a host of grazers such as the amphipods, isopods and snails reported in this research (45) It also provides protective cover to crabs and shrimp, which were also documented in this report. In summary, eelgrass might be considered a more stable and predictable component of the system than phytoplankton, but it is less nutritious as a food source and requires a period of aging on the bottom. Although it serves in an additional capacity as substrate and cover, these functions must be substantially reduced during the winter dieback.

The macroalgal communities in the River system maintain a relatively stable biomass except in exposed areas. Also they persist throughout the year. Individual species may be seasonal, but replacement by other species stabilizes the biomass of the community as a whole. This contrasts to the exposed areas dominated by kelp (*Laminaria*), where most of the biomass is torn loose in fall and winter storms resulting in great masses of drift algae.

Macroalgae are more widespread than eelgrass because their habitat extends from the upper intertidal zone to depths exceeding 6 m (18 ft) and they utilize both hard and soft substrates. They are functionally similar to the eelgrass in providing attachment surfaces for epiphytes and grazers and protective cover for invertebrates and fish. Unlike the eelgrass, their role is not diminished in winter by diebacks except in exposed areas. The algae are more readily grazed in their living state than the eelgrass because their cell walls are more easily digested. Moreover they also have a higher nitrogen content than eelgrass which makes them a more nutritional food source. The macroalgae maintain high levels of biomass, and even during their normal growth cycle they slough off small particles of biomass or release spores into the water column. These materials are in a size range which can be utilized by filter feeders. Thus, like phytoplankton, macroalgae provide continuous contributions to the trophic pool. In addition, like eelgrass, they add large pulses of material to the detrital pool, where their decomposition times vary from days for many red algae to weeks for the green algae to months for the brown algae. Based on sloughed biomass alone, it is estimated that total production for macroalgae is between 3 and 5 times their maximum standing crop biomass (12).

From these considerations it can be seen that the macroalgal community contributes substantially to the mosaic nature of the Thames River ecosystem by providing a diversity of plants with a range of functional attributes which cover those of both phytoplankton and eelgrass. This scope of functional characteristics alone imply that the macroalgae play a key role in the stability of the Thames River ecosystem. Some tentative estimates of the importance of macroalgae are given below.

1. The system supports at least 7 identifiable assemblages of subtidal macroalgae and a typical, zoned assemblage of intertidal macroalgae. Biomass within the subtidal plant beds ranged from 19-1842 gdw/m^2. The median density was 443 gdw/m^2. Intertidal biomass ranged from 314-5426 gdw/m^2, with a median density of 984 gdw/m^2. Based on the lower value for the production:biomass ratio discussed above, the range of production represented by these standing crops would be 942 - 16278 gdw/m^2-yr (median = 2952 gdw/m^2-yr) for intertidal beds and 57 - 5526 gdw/m^2 (median = 1329 gdw/m^2) for subtidal beds.

2. There are about 19 km of shoreline classified as natural rock within the study area and 5 km classified as rip-rap (including wharves and piers). Allowing an average intertidal width for natural rock of 1.54 m (calculated from a 45° slope and a spring tidal range of 1.09 m) and 1.09 m for rip-rap (assuming a vertical surface), estimates for intertidal area are 29,260 m^2 and 5,450 m^2 respectively. One estimate for total intertidal biomass for the rocky shoreline, based on the median of the measured intertidal biomass (984 gdw/m^2), would be 25,840 kg. This estimate may be high due to the natural fertilization by birds of the measured transects. Based on the lowest biomass measurement for these transects (314 gdw/m^2), total intertidal biomass for the study area would be 8,246 kg. Biomass was not measured on rip-rap. Since the area of the habitat was estimated at less than 19% that of the hardrock, and since the quality of the intertidal community was so poor, biomass is probably less than 1500 kg. Moreover, the algae along the industrialized shorelines may be a liability to the ecosystem due to their exposure to pollution.

3. There are no good estimates of area for subtidal rocky ledges. As discussed in Sections 3.3.2.3, a simple planimetric estimate of hardrock bottom would underestimate its extent because of the three-dimensional nature of these boulder-strewn subtidal areas. A qualitative guess, based on the information we used to construct Figures 3-1 and 3-12, is that 5% of the study area (410,000 m^2) is subtidal ledge. Based on the median value in (1) above, this area would produce 544,890 kg algae per year.

4. Many areas of macroalgal growth (on cobbles throughout the area, trapped in eelgrass beds and in sheltered areas) were not addressed quantitatively in this study. The distributions were far more extensive than we had expected. Moreover, some of these algae were attached and some were drifting, and as discussed in Section 3.3.2.4 and 3.3.3.3, the status of drift algae is largely enigmatic in this system. Presuming that soft substrates cover the remaining 95% of the study area (see (3)), an average of 70 gdw/m^2 algal biomass would match the total production of the rocky areas.

In addition to their trophic role, algal beds have been shown to provide living space for a variety of associated marine animals which also remain active throughout the year. These animal assemblages include the young stages of many large crabs, some of which are commercially important. There are also dense populations of amphipods and isopods which are prime food items for commercially important fish. The three-dimensional configuration of the algal beds as contrasted to bare substrate allows development of a rich species assemblage of associated epifauna which reach enormous densities per square meter of bottom area as shown in Table A4a-d (subtidal) and 3-10 (intertidal).

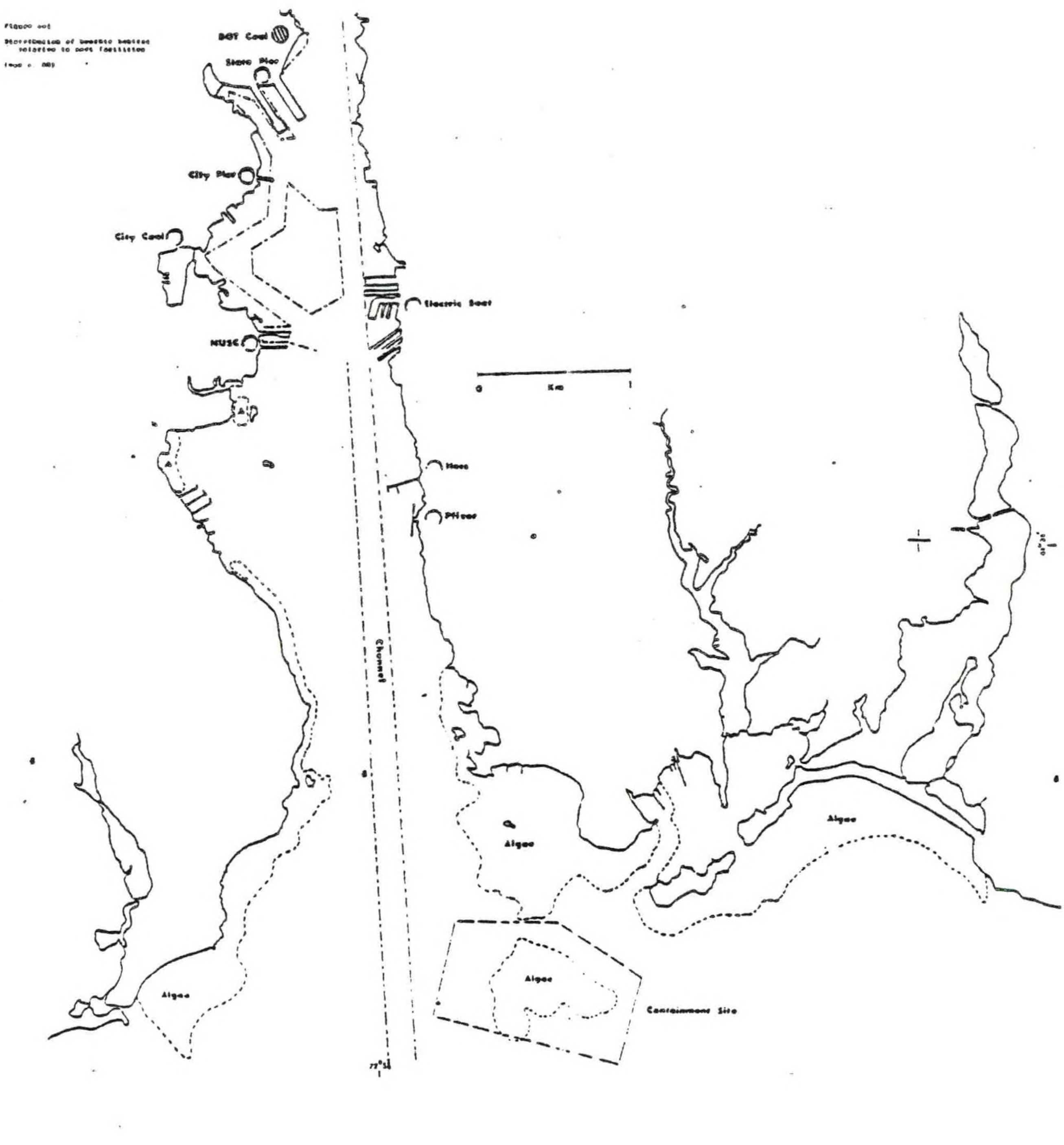
This study has shown that the plant beds reach their greatest densities in the lower harbor and adjacent coastal zone (Fig.4-1). North of the White Island / Green's Harbor area of the river the algae become sparser and more localized. While the densest macroalgal beds were those developed on hardrock aprons adjacent to natural rocky shores or on subtidal ledges, this study has demonstrated that their growth is not confined to such areas as conventionally assumed. We have charted substantial beds of Laminaria, Chondrus, Ulva and other typically productive species over sand or mud bottoms, utilizing cobble, gravel, shell and worm tubes as substrate for attachment. We have documented the mobility of algae as a normal part of their life cycle by documenting their extensive distribution as drifting benthic masses containing species that are well outside their usual growth areas. The condition of much of this drift algae suggests that it is healthy and growing. This is in contrast to the conventional assumption that drifting algae which is not a recognized pelagic species such as Sargassum is in a state of death and decay.

4.2 Characteristics of Impact.

Over the past 100 years or so, the Thames River has been increasingly exploited for commerce, industry, defense and recreation. These activities have produced identifiable impacts on the system. Sewage outfalls have probably had the most extensive impact on the river because they have affected its functional properties. By providing high levels of nutrient supplements in summer, they have altered the seasonal patterns of phytoplankton and increased its production. The added production has increased organic loadings to the sediments which has probably contributed heavily to summer anoxia in the upper half of the river, greatly altering the structure of the heterotrophic community there. These effects have been more pronounced in the more restricted upper half of the river. Physical development of state, municipal, industrial, and military structures, pollution associated with their operation, and dredging to maintain access routes have been far more obvious activities, but their impacts have consisted primarily of localized losses or degradations rather than widespread changes in the functional characteristics of the system. In the New London Harbor area, where industrialization has been most intense, the ecosystem has become spatially partitioned, especially with respect to its benthic plant habitats. The industrialized waterfronts are relatively barren, but the remainder of the system remains relatively healthy and productive. This robust quality reflects a resiliency to temporary impact. The diversity and heterogeneity which characterize this

Figure 4-1 Distribution of benthic habitats in the Thames River area with respect to the dredged channel and port facilities. Proposed facilities are signified by ().

(Submitted as a large figure)



system impart such resiliency because they provide local alternative production areas during impact and local resources for recolonization during recovery.

5.0 Application to CEIP Management Goals.

New London Harbor represents a space-limited resource, and any port development will increase certain day-to-day stresses simply through increased usage. The extent to which harbor areas should be further allocated to industrial port development versus recreational usage is a sociological decision for the communities involved. With respect to the ecosystem, the extent of our present knowledge indicates that the harbor area can support increased usage by either industrial or recreational interests without major impact, but that several basic functional attributes of the system should be recognized and protected.

Hydrologically, the harbor area is fairly well flushed by tides, although we have pointed out some phenomena such as summertime anoxia and tidal recycling upstream from the harbor which suggest that the case for flushing of the river as a whole is somewhat oversimplified. There is a need for more hydrological information on the river system before a realistic assessment can be made for the effects of harbor activities on upstream areas.

Large portions of the harbor lie away from industrialized shorelines and they do not appear to be heavily stressed, despite the port development which has already taken place. Likewise, there is no evidence that present levels of commercial ship traffic in the channel are adversely impacting plants growing adjacent to the channel at the harbor entrance. Within the river, port-related activities have severely impacted benthic communities and intertidal algae around dredged berthing areas, wharf areas and loading facilities. The water column in these areas is highly turbid, which is probably a joint impact of port activities and the two municipal sewage outfalls located in the same area.

Major algal beds are now separated from the industrialized zones; there are no major growing areas north of Green's Harbor. The natural bathymetry of the lower river is asymmetric, dividing the area into a channel and commercial traffic zone on the east and a recreational boating and swimming zone north and south of the main port area on the west. Outside the river, recreational areas lie to the east and west, but the commercial traffic lanes run directly offshore to the south. Thus a reasonable compatibility now exists between recreational areas and industrialized areas of the river.

Macrophyte growth is relatively compatible with recreational usage, but there would be a number of ecological hazards associated with further port development. The channel in New London Harbor is narrow, and increasing the commercial traffic in the relatively restricted harbor will increase the hazard for collision, grounding and episodic spills of petroleum and other hazardous cargo. Heavy fog is a frequent occurrence and confounds the situation. There will also be increased potential for chronic spillage during transfer activities or seepage from waterfront storage facilities. Pollutants spilled in the narrow confines of the harbor could quickly spread and block the river as a zone of passage for spawning or migrating species. Petroleum is known to adsorb readily to eelgrass and algae and other pollutants may be taken into their tissues. If the contaminated plants are not removed, they become a source of continuing pollution. The propensity of these plants to detach and drift about or for plants from neighboring systems to drift into the harbor increases the hazard of spreading adsorbed and absorbed pollutants to adjacent systems. Fine sediments also become contaminated and provide a source for continued pollution. Animals may be affected directly or through consumption of a polluted food supply. A classic documentation of the effects of oil in a temperate environment may be found in the studies conducted in Buzzards Bay after the spill of the barge Florida in 1969 (1,4,25). A recent general review is provided by Olsen et al. (20).

Another potential hazard associated with port development is dredging, especially if it is conducted within plant beds or during critical spawning and migration periods of animals important to the commercial fishery. However, there have been no significant ecological impacts which can be directly attributed to the extensive dredging which has already been conducted in the river.

These hazards reduce to three categories which could be addressed in the planning stages of port development and thus greatly reduce the potential for impact. The categories are (1) physical damage, (2) contamination by pollutants, and (3) turbidity(43, 44)

Localized physical damage and turbidity adjacent to port facilities could be minimized if port development were focused along shorelines which are already impacted and if management plans were devised to control traffic levels within the river, enforce safe docking and transfer procedures, enforce deployment of protective barriers during transfers and provide for rapid detection and response when spills occur.

Depending on the degree of spillage, the location, and the tidal and meteorological conditions, it is highly likely that a moderate to heavy spill of oil or other pollutants in the harbor would necessitate rapid action to prevent the pollutant from spreading to algal beds, from being carried upstream to areas of lowered oxygen content or from blocking off the river as a zone of passage. If plant beds or drifting plants become contaminated, they may have to be removed to landfill areas. The procurement of appropriate equipment and landfill dumping permits in anticipation of these special environmental needs would mitigate the pollution hazard by reducing the response time to a major spill.

This study has identified critical areas for protection with respect to algal beds, zones of passage, spawning and nursery areas and shellfish beds. There is a real need, however, for the development of an accurate predictive model for hydrologic transport of pollutants from specific potential point sources created by port activities under a variety of meteorological conditions specific to New London Harbor. There is also a need for better information on the soft-bottom communities of the shoal areas of the lower harbor and for information about ecosystem north of Bailey Point.

6.0 Epilogue

This study has attempted to examine some basic attributes of the Thames River ecosystem by combining the results of past studies with a brief (one year) field study of attached algal communities. The findings have been illuminating, and have raised several new questions about the system. The extensiveness of macroalgal habitats other than on rocky substrates and the significant degree of mobility of algae as living plants has not been pursued scientifically in Long Island Sound or, to our knowledge, anywhere else.

The quantitative aspects of the results are based on small sample sizes and are therefore tentative estimates. They should not be interpreted as a comprehensive and final measure of the system. The qualitative importance of diversity and habitat heterogeneity, however, is real and its value to the resiliency of the Thames River system cannot be overstated. These attributes enable the system to maintain itself and repair damage. Since self-maintenance and self-repair are far more effective and far less costly than rehabilitation projects, it would be prudent to periodically monitor the system to ensure that we do not exceed its resilient capacity.

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APPENDIX

TABLES

Table A1-A. Annelids reported from the lower Thames River. Area I = north of I-95 bridge, Area II = bridge to mouth, Area III = Black Ledge and New London Ledge area. Data composited from refs 11, 22, 28, 29.

GROUP	SPECIES	Area I Softbottom	Area II Softbottom	Area III Softbottom	Area III Gravel	Area III Hardbottom
POLYCHAETA	*Aglaophamus neogenus*			X		
	Ampharete arctica			X		
	Ampharetidae unid.			X	X	X
	Amphicteis gunneri			X		
	Amphitrite johnstoni					X
	Amphitrite sp.					X
	Anaitides mucosa			X	X	
	Anaitides sp			X		
	Aricidea sp			X	X	
	Asabellides oculata			X	X	
	Autolytus sp.					X
	Capitella capitata		X		X	X
	Cirratulus sp					X
	Clymenella torquata	X	X	X	X	
	Cossura longocirrata			X		
	Diopatra cuprea	X				
	Disoma carica			X		
	Dorvilleidae unid.			X	X	X
	Drilonereis longa				X	
	Drilonereis magna			X		
	Ephesiella minuta				X	
	Euchone sp.			X		
	Eulalia viridis					X
	Eumida sanguinea			X	X	
	Eunicea unid.			X	X	X
	Exogone sp			X		X
	Glycera americana	X		X	X	
	Harmathoe imbricata		X	X	X	X
	Iphinoe trispinosa	X			X	
	Lepidonotus squamatus		X		X	X
	Lepidonotus sublevis				X	
	Lumbrineris lutreilli		X		X	
	Lumbrineris sp.			X	X	
	Maldanopsis elongata	X	X	X		
	Marphysa sanguinea				X	X
	Mediomastus ambiseta			X	X	
	Melinna cristata			X		
	Nephthys caeca	X				
	Nephthys incisa		X	X	X	
	Nephthys picta		X	X		
	Nereis arenaceodonta				X	
	Nereis pelagica				X	X
	Nereis succinea					X
	Nereis virens	X			X	X
	Nicolea venustula					X
	Ninoe nigripes	X		X	X	X
	Notomastus sp				X	
	Onuphis quadricuspis			X		
(cont.)	Orbiniidae unid.				X	

Table A1-A. Annelids reported from the lower Thames River. Area I = north of I-95 bridge, Area II = bridge to
(cont) mouth, Area III = Black Ledge and New London Ledge area. Data composited from refs 11, 22, 28, 29.

		Area I	Area II	Area III		
GROUP	SPECIES	Softbottom	Softbottom	Softbottom	Gravel	Hardbottom
Polychaeta (cont.)	*Paraonis fulgens*			X		
	Paraonis gracilis		X			
	Paraonis sp			X	X	
	Parapionosillis longicirrata				X	X
	Pectenaria gouldii	X	X	X	X	X
	Pherusa affinis			X	X	
	Pholoe minuta			X	X	X
	Phyllodocidae unid.			X	X	
	Pista palmata				X	
	Polycirrus eximius			X	X	X
	Polydora ligni	X	X			
	Polydora socialis			X		
	Polydora sp			X	X	
	Polygordius sp				X	
	Potamilla neglecta					X
	Potamilla reniformis	X			X	X
	Prionospio cirrifera			X		
	Pygospio elegans			X		
	Sabellaria vulgaris	X		X		X
	Sabella microphthalma	X				
	Scalibregma inflatum			X	X	
	Scolelepis squamata			X		
	Scoloplos acutus		X	X		
	Scoloplos robustus	X	X			
	Scale worms (Polynoidae, Sigalionidae)	X				
	Sigambra tentaculata			X	X	
	Sipuncula unid			X	X	
	Sphaerosyllis sp					X
	Spiochaetopterus oculatus			X		
	Spionidae unid.			X	X	
	Spiophanes bombyx			X	X	
	Spirorbis borealis		X			
	Stenelais boa				X	
	Sthenelais limicola			X		X
	Streblospio benedicti		X	X		X
	Syllinae/Eusyllinae unid.			X	X	X
	Terebellidae sp.	X				
	Tharyx acutus		X	X	X	X
Oligochaeta	Oligochaeta unid		X	X	X	X

Table A1-B. Molluscs reported from the lower Thames River. Area I = north of I-95 bridge, Area II = bridge to mouth, Area III = Black Ledge and New London Ledge area. Data collated from refs 11, 22, 28, 29.

GROUP	SPECIES	Area I Hard	Area II Soft	Area II Hard	Area III Soft	Area III Gravel	Area III Hard
Mollusca Bivalves	*Astarte undata*				X		
	Bivalvia unid.					X	X
	Cerastoderma pinnulatum				X		
	Crassostrea virginica	X	X				
	Crenella glandula					X	
	Cumingia tellinoides						X
	Cyclocardium borealis				X		
	Ensis directus	X	X		X		
	Lyonsia hyalina	X			X	X	
	Macoma balthica		X		X	X	
	Mercenaria mercenaria	X	X		X	X	
	Modiolus modiolus						X
	Mulinia lateralis		X		X		
	Mytilus edulis		X				X
	Mya arenaria	X	X				
	Nucula delphinodonta				X	X	X
	Nucula proxima		X		X	X	X
	Nucula tenuis		X				
	Pandora gouldiana	X					
Gastropods	*Acmaea testudinalis*			X			
	Petricola pholadiformis				X		
	Pitar morrhuanus				X		
	Solemya velum				X		
	Tellina agilis		X		X	X	X
	Teredo navalis	X					
	Teredo sp		X				
	Thracia conradi				X		
	Yoldia limatula	X	X		X		
	Acteocina canaliculata		X		X		
	Alvania sp			X			X
	Anachis avara					X	X
	Anachis translirata			X			
	Buccinium sp					X	X
	Busycon canaliculatum	X					X
	Busycon sp		X		X		
	Cerianthiopsis greeni			X			
	Cingula aculeus						X
	Pandora sp		X		X		
	Colus obesa						X
	Crassinella lunulata					X	
	Crepedula convexa			X			
	Crepidula fornicata	X	X	X		X	X
	Crepidula plana	X	X	X		X	X
	Crepidula sp				X		
	Cylichna oryza				X		
	Epitonium humphreysi						X
	Eupleura caudata	X					
(cont.)	Gastropod unid			X			

Table A1-B. Molluscs reported from the lower Thames River. Area I = north of I-95 bridge, Area II = bridge to (cont.) mouth, Area III = Black Ledge and New London Ledge area. Data composited from refs 11, 22, 28, 29.

		Area I	Area II		Area III		
GROUP	SPECIES	Softbottom	Softbottom	Hardbottom	Softbottom	Gravel	Hardbottom
Gastropods (cont.)	*Ilyanassa obsoletus*	X	X		X		
	Lacuna vincta			X		X	X
	Littorina littorea		X	X			
	Littorina obtusata			X			
	Lunatia heros	X			X	X	
	Lunatia triseriata			X	X	X	
	Mitrella dissimilis				X		
	Mitrella lunata			X	X	X	X
	Nassarius trivittatus		X		X		X
	Naticidae unid			X			
	Odostomia dealbata			X			
	Odostomia gibbosa						X
	Odostomia seminuda			X			X
	Odostomia striata			X			
	Onoba (Cingula) aculeus			X			
	Philine lima					X	
	Skeneopis planorbis					X	
	Turbonilla sp				X	X	X
	Urosalpinx cinerea		X	X			X

Table A1-C. Crustaceans reported from the lower Thames River. Area I = north of I-95 bridge, Area II = bridge to mouth, Area III = Black Ledge and New London Ledge area. Data composited from Refs: 11, 22, 28, 29.

		Area I	Area II		Area III		
Group	Species	Softbottom	Softbottom	Hardbottom	Softbottom	Gravel	Hardbottom
OSTRACODA	*Cylindroleberis mariae*					X	X
	Cythereis vineyardensis					X	
	Ostracoda unid.				X	X	
	Sarsiella sp				X	X	
COPEPODA	Unid 7 spp			X			
CIRRIPEDIA	*Balanus crenatus*	X					
	Balanus balanoides	X					
	Balanus balanus	X	X		X		
CUMACEA	*Campylaspis rubicunda*					X	
	Diastylis polita			X			
	Eudorella pusilla				X	X	
	Oxyurostylis smithi				X	X	
TANAIDACEA	*Leptochelia savignyi*			X		X	
	Tanais cavolinii			X			
ISOPODA	*Edotea triloba*			X	X		
	Erichsonella filiformis					X	X
	Erichsonella sp			X			
	Idotea baltica			X			
	Idotea phosphorea			X		X	X
	Isopod sp.	X					
	Jaera marina			X			
	Ptilanthura tenuis					X	
AMPHIPODA	*Ampelisca abdita*				X	X	
	Ampelisca vadorum		X			X	X
	Ampelisca verrilli				X		
	Ampelisca sp				X		
	Amphithoe longimana					X	X
	Amphithoe rubricata			X			
	Byblis serrata				X		
	Calliopius laeviusculus			X			
	Caprellidae unid.			X	X	X	X
	Corophium acutum			X		X	X
	Corophium bonelli				X	X	
	Cymadusa compta			X			
	Dexamine thea			X		X	X
	Elasmopus levis			X			X
	Erichthonius rubricornis				X	X	
	Gammarus oceanicus	X		X			
	Harpinia sp			X			
	Hyale nilssoni			X			
	Ischyrocerus anguipes			X			
	Jassa falcata			X		X	X
(cont.)	*Lembos websteri*					X	X

Table A1-C. Crustaceans reported from the lower Thames River. Area I = north of I-95 bridge, Area II = bridge to (cont.) mouth, Area III = Black Ledge and New London Ledge area. Data composited from Refs: 11, 22, 28, 29.

Group	Species	Area I	Area II		Area III		
		Softbottom	Softbottom	Hardbottom	Softbottom	Gravel	Hardbottom
Amphipoda (cont.)	*Leptocheirus pinguis*		X		X	X	
	Lysianopsis alba					X	X
	Microdeutopus anomalus			X			
	Microdeutopus gryllotalpa						X
	Micropropotus raneyi			X			
	Paraphoxus spinosus					X	X
	Photis sp				X		
	Phoxocephalus holbolli					X	X
	Pleusymtes glaber						X
	Pontogeneia inermis			X			
	Stenothoe minuta				X		X
	Trichophoxus epistomus						X
	Trichophoxus sp			X			
	Unciola irrorata			X	X	X	
	Unciola serrata			X			
MYSIDACEA	*Heteromysis formosa*				X	X	X
	Neomysis americana		X				
	Unid sp					X	
DECAPODA	*Callinectes sapidus*	X	X				
	Cancer borealis						X
	Cancer irroratus	X	X				X
	Crangon septemspinosus	X	X		X	X	
	Homarus americanus	X					
	Libinia dubia				X	X	X
	Libinia sp						
	Neopanope sayi					X	X
	Pagurus longicapus	X	X		X	X	
	Pagurus pollicaris	X					
	Pagurus sp		X				
	Palaemonetes pugio	X					
	Pinnotheres maculatus						X
	Rithropanopeus harrissi	X					
PYCNOGONIDA	*Achelia spinosa*			X			
	Callipallene brevirostris			X			
	Phoxichilidium femoratum			X			
	Pycnogonida unid.					X	X

Table A1-D. Invertebrates reported from the lower Thames River (except polychaetes, annelids, molluscs and crustaceans reported elsewhere. Area I = north of I-95 bridge, Area II = bridge to mouth, Area III = Black Ledge and New London Ledge area. Data collated from refs:11, 22, 28, 29.

		Area I	Area II	Area III		
Group	Species	Softbottom	Softbottom	Softbottom	Gravel	Hardbottom
PORIFERA	*Cliona celata*		X			
	Cliona spp	X	X			
	Haliclona spp	X				
HYDROZOA	*Campanularia sp*		X			
	Hydractinia sp	X				
	Tubularia sp	X				
	Hydroids unid	X				
ANTHOZOA	*Astrangia sp*		X			
	Cerianthus sp			X		
	Edwardsia sp			X		
	Haliplanella luciae	X				
	Metridium senile	X	X			X
NEMERTEA	*Cerebratulus sp*	X		X		
	Tubulanus pellucidus			X		
	Nemertean unid			X	X	X
ECTOPROCTA	*Alcyonidium sp*	X				
	Cryptosula sp	X				
	Ectoproct unid	X	X			
	Electra sp	X				
	Bryozoan unid		X			
BRACHIOPODA	Phoronida unid			X	X	
ECHINOIDEA	*Arbacia sp*		X			X
	Strongylocentrotus drobachiensis		X			
ASTEROIDEA	*Asterias forbesi*	X	X	X		X
	Henricia sanguinolenta				X	X
	Henricia sp		X			
OPHIUROIDEA	*Ampholis squamata*				X	X
HEMICHORDATA	Enteropneusta unid			X		

Table A2-A. Winter quadrats. Algal biomass (g dry wt/m²).

Species	WQB1	WQB2	WQB3	WQF1	WQF2	TOTAL
Ahnfeltia plicata	0	0	0	0	0	0
Amphipleura sp.	0	1.52	.04	0	0	1.56
Antithamnion americanum	0	0	0	0	0	0
Antithamnion cruciatum	0	0	0	0	0	0
Antithamnion plylaisaei	0	0	0	0	0	0
Antithamnion sp.	0	0	0	0	0	0
Bonnemaisonia hamifera	0	.36	.12	0	0	.48
Bryopsis plumosa	0	0	0	0	0	0
Callithamnion byssoides	0	6.24	2.32	0	0	8.56
Callithamnion roseum	0	0	0	0	0	0
Callithamnion tetragonum	0	0	0	0	0	0
Callithamnion sp.	0	0	0	0	0	0
Ceramium rubrum	0	0	0	0	0	0
Chaetomorpha linum	0	0	.04	0	0	.04
Champia parvula	3.2	2.16	6.2	0	0	11.56
Chondrus crispus	0	0	0	0	0	0
Cladophora albida	0	0	0	0	0	0
Cladophora glomerata	0	0	0	0	0	0
Cladophora sericea	0	0	0	0	0	0
Cladophora sp.	0	0	0	0	0	0
Codium fragile	0	.04	0	0	0	.04
Corallina officinalis	0	0	0	0	0	0
Cystoclonium purpureum	0	0	0	0	0	0
Dasya baillouviana	0	0	0	0	0	0
Desmarestia aculeata	0	0	0	0	0	0
Desmarestia viridis	0	0	0	0	0	0
Ectocarpus siliculosus	0	0	0	0	0	0
Ectocarpus sp.	0	0	0	0	0	0
Enteromorpha sp	0	0	0	0	0	0
Fucus distichus	0	0	0	0	0	0
Fucus vesiculosus	0	0	0	0	0	0
Fucus spiralis	0	0	0	5.08	0	5.08
Gracilaria tikvahiae	0	1.04	0	0	90.96	92
Grinnelia americana	0	0	0	0	0	0
Laminaria digitata	0	0	0	0	0	0
Laminaria saccharina	92.96	94.12	0	30.24	82.08	299.4
Licomorpha sp.	0	0	0	0	0	0
Membranoptera alata	0	0	0	0	.92	.92
Membranoptera denticulata	0	0	0	0	0	0
Neoagardhialla baileyi	.72	127.16	37.52	174.159	0	339.56
Palmeria palmata	0	0	0	0	0	0
Phycodrys rubens	13.8	0	0	0	0	13.8
Phyllophora pseudoceranoide	188.8	16.92	0	0	0	205.72
Phyllophora truncata	0	78.76	127.12	211.84	53.76	471.48
Polyides rotundus	0	14.44	32.28	32.52	0	79.25
Polysiphonia denuda	0	0	0	0	0	0
Polysiphonia elongata	0	0	0	0	0	0
Polysiphonia lanosa	0	0	0	0	0	0
Polysiphonia nigra	0	0	0	0	0	0
Polysiphonia nigrescens	0	0	.04	0	0	.04
Polysiphonia novai-angliae	0	0	0	0	0	0
Polysiphonia subtilissima	0	0	0	0	0	0
Polysiphonia urceolata	0	0	0	0	0	0
Rhizoclonium tortuosum	0	0	0	0	0	0
Spermothamnion repens	0	0	0	0	0	0
Ulothrix sp.	0	0	0	0	0	0
Ulva lactuca	0	9.6	0	0	0	9.6
Vaucheria sp.	0	0	0	0	0	0
Zostera marina	0	0	0	0	.08	.08
Total:	299.48	352.36	205.68	453.85	227.8	1539.2

Table A2-8. Spring quadrats. Algal biomass (dry wt/m^2). Stations as in Figure 3-7.
Prefix letters VQ = Vernal (spring) Quadrat. Numbers identify replicates.

Species	VQA1	VQA2	VQA3	VQA4	VQA5	VQA6	VQB1	VQB2	VQB3	VQC1	VQC2
Ahnfeltia plicata	0.00	0.00	1.76	1.88	0.00	0.00	11.80	0.00	0.00	0.00	.64
Amphipleura sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion americanum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion cruciatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion plylaisaei	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.24	0.00
Ascophyllum nodosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bonnemaisonia hamifera	0.00	0.00	0.00	0.00	0.00	0.00	14.88	1.32	2.40	0.00	0.00
Bryopsis plumosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion byssoides	0.00	0.00	.96	0.00	0.00	0.00	0.00	0.00	22.00	0.00	0.00
Callithamnion roseum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion tetragonum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ceramium rubrum	0.00	0.00	0.00	.24	49.52	0.00	0.00	0.00	0.00	0.00	0.00
Chaetomorpha linum	0.00	0.00	0.00	0.00	0.00	0.00	.20	0.00	0.00	0.00	0.00
Champia parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chondrus crispus	0.00	0.00	6.36	.68	0.00	4.48	88.60	16.00	76.00	17.16	14.76
Cladophora albida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora glomerata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sericea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.72
Codium fragile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corallina officinalis	.36	0.00	0.00	0.00	0.00	0.00	31.00	0.00	0.00	7.52	0.00
Cystoclonium purpureum	.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dasya baillouviana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desmerestia aculeata	61.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desmerestia viridis	0.00	0.00	13.68	0.00	0.00	14.56	0.00	0.00	0.00	0.00	0.00
Ectocarpus siliculosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ectocarpus sp.	0.00	0.00	0.00	0.00	0.00	3.24	0.00	0.00	0.00	0.00	0.00
Enteromorpha sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus distichus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus spiralis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus vesiculosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gracilaria tikvahiae	0.00	0.00	0.00	.84	0.00	0.00	0.00	0.00	0.00	0.00	1.88
Grinnelia americana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria digitata	0.00	0.00	146.84	0.00	231.88	62.60	0.00	0.00	0.00	0.00	0.00
Laminaria saccharina	15.28	46.16	224.20	991.76	888.24	404.44	0.00	0.00	0.00	2587.72	2707.52
Licomorpha sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera alata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera denticulata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neoagardhialla baileyi	0.00	0.00	41.32	0.00	0.00	0.00	.80	105.72	213.36	1.92	0.00
Palmeria palmata	0.00	0.00	0.00	0.00	.20	1.60	0.00	0.00	0.00	10.40	6.80
Phycodrys rubens	16.20	0.00	.16	0.00	0.00	0.00	0.00	1.32	0.00	.96	0.00
Phyllophora pseudoceranoides	0.00	0.00	24.28	0.00	0.00	5.56	0.00	74.32	78.36	0.00	30.00
Phyllophora truncata	185.96	0.00	21.40	0.00	0.00	2.80	0.00	0.00	0.00	145.08	243.40
Polyides rotundus	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.48	8.00
Polysiphonia denuda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia elongata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia harveyi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia lanosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigra	0.00	3.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigrescens	0.00	0.00	0.00	0.00	0.00	0.00	.96	0.00	0.00	0.00	0.00
Polysiphonia novai-angliae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia subtilissima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia urceolata	0.00	0.00	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rhizoclonium tortuosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spermothamnion repens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulothrix sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.64	0.00
Ulva lactuca	0.00	0.00	1.40	3.80	45.16	11.68	0.00	0.00	0.00	2.52	0.00
Vaucheria sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zostera marina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total:	280.92	49.92	483.60	999.20	1215.00	510.96	148.24	198.68	392.12	2810.64	3013.72

Table A2-B. Spring quadrats. Algal biomass (dry wt/m²). Stations as in Figure 3-7. (cont.)

Species	VQD1	VQD2	VQE1	VQE2	VQE3	VQF1	VQF2	VQF3	VQH1	VQH2	TOTAL
Ahnfeltia plicata	0.00	1.48	0.00	0.00	0.00	0.00	4.76	0.00	0.00	86.72	109.04
Amphipleura sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion americanum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion cruciatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion plylaisaei	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.24
Ascophyllum nodosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bonnemaisonia hamifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24	19.84
Bryopsis plumosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion byssoides	0.00	0.00	0.00	0.00	0.00	0.00	.96	0.00	0.00	0.00	23.92
Callithamnion roseum	0.00	0.00	0.00	.88	1.20	0.00	0.00	0.00	0.00	0.00	2.08
Callithamnion tetragonum	0.00	0.00	0.00	0.00	.44	0.00	0.00	0.00	0.00	0.00	.44
Callithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ceramium rubrum	0.00	0.00	0.00	3.32	0.00	3.48	0.00	0.00	19.08	15.84	91.48
Chaetomorpha linum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.20
Champia parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chondrus crispus	74.04	13.84	0.00	5.36	.52	60.64	5.16	342.68	351.80	265.20	1343.28
Cladophora albida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora glomerata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sericea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.72
Codium fragile	0.00	.20	0.00	0.00	0.00	0.00	0.00	0.00	.52	0.00	.72
Corallina officinalis	0.00	.80	0.00	0.00	0.00	455.68	83.48	31.20	0.00	0.00	610.04
Cystoclonium purpureum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.84
Dasya baillouviana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desmarestia aculeata	0.00	0.00	0.00	0.00	4.84	0.00	0.00	0.00	0.00	0.00	65.88
Desmarestia viridis	0.00	0.00	0.00	160.20	0.00	0.00	0.00	0.00	0.00	0.00	188.44
Ectocarpus siliculosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ectocarpus sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.24
Enteromorpha sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus distichus	6.36	.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.12
Fucus spiralis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus vesiculosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gracilaria tikvahiae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.72
Grinnelia americana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria digitata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	441.32
Laminaria saccharina	51.32	52.28	12.04	1086.92	266.28	0.00	0.00	1.16	67.16	0.00	9402.48
Licomorpha sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera alata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera denticulata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neoagardhialla baileyi	409.76	370.48	4.00	1.96	32.60	1.64	63.56	70.08	94.00	0.00	1411.20
Palmeria palmata	0.00	.12	0.00	0.00	0.00	0.00	0.00	0.00	.28	0.00	19.40
Phycodrys rubens	0.00	0.00	0.00	0.00	1.12	0.00	0.00	0.00	0.00	0.00	19.76
Phyllophora pseudoceranoides	27.32	0.00	170.12	11.40	103.52	0.00	45.16	0.00	0.00	0.00	570.24
Phyllophora truncata	197.24	102.40	21.84	.84	31.68	8.00	0.00	14.36	0.00	2.68	977.68
Polyides rotundus	0.00	0.00	0.00	0.00	0.00	11.64	12.60	.84	0.00	0.00	70.80
Polysiphonia denuda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia elongata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia harveyi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia lanosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.88	0.00	1.88
Polysiphonia nigra	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.76
Polysiphonia nigrescens	0.00	0.00	.52	.32	0.00	0.00	0.00	0.00	.36	5.72	7.88
Polysiphonia novai-angliae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia subtilissima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia urceolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24
Rhizoclonium tortuosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spermothamnion repens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulothrix sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.64
Ulva lactuca	0.00	.12	0.00	5.72	0.00	20.68	0.00	7.52	772.60	18.52	889.72
Vaucheria sp.	0.00	0.00	0.00	0.00	0.00	0.00	1.88	0.00	4.92	0.00	6.80
Zostera marina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.96	0.00	2.96
Total:	766.24	542.48	208.52	1276.92	442.20	561.76	217.56	467.84	1315.56	395.92	16298.00

Table A2-C. Summer quadrats. Total biomass (gdw/m^2).

SPECIES	SQA1	SQA2	SQB1	SQB2	SQC1	SQC2	SQD1	SQD2	SQE1	SQE2	SQF1	SQF2
Ahnfeltia plicata	0.00	0.00	0.00	0.00	13.09	0.00	0.00	0.00	0.00	0.00	7.16	5.04
Amphipleura sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion americanum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.16
Antithamnion cruciatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion plylaisaei	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.16	0.00
Antithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.92	0.00	0.00	0.00	0.00
Ascophyllum nodosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bonnemaisonia hamifera	0.00	0.00	0.00	.80	0.00	0.00	0.00	0.00	0.00	0.00	4.36	0.00
Bryopsis plumosa	0.00	0.00	0.00	0.00	1.17	0.00	0.00	0.00	0.00	0.00	2.16	0.00
Callithamnion byssoides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion roseum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion tetragonum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ceramium rubrum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.08	0.00	0.00	0.00	.68
Chaetomorpha linum	0.00	0.00	.72	2.20	24.13	102.34	155.44	24.08	0.00	0.00	0.00	0.00
Champia parvula	2.76	3.72	338.32	86.80	56.78	0.00	0.00	103.76	0.00	0.00	0.00	1.72
Chondrus crispus	6.52	1.04	31.12	13.32	730.54	1194.55	1304.76	173.52	17.76	3.96	182.15	135.63
Cladophora albida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora glomerata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sericea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sp.	0.00	0.00	19.16	67.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Codium fragile	0.00	0.00	10.44	2.92	26.20	0.00	0.00	0.00	2.24	0.00	5.28	5.56
Corallina officinalis	0.00	0.00	0.00	0.00	20.71	19.19	0.00	0.00	0.00	0.00	9.32	2.84
Cystoclonium purpureum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dasya baillouviana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desmarestia aculeata	0.00	0.00	0.00	.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desmarestia viridis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ectocarpus siliculosus	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ectocarpus sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Enteromorpha sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus distichus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus spiralis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus vesiculosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gracilaria tikvahiae	0.00	0.00	0.00	0.00	1.56	5.48	0.00	0.00	0.00	0.00	0.00	0.00
Grinnelia americana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria digitata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria saccharina	120.04	1689.89	39.44	0.00	96.52	0.00	0.00	140.00	435.34	1329.08	66.68	169.52
Licomorpha sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera alata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neoagardhialla baileyi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Palmeria palmata	.52	0.00	0.00	0.00	0.00	0.00	0.00	.12	0.00	0.00	.72	.96
Phycodrys rubens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phyllophora pseudoceranoides	0.00	0.00	0.00	0.00	37.44	0.00	0.00	63.60	0.00	1.24	0.00	0.00
Phyllophora truncata	0.00	17.28	107.72	152.32	0.00	0.00	0.00	139.40	0.00	0.00	52.40	1.04
Polyides rotundus	0.00	0.00	6.56	2.44	0.00	0.00	0.00	0.00	0.00	0.00	13.16	11.40
Polysiphonia denuda	40.60	1.24	0.00	0.00	3.12	0.00	0.00	0.00	.08	0.00	0.00	0.00
Polysiphonia elongata	0.00	0.00	0.00	0.00	3.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia harveyi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia lanosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigra	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigrescens	0.00	0.00	.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia novai-angliae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia subtilissima	0.00	0.00	0.00	0.00	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia urceolata	0.00	0.00	0.00	0.00	0.00	18.44	0.00	0.00	0.00	0.00	14.72	0.00
Rhizoclonium tortuosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spermothamnion repens	0.00	0.00	0.00	0.00	1.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulothrix sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulva lactuca	40.28	110.64	4.80	0.00	20.00	0.00	0.00	.24	67.40	10.16	67.60	127.78
Vaucheria sp.	0.00	0.00	1.24	0.00	5.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zostera marina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total:	210.72	1829.81	559.92	329.16	1043.38	1321.55	1460.20	670.72	522.82	1344.44	427.87	463.32

Table A2-C. Summer quadrats. Total biomass (gdw/m²).
(EBAR)

SPECIES	SQG1	SQG2	SQH1	SQH2	TOTAL
Ahnfeltia plicata	0.00	0.00	0.00	1.40	26.69
Amphipleura sp.	0.00	0.00	0.00	0.00	0.00
Antithamnion americanum	0.00	0.00	0.00	0.00	1.16
Antithamnion cruciatum	0.00	0.00	0.00	0.00	0.00
Antithamnion plylaisaei	0.00	0.00	0.00	0.00	2.16
Antithamnion sp.	0.00	0.00	0.00	0.00	25.92
Ascophyllum nodosum	0.00	0.00	0.00	0.00	0.00
Bonnemaisonia hamifera	0.00	0.00	.68	4.88	10.72
Bryopsis plumosa	0.00	0.00	0.00	.64	3.97
Callithamnion byssoides	0.00	0.00	0.00	0.00	0.00
Callithamnion roseum	0.00	0.00	0.00	0.00	0.00
Callithamnion tetragonum	0.00	0.00	0.00	0.00	0.00
Callithamnion sp.	0.00	0.00	0.00	0.00	0.00
Ceramium rubrum	0.00	0.00	0.00	0.00	.76
Chaetomorpha linum	120.96	5.16	193.25	84.23	712.51
Champia parvula	0.00	0.00	6.00	0.00	599.86
Chondrus crispus	170.56	9.60	1616.44	0.00	5591.46
Cladophora albida	0.00	.32	0.00	.40	.72
Cladophora glomerata	0.00	0.00	.80	0.00	.80
Cladophora sericea	0.00	0.00	0.00	.48	.48
Cladophora sp.	0.00	0.00	0.00	0.00	86.88
Codium fragile	0.00	0.00	0.00	0.00	52.64
Corallina officinalis	0.00	0.00	0.00	0.00	52.06
Cystoclonium purpureum	0.00	0.00	0.00	0.00	0.00
Dasya baillouviana	0.00	0.00	0.00	0.00	0.00
Desmarestia aculeata	0.00	0.00	0.00	0.00	.64
Desmarestia viridis	0.00	0.00	0.00	0.00	0.00
Ectocarpus siliculosus	0.00	0.00	.92	0.00	6.92
Ectocarpus sp.	0.00	0.00	0.00	0.00	0.00
Enteromorpha sp	0.00	0.00	0.00	0.00	0.00
Fucus distichus	0.00	11.92	0.00	0.00	11.92
Fucus spiralis	0.00	0.00	0.00	0.00	0.00
Fucus vesiculosus	0.00	0.00	0.00	0.00	0.00
Gracilaria tikvahiae	0.00	0.00	0.00	0.00	7.04
Grinnelia americana	0.00	0.00	0.00	0.00	0.00
Laminaria digitata	0.00	0.00	0.00	0.00	0.00
Laminaria saccharina	0.00	0.00	0.00	337.07	4423.57
Licomorpha sp.	0.00	0.00	0.00	0.00	0.00
Membranoptera alata	0.00	0.00	0.00	0.00	0.00
Neoagardhiella baileyi	0.00	0.00	0.00	0.00	0.00
Palmaria palmata	0.00	0.00	2.24	62.40	66.96
Phycodrys rubens	0.00	0.00	0.00	0.00	0.00
Phyllophora pseudoceranoides	0.00	0.00	0.00	0.00	102.28
Phyllophora truncata	0.00	0.00	0.00	0.00	470.16
Polyides rotundus	0.00	0.00	0.00	0.00	33.56
Polysiphonia denuda	0.00	0.00	0.00	0.00	45.04
Polysiphonia elongata	0.00	0.00	0.00	0.00	3.93
Polysiphonia harveyi	0.00	0.00	0.00	0.00	0.00
Polysiphonia lanosa	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigra	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigrescens	0.00	0.00	16.16	7.04	23.60
Polysiphonia novai-angliae	0.00	0.00	0.00	0.00	0.00
Polysiphonia subtilissima	0.00	0.00	0.00	5.68	6.85
Polysiphonia urceolata	18.24	2.20	0.00	0.00	53.60
Rhizoclonium tortuosum	0.00	0.00	0.00	.12	.12
Spermothamnion repens	0.00	0.00	0.00	0.00	1.95
Ulothrix sp.	0.00	0.00	0.00	0.00	0.00
Ulva lactuca	31.04	146.79	2.56	27.72	657.00
Vaucheria sp.	0.00	0.00	0.00	0.00	6.31
Zostera marina	0.00	0.00	2.92	1.16	4.08
Total:	340.80	175.99	1841.97	533.22	13075.88

Table A2-D. Fall quadrats. Algal biomass (gdw/m²). Stations as in Figure 3-7.

Species	FQA1	FQA2	FQA3	FQB1	FQB2	FQC1	FQC2	FQD1	FQD2
Ahnfeltia plicata	0.00	0.00	0.00	0.00	0.00	.12	0.00	0.00	0.00
Amphipleura sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion americanum	0.00	0.00	.20	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion cruciatum	0.00	0.00	.16	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion plylaisaei	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ascophyllum nodosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bonnemaisonia hamifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bryopsis plumosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion byssoides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion roseum	0.00	0.00	.28	0.00	0.00	.08	0.00	0.00	2.44
Callithamnion tetragonum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion sp.	0.00	0.00	0.00	0.00	1.16	0.00	0.00	0.00	0.00
Ceramium rubrum	0.00	0.00	1.36	0.00	0.00	0.00	0.00	0.00	0.00
Chaetomorpha linum	0.00	0.00	0.00	0.00	.64	0.00	0.00	0.00	.68
Champia parvula	0.00	.44	.32	0.00	1.64	.24	.52	1.24	4.04
Chondrus crispus	60.36	0.00	1.48	10.88	19.44	0.00	.08	16.72	371.16
Cladophora albida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora glomerata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sericea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Codium fragile	0.00	0.00	0.00	685.32	.20	0.00	0.00	2.36	0.00
Corallina officinalis	0.00	0.00	0.00	0.00	0.00	1.16	1.08	0.00	0.00
Cystoclonium purpureum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dasya baillouviana	0.00	0.00	.20	0.00	0.00	0.00	0.00	0.00	0.00
Desmarestia aculeata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desmarestia viridis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ectocarpus siliculosus	0.00	0.00	.16	0.00	0.00	0.00	0.00	0.00	0.00
Ectocarpus sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Enteromorpha sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus distichus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus vesiculosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus spiralis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gracilaria tikvahiae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grinnelia americana	0.00	0.00	.04	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria digitata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria saccharina	153.16	140.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Licomorpha sp.	0.00	0.00	.12	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera alata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera denticulata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neoagardhialla baileyi	0.00	1.72	0.00	3.04	4.96	.60	2.24	25.04	31.28
Palmaria palmata	0.00	.64	0.00	.12	0.00	0.00	0.00	0.00	0.00
Phycodrys rubens	.68	1.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phyllophora pseudoceranoides	168.60	376.48	22.88	14.40	45.88	67.48	136.56	165.80	354.32
Phyllophora truncata	27.28	0.00	1.80	0.00	0.00	0.00	0.00	0.00	0.00
Polyides rotundus	0.00	0.00	0.00	.80	1.68	3.60	.32	.12	0.00
Polysiphonia denuda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia elongata	0.00	0.00	0.00	.28	0.00	0.00	0.00	.80	0.00
Polysiphonia harveyi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia lanosa	0.00	0.00	0.00	1.52	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigra	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigrescens	0.00	0.00	0.00	0.00	.28	0.00	0.00	0.00	0.00
Polysiphonia novai-angliae	0.00	0.00	0.00	28.56	0.00	0.00	0.00	0.00	0.00
Polysiphonia subtilissima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia urceolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.21
Rhizoclonium tortuosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spermothamnion repens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulothrix sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulva lactuca	.44	0.00	2.08	14.44	0.00	0.00	0.00	66.48	4.80
Vaucheria sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zostera marina	0.00	0.00	0.00	0.00	.04	0.00	0.00	.68	0.00
Total:	410.52	521.52	31.08	759.60	75.92	73.36	142.64	279.24	772.93

Table A2-D. Fall algal biomass (gdw/m²). Stations as in Figure 3-7.
(cont)

Species	FQE1	FQE2	FQF1	FQF2	FQG1	FQG2	FQH1	FQH2	TOTAL
Ahnfeltia plicata	.72	0.00	0.00	0.00	0.00	0.00	4.20	12.72	17.76
Amphipleura sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion americanum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.20
Antithamnion cruciatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.16
Antithamnion plylaisaei	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ascophyllum nodosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bonnemaisonia hamifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bryopsis plumosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion byssoides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion roseum	0.00	0.00	0.00	1.68	0.00	0.00	0.00	0.00	4.48
Callithamnion tetragonum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.16
Ceramium rubrum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.04	2.40
Chaetomorpha linum	0.00	0.00	0.00	5.40	0.00	.16	0.00	0.00	6.88
Champia parvula	.24	1.56	3.40	4.16	29.60	1.40	.08	0.00	48.88
Chondrus crispus	4.48	77.76	766.04	419.64	294.08	91.96	.16	14.96	2149.20
Cladophora albida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora glomerata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sericea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Codium fragile	0.00	0.00	0.00	0.00	10.52	0.00	7.20	1.00	706.60
Corallina officinalis	0.00	0.00	48.12	6.44	0.00	0.00	.12	0.00	56.92
Cystoclonium purpureum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dasya baillouviana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.20
Desmarestia aculeata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desmarestia viridis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ectocarpus siliculosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.16
Ectocarpus sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Enteromorpha sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus distichus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus vesiculosus	0.00	0.00	0.00	0.00	9.52	0.00	0.00	0.00	9.52
Fucus spiralis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gracilaria tikvahiae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grinnelia americana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.04
Laminaria digitata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria saccharina	0.00	19.04	0.00	0.00	0.00	4.20	0.00	0.00	316.68
Licomorpha sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.12
Membranoptera alata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera denticulata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neoagardhialla baileyi	.12	2.16	7.28	2.08	17.80	112.40	0.00	0.00	210.72
Palmeria palmata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.76
Phycodrys rubens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.64
Phyllophora pseudoceranoides	111.48	174.56	83.00	24.80	5.00	144.16	.04	0.00	1895.44
Phyllophora truncata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.08
Polyides rotundus	3.76	0.00	11.00	19.36	0.00	0.00	0.00	0.00	40.64
Polysiphonia denuda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia elongata	0.00	0.00	0.00	0.00	0.00	0.00	.40	0.00	1.48
Polysiphonia harveyi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia lanosa	0.00	0.00	0.00	0.00	0.00	0.00	.04	0.00	1.56
Polysiphonia nigra	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigrescens	0.00	0.00	0.00	0.00	1.76	0.00	0.00	0.00	2.04
Polysiphonia novai-angliae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.56
Polysiphonia subtilissima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia urceolata	0.00	0.00	0.00	0.00	3.28	0.00	0.00	.36	7.85
Rhizoclonium tortuosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spermothamnion repens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulothrix sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulva lactuca	.80	0.00	1.36	0.00	64.44	58.64	3.68	.84	218.00
Vaucheria sp.	0.00	0.00	0.00	0.00	0.00	.08	0.00	0.00	.08
Zostera marina	1.72	0.00	0.00	0.00	1.24	.32	3.04	.80	7.84
TOTAL:	123.32	275.76	920.20	483.56	437.24	413.44	18.96	31.76	5771.05

Table A3-A. Winter quadrats. Algal biomass as percent of total for individual quadrats. Stations as in Fig. 3-7.

Species	WQB1	WQB2	WQB3	WQF1	WQF2
Ahnfeltia plicata					
Amphipleura sp.		.43	.02		
Antithamnion americanum					
Antithamnion cruciatum					
Antithamnion plylaisaei					
Antithamnion sp.					
Ascophyllum nodosum					
Bonnemaisonia hamifera		.10	.06		
Bryopsis plumosa					
Callithamnion byssoides		1.77	1.13		
Callithamnion roseum					
Callithamnion tetragonum					
Callithamnion sp.					
Ceramium rubrum					
Chaetomorpha linum			.02		
Champia parvula	1.07	.61	3.01		
Chondrus crispus					
Cladophora albida					
Cladophora glomerata					
Cladophora sericea					
Cladophora sp.					
Codium fragile		.01			
Corallina officinalis					
Cystoclonium purpureum					
Dasya baillouviana					
Desmerestia aculeata					
Desmerestia viridis					
Ectocarpus siliculosus					
Ectocarpus sp.					
Enteromorpha sp					
Fucus distichus					
Fucus vesiculosus					
Fucus spiralis				1.12	
Gracilaria tikvahiae		.30			39.93
Grinnelia americana					
Laminaria digitata					
Laminaria saccharina	31.04	26.71		6.66	36.03
Licomorpha sp.					
Membranoptera alata					.40
Membranoptera denticulata					
Neoagardhiella baileyi	.24	36.09	18.24	38.38	
Palmeria palmata					
Phycodrys rubens	4.61				
Phyllophora pseudoceranoides	63.04	4.80			
Phyllophora truncata		22.35	61.80	46.67	23.60
Polyides rotundus		4.10	15.69	7.17	
Polysiphonia denuda					
Polysiphonia elongata					
Polysiphonia harveyi					
Polysiphonia lanosa					
Polysiphonia nigra					
Polysiphonia nigrescens			.02		
Polysiphonia novai-angliae					
Polysiphonia subtilissima					
Polysiphonia urceolata					
Rhizoclonium tortuosum					
Spermothamnion repens					
Ulothrix sp.					
Ulva lactuca		2.72			
Vaucheria sp.					
Zostera marina					.04
Total Marine Plants:	100.00	97.27	99.98	100.00	99.96
Leaves (detrital):	0.00	2.73	.02	0.00	.04
Total plant material:	100.00	100.00	100.00	100.00	100.00

Table A3-B. Spring quadrats. Algal biomass as percent of total biomass for the quadrat. Stations as in Figure 3-7.

Species	VQA1	VQA2	VQA3	VQA4	VQA5	VQA6	VQB1	VQB2	VQB3	VQC1	VQC2
Ahnfeltia plicata	0.00	0.00	.36	.19	0.00	0.00	7.96	0.00	0.00	0.00	.02
Amphipleura sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion americanum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion cruciatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion plylaisaei	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01	0.00
Ascophyllum nodosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bonnemaisonia hamifera	0.00	0.00	0.00	0.00	0.00	0.00	10.04	.66	.61	0.00	0.00
Bryopsis plumosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion byssoides	0.00	0.00	.20	0.00	0.00	0.00	0.00	0.00	5.61	0.00	0.00
Callithamnion roseum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion tetragonum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ceramium rubrum	0.00	0.00	0.00	.02	4.08	0.00	0.00	0.00	0.00	0.00	0.00
Chaetomorpha linum	0.00	0.00	0.00	0.00	0.00	0.00	.13	0.00	0.00	0.00	0.00
Champia parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chondrus crispus	0.00	0.00	1.32	.07	0.00	.88	59.77	8.05	19.38	.61	.49
Cladophora albida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora glomerata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sericea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.02
Cladophora sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Codium fragile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corallina officinalis	.13	0.00	0.00	0.00	0.00	0.00	20.91	0.00	0.00	.27	0.00
Cystoclonium purpureum	.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dasya baillouviana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.00	0.00
Desmarestia aculeata	21.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desmarestia viridis	0.00	0.00	2.83	0.00	0.00	2.85	0.00	0.00	0.00	0.00	0.00
Ectocarpus siliculosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ectocarpus sp.	0.00	0.00	0.00	0.00	0.00	.63	0.00	0.00	0.00	0.00	0.00
Enteromorpha sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus distichus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus vesiculosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus spiralis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gracilaria tikvahiae	0.00	0.00	0.00	.08	0.00	0.00	0.00	0.00	0.00	0.00	.06
Grinnelia americana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria digitata	0.00	0.00	30.36	0.00	19.08	12.25	0.00	0.00	0.00	0.00	0.00
Laminaria saccharina	5.44	92.47	46.36	99.26	73.11	79.15	0.00	0.00	0.00	92.07	89.84
Licomorpha sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera alata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera denticulata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neoagardhialla baileyi	0.00	0.00	8.54	0.00	0.00	0.00	.54	53.21	54.41	.07	0.00
Palmaria palmata	0.00	0.00	0.00	0.00	.02	.31	0.00	0.00	0.00	.37	.23
Phycodrys rubens	5.77	0.00	.03	0.00	0.00	0.00	0.00	.66	0.00	.03	0.00
Phyllophora pseudoceranoides	0.00	0.00	5.02	0.00	0.00	1.09	0.00	37.41	19.98	0.00	1.00
Phyllophora truncata	66.20	0.00	4.43	0.00	0.00	.55	0.00	0.00	0.00	5.16	8.08
Polyides rotundus	.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30	.27
Polysiphonia denuda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia elongata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia harveyi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia lanosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigra	0.00	7.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigrescens	0.00	0.00	0.00	0.00	0.00	0.00	.65	0.00	0.00	0.00	0.00
Polysiphonia novai-angliae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia subtilissima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia urceolata	0.00	0.00	.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rhizoclonium tortuosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spermothamnion repens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulothrix sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.02	0.00
Ulva lactuca	0.00	0.00	.29	.38	3.72	2.29	0.00	0.00	0.00	.09	0.00
Vaucheria sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zostera marina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

continued->

Table A3-B. Spring quadrats. Algal biomass as percent of total biomass for the quadrat. Stations as
(cont) in Figure 3-6.

Species	VQD1	VQD2	VQE1	VQE2	VQE3	VQF1	VQF2	VQF3	VQH1	VQH2
Ahnfeltia plicata	0.00	.27	0.00	0.00	0.00	0.00	2.19	0.00	0.00	21.90
Amphipleura sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion americanum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion cruciatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion plylaisaei	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ascophyllum nodosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bonnemaisonia hamifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.31
Bryopsis plumose	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion byssoides	0.00	0.00	0.00	0.00	0.00	0.00	.44	0.00	0.00	0.00
Callithamnion roseum	0.00	0.00	0.00	.07	.27	0.00	0.00	0.00	0.00	0.00
Callithamnion tetragonum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion sp.	0.00	0.00	0.00	0.00	.10	0.00	0.00	0.00	0.00	0.00
Ceramium rubrum	0.00	0.00	0.00	.26	0.00	.62	0.00	0.00	1.45	4.00
Chaetomorpha linum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Champia parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chondrus crispus	9.66	2.55	0.00	.42	.12	10.79	2.37	73.25	26.74	66.98
Cladophora albida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora glomerata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sericea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Codium fragile	0.00	.04	0.00	0.00	0.00	0.00	0.00	0.00	.04	0.00
Corallina officinalis	0.00	.15	0.00	0.00	0.00	81.12	38.37	6.67	0.00	0.00
Cystoclonium purpureum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dasya baillouviana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desmerestia aculeata	0.00	0.00	0.00	0.00	1.09	0.00	0.00	0.00	0.00	0.00
Desmerestia viridis	0.00	0.00	0.00	12.55	0.00	0.00	0.00	0.00	0.00	0.00
Ectocarpus siliculosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ectocarpus sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Enteromorpha sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus distichus	.83	.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus vesiculosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus spiralis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gracilaria tikvahiae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grinnelia americana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria digitata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria saccharina	6.70	9.64	5.77	85.12	60.22	0.00	0.00	.25	5.11	0.00
Licomorpha sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera alata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera denticulata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neoagardhialla baileyi	53.48	68.29	1.92	.15	7.37	.29	29.21	14.98	7.15	0.00
Palmeria palmata	0.00	.02	0.00	0.00	0.00	0.00	0.00	0.00	.02	0.00
Phycodrys rubens	0.00	0.00	0.00	0.00	.25	0.00	0.00	0.00	0.00	0.00
Phyllophora pseudoceranoides	3.59	0.00	81.58	.89	23.41	0.00	20.76	0.00	0.00	0.00
Phyllophora truncata	25.74	18.88	10.47	.07	7.16	1.42	0.00	3.07	0.00	.68
Polyides rotundus	0.00	0.00	0.00	0.00	0.00	2.07	5.79	.18	0.00	0.00
Polysiphonia denuda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia elongata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia harveyi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia lanosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.14	0.00
Polysiphonia nigra	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigrescens	0.00	0.00	.25	.03	0.00	0.00	0.00	0.00	.03	1.44
Polysiphonia novai-angliae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia subtilissima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia urceolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rhizoclonium tortuosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spermothamnion repens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulothrix sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulva lactuca	0.00	.02	0.00	.45	0.00	3.68	0.00	1.61	58.73	4.68
Vaucheria sp.	0.00	0.00	0.00	0.00	0.00	0.00	.86	0.00	.37	0.00
Zostera marina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.22	0.00
Total:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table A3-C. Summer quadrats. Algal biomass as percent of total biomass for the quadrat. Stations as in Figure 3-7.

Species	SQA1	SQA2	SQB1	SQB2	SQC1	SQC2	SQD1	SQD2
Ahnfeltia plicata	0.00	0.00	0.00	0.00	1.25	0.00	0.00	0.00
Amphipleura sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion americanum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion cruciatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion plylaisaei	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.86
Ascophyllum nodosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bonnemaisonia hamifera	0.00	0.00	0.00	.24	0.00	0.00	0.00	0.00
Bryopsis plumosa	0.00	0.00	0.00	0.00	.11	0.00	0.00	0.00
Callithamnion byssoides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion roseum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion tetragonum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ceramium rubrum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01
Chaetomorpha linum	0.00	0.00	.13	.67	2.31	7.64	10.65	3.59
Champia parvula	1.31	.20	60.42	26.37	5.44	0.00	0.00	15.47
Chondrus crispus	3.09	.06	5.56	4.05	70.02	89.14	89.35	25.87
Cladophora albida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora glomerata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sericea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladophora sp.	0.00	0.00	3.42	20.57	0.00	0.00	0.00	0.00
Codium fragile	0.00	0.00	1.86	.89	2.51	0.00	0.00	0.00
Corallina officinalis	0.00	0.00	0.00	0.00	1.98	1.43	0.00	0.00
Cystoclonium purpureum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dasya baillouviana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desmarestia aculeata	0.00	0.00	0.00	.19	0.00	0.00	0.00	0.00
Desmarestia viridis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ectocarpus siliculosus	0.00	.33	0.00	0.00	0.00	0.00	0.00	0.00
Ectocarpus sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Enteromorpha sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus distichus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus vesiculosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus spiralis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gracilaria tikvahiae	0.00	0.00	0.00	0.00	.15	.41	0.00	0.00
Grinnelia americana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria digitata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria saccharina	56.97	92.35	7.04	0.00	9.25	0.00	0.00	20.87
Licomorpha sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera alata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera denticulata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neoagardhialla baileyi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Palmeria palmata	.25	0.00	0.00	0.00	0.00	0.00	0.00	.02
Phycodrys rubens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phyllophora pseudoceranoides	0.00	0.00	0.00	0.00	3.59	0.00	0.00	9.48
Phyllophora truncata	0.00	.94	19.24	46.28	0.00	0.00	0.00	20.78
Polyides rotundus	0.00	0.00	1.17	.74	0.00	0.00	0.00	0.00
Polysiphonia denuda	19.27	.07	0.00	0.00	.30	0.00	0.00	0.00
Polysiphonia elongata	0.00	0.00	0.00	0.00	.38	0.00	0.00	0.00
Polysiphonia harveyi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia lanosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigra	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigrescens	0.00	0.00	.07	0.00	0.00	0.00	0.00	0.00
Polysiphonia novai-angliae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia subtilissima	0.00	0.00	0.00	0.00	.11	0.00	0.00	0.00
Polysiphonia urceolata	0.00	0.00	0.00	0.00	0.00	1.38	0.00	0.00
Rhizoclonium tortuosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spermothamnion repens	0.00	0.00	0.00	0.00	.19	0.00	0.00	0.00
Ulothrix sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulva lactuca	19.12	6.05	.86	0.00	1.92	0.00	0.00	.04
Vaucheria sp.	0.00	0.00	.22	0.00	.49	0.00	0.00	0.00
Zostera marina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Marine Plants:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99
Leaves (detrital):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01
Total Plant Material:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table A3-C. Summer quadrats. Algal biomass as percent of total biomass for the quadrat.
(cont.) Stations as in Figure 3-7.

Species	SQE1	SQE2	SQF1	SQF2	SQG1	SQG2	SQH1	SQH2
Ahnfeltia plicata	0.00	0.00	1.67	1.09	0.00	0.00	0.00	.26
Amphipleura sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion americanum	0.00	0.00	0.00	.25	0.00	0.00	0.00	0.00
Antithamnion cruciatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antithamnion plylaisaei	0.00	0.00	.50	0.00	0.00	0.00	0.00	0.00
Antithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ascophyllum nodosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bonnemaisonia hamifera	0.00	0.00	1.02	0.00	0.00	0.00	.04	.92
Bryopsis plumosa	0.00	0.00	.50	0.00	0.00	0.00	0.00	.12
Callithamnion byssoides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion roseum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion tetragonum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callithamnion sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ceramium rubrum	0.00	0.00	0.00	.15	0.00	0.00	0.00	0.00
Chaetomorpha linum	0.00	0.00	0.00	0.00	35.49	2.93	10.49	15.80
Champia parvula	0.00	0.00	0.00	.37	0.00	0.00	.33	0.00
Chondrus crispus	3.40	.29	42.57	29.27	50.05	5.45	87.76	0.00
Cladophora albida	0.00	0.00	0.00	0.00	0.00	.18	0.00	.08
Cladophora glomerata	0.00	0.00	0.00	0.00	0.00	0.00	.04	0.00
Cladophora sericea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.09
Cladophora sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Codium fragile	.43	0.00	1.23	1.20	0.00	0.00	0.00	0.00
Corallina officinalis	0.00	0.00	2.18	.61	0.00	0.00	0.00	0.00
Cystoclonium purpureum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dasya baillouviana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desmarestia aculeata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desmarestia viridis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ectocarpus siliculosus	0.00	0.00	0.00	0.00	0.00	0.00	.05	0.00
Ectocarpus sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Enteromorpha sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus distichus	0.00	0.00	0.00	0.00	0.00	6.77	0.00	0.00
Fucus vesiculosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fucus spiralis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gracilaria tikvahiae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grinnelia americana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria digitata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laminaria saccharina	83.27	98.86	15.58	36.59	0.00	0.00	0.00	63.21
Licomorpha sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera alata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranoptera denticulata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neoagardhialla baileyi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Palmaria palmata	0.00	0.00	.17	.21	0.00	0.00	.12	11.70
Phycodrys rubens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phyllophora pseudoceranoides	0.00	.09	0.00	0.00	0.00	0.00	0.00	0.00
Phyllophora truncata	0.00	0.00	12.25	.22	0.00	0.00	0.00	0.00
Polyides rotundus	0.00	0.00	3.08	2.46	0.00	0.00	0.00	0.00
Polysiphonia denuda	.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia elongata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia harveyi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia lanosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigra	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia nigrescens	0.00	0.00	0.00	0.00	0.00	0.00	.88	1.32
Polysiphonia novai-angliae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polysiphonia subtilissima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07
Polysiphonia urceolata	0.00	0.00	3.44	0.00	5.35	1.25	0.00	0.00
Rhizoclonium tortuosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.02
Spermothamnion repens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulothrix sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulva lactuca	12.89	.76	15.80	27.58	9.11	83.41	.14	5.20
Vaucheria sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zostera marina	0.00	0.00	0.00	0.00	0.00	0.00	.16	.22
Total Marine Plants:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Leaves (detrital):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Plant Material:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table A3-D. Fall quadrats. Algal biomass as percent of total biomass for the quadrat. Stations as in Figure 3-7.

Species	FQA1	FQA2	FQA3	FQB1	FQB2	FQC1	FQC2	FQD1	FQD2
Ahnfeltia plicata						.16		0.00	
Amphipleura sp.									
Antithamnion americanum			.64						
Antithamnion cruciatum			.51						
Antithamnion plylaisaei									
Antithamnion sp.									
Ascophyllum nodosum									
Bonnemaisonia hamifera									
Bryopsis plumosa									
Callithamnion byssoides									
Callithamnion roseum			.90			.11			.32
Callithamnion tetragonum									
Callithamnion sp.					1.53				
Ceramium rubrum			4.38						
Chaetomorpha linum				0.00	.84		0.00		.09
Champia parvula		.08	1.03		2.16	.33	.36	.44	.32
Chondrus crispus	14.70		4.76	1.43	25.61		.06	5.99	48.02
Cladophora albida									
Cladophora glomerata									
Cladophora sericea									
Cladophora sp.									
Codium fragile				90.22	.26			.85	
Corallina officinalis						1.58	.76		
Cystoclonium purpureum									
Dasya baillouviana			.64						
Desmarestia aculeata									
Desmarestia viridis									
Ectocarpus siliculosus			.51						
Ectocarpus sp.									
Enteromorpha sp									
Fucus distichus									
Fucus vesiculosus									
Fucus spiralis									
Gracilaria tikvahiae									
Grinnelia americana			.13					0.00	
Laminaria digitata									
Laminaria saccharina	37.31	26.90							
Licomorpha sp.			.39						
Membranoptera alata									
Membranoptera denticulata									
Neoagardhiella baileyi		.33		.40	6.53	.82	1.37	8.97	4.05
Palmaria palmata		.12		.02					
Phycodrys rubens	.17	.38							
Phyllophora pseudoceranoides	41.07	72.19	73.62	1.90	60.43	91.98	95.74	59.38	45.84
Phyllophora truncata	6.65		5.79						
Polyides rotundus				.11	2.21	4.91	.22	.04	
Polysiphonia denuda									
Polysiphonia elongata				.04				.29	
Polysiphonia harveyi									
Polysiphonia lanosa				.20					
Polysiphonia nigra									
Polysiphonia nigrescens					.37				
Polysiphonia novae-angliae				3.76					
Polysiphonia subtilissima									
Polysiphonia urceolata									.54
Rhizoclonium tortuosum									
Spermothamnion repens				.03		.11	1.29		
Ulothrix sp.									
Ulva lactuca	.11		6.69	1.90		0.00		23.81	.62
Vaucheria sp.									
Zostera marina					.05			.24	
Total:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

continued->

Table A3-D. Fall quadrats. Algal biomass as percent of total biomass for the quadrat.
(cont) Stations as in Figure 3-7.

Species	FQE1	FQE2	FQF1	FQF2	FQG1	FQG2	FQH1	FQH2
Ahnfeltia plicata	.58						22.15	40.05
Amphipleura sp.								
Antithamnion americanum								
Antithamnion cruciatum								
Antithamnion plylaisaei								
Antithamnion sp.								
Ascophyllum nodosum								
Bonnemaisonia hamifera								
Bryopsis plumosa								
Callithamnion byssoides								
Callithamnion roseum				.35				
Callithamnion tetragonum								
Callithamnion sp.								
Ceramium rubrum								3.27
Chaetomorpha linum	0.00			1.12		.04	0.00	0.00
Champia parvula	.19	.57	.37	.86	6.77	.34	.42	0.00
Chondrus crispus	3.63	28.20	83.25	86.78	67.26	22.24	.84	47.10
Cladophora albida								
Cladophora glomerata								
Cladophora sericea								
Cladophora sp.								
Codium fragile					2.41		37.97	3.15
Corallina officinalis			5.23	1.33			.63	
Cystoclonium purpureum								
Dasya baillouviana								
Desmerestia aculeata								
Desmerestia viridis								
Ectocarpus siliculosus								
Ectocarpus sp.								
Enteromorpha sp								
Fucus distichus								
Fucus vesiculosus					2.18			
Fucus spiralis								
Gracilaria tikvahiae								
Grinnelia americana								
Laminaria digitata								
Laminaria saccharina		6.90				1.02		
Licomorpha sp.								
Membranoptera alata								
Membranoptera denticulata								
Neoagardhiella baileyi	.10	.78	.79	.43	4.07	27.19		
Palmaria palmata				0.00				
Phycodrys rubens								
Phyllophora pseudoceranoides	90.40	63.30	9.02	5.13	1.14	34.87	.21	
Phyllophora truncata								
Polyides rotundus	3.05		1.20	4.00				
Polysiphonia denuda								
Polysiphonia elongata				0.00		0.00	2.11	
Polysiphonia harveyi								
Polysiphonia lanosa	0.00						.21	
Polysiphonia nigra								
Polysiphonia nigrescens					.40			
Polysiphonia novai-angliae								
Polysiphonia subtilissima								
Polysiphonia urceolata					.75			1.13
Rhizoclonium tortuosum								
Spermothamnion repens	0.00	.25				.03		.13
Ulothrix sp.								
Ulva lactuca	.65		.15	0.00	14.74	14.18	19.41	2.64
Vaucheria sp.						.02		
Zostera marina	1.39				.28	.08	16.03	2.52
Total:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table A4-A. Animals, winter quadrats. Values are individuals /gdw*m². NA=not appropiate to count.
***= too numerous to count.

Phylum	Species	WQB1	WQB2	WQB3	WQF1	WQF2	TOTAL	FREQ	MAXI
SPONGES	Unk 1-Amorphous	NA	0	0	0	0	NA	1	NA
	Unk 2-Yellow	0	NA	0	0	0	NA	1	NA
CNIDARIANS	Anemone Unid	0	0	16	0	0	16	1	16
BRYOZOA	Bryozoan Unid	NA	0	0	0	0	NA	1	NA
MOLLUSCS-BIVALVES	*Mytilus edulis*	0	4	4	0	0	8	2	4
	Solemya velum	0	0	0	56	0	56	1	56
MOLLUSCS-GASTROPODS	*Anachis sp*	***	668	276	96	16	1056	5	668
	Bittium alternatum	4	0	0	0	0	4	1	4
	Crepidula convexa	0	0	0	4768	0	4768	1	4768
	Crepidula fornicata	4	0	0	0	0	4	1	4
	Lacuna sp	***	200	148	940	16	1304	5	940
	Littorina littorea	8	4	0	0	0	12	2	8
	Lunatia sp	0	0	4	0	0	4	1	4
	Mitrella sp	***	128	164	2588	16	2896	5	2588
	Urosalpinx cinerea	0	36	12	0	0	48	2	36
POLYCHAETES	*Ampharete sp*	0	4	0	0	0	4	1	4
	Amphartrite johnsoni	0	4	0	0	0	4	1	4
	Dodecaceria coralli	0	4	0	0	0	4	1	4
	Lepidonotus squamatus	56	52	12	304	0	424	4	304
	Spirorbis sp	0	0	***	0	0	0	1	0
	Unk 1-Maldanidae or Owenidae	0	0	0	56	0	56	1	56
	Unk 2- Onupihdae	0	0	0	4	0	4	1	4
	Unk 3-Terebellidae	8	0	0	0	0	8	1	8
	Unk 4- Polychaete	28	8	0	168	0	204	3	168
ARTHROPODS	Arachnida (sea mite)	0	0	0	120	0	120	1	120
ARTHROPODS-CRUSTACEA	Unk 1-Amphipod	16	504	56	4268	0	4844	4	4268
	Caprella sp	0	16	12	0	0	28	2	16
	Unk 2-Isopod	20	0	120	560	0	700	3	560
	Libinia dubia	20	36	36	120	4	216	5	120
	Neopanope sayi	12	24	12	0	4	52	4	24
	Ovalipes sp	0	0	12	0	0	12	1	12
	Pagurus longicarpus	12	0	0	112	0	124	2	112
	Arbacia punctulata	0	0	0	4	0	4	1	4
ECHINODERMS	*Asterias forbesi*	8	0	0	0	0	8	1	8
	Henricia sanguinolenta	0	8	4	8	4	24	4	8
	Axiognathus squamatus	0	20	8	0	0	28	2	20
HEMICHORDATES	Ascidian unid	24	180	48	216	0	468	4	216
OTHER	Egg mass unid 1	4	0	0	0	0	4	1	4
	Eggs unid 2	0	***	0	0	0	0	1	0
	Total:	NA	NA	944	14388	60			
	Number of Species:	19	20	18	17	6			
	Maximum Number Individuals:	NA	NA	276	4768	16			

Table A4-8. Animals in spring quadrats. Values are indiiduals/m^2. NA=not appropiate or too numerous to count. Stations as in Figure 3-7.

Phylum	Species	VQA1	VQA2	VQA3	VQA4	VGA5	VQA6	VQB1	VQB2	VQB3	VQC1	VQC2
PORIFERA	Haliclona loosanoffi	0	0	0	0	0	0	0	0	0	0	0
	Unki-amorphous	0	0	0	0	0	0	0	*	*	0	0
CINDARIA	Sertularia pumila	0	0	0	0	0	0	0	0	0	0	0
	Unk 1-Anemone	0	0	4	4	0	0	0	0	0	0	0
PLATYHELMINTHES	Unk 1-Flatworm	0	0	0	0	0	0	0	0	0	0	0
BRYOZOA	Unk 1-Bryozoan	0	0	0	0	0	0	*	0	0	*	*
MOLLUSCA-BIVALVES	Anomia simplex	0	0	0	0	0	0	0	0	0	12	20
	Astarte undata	0	4	0	0	0	0	0	0	0	0	0
	Mytilus edulis	0	0	92	0	0	0	0	0	0	0	0
	Nuculana tenisulcata	0	0	0	0	0	0	0	0	0	4	0
MOLLUSCA-GASTROPODS	Acmaea testudinalis	0	0	0	0	0	0	0	0	12	0	0
	Anachis sp	4	0	20	52	72	52	76	188	12	204	80
	Crepidula convexa	0	0	0	0	0	0	0	0	16	4	0
	Crepidula fornicata	0	0	0	0	0	0	0	0	0	0	0
	Crepidula plana	0	0	0	0	0	0	4	0	0	0	0
	Lacuna sp	0	0	0	0	0	0	0	4	***	***	0
	Littorina littorea	0	0	0	0	0	8	0	0	0	8	0
	Mitrella sp	0	0	28	0	0	0	0	0	0	0	0
	Urosalpinx cinerea	0	0	0	0	0	0	0	4	36	0	0
POLYCHAETA	Cirratulus sp	0	0	0	0	0	8	0	0	0	0	0
	Eunice sp	0	0	0	0	0	4	0	0	0	4	12
	Lepidonotus squamatus	16	0	16	28	16	40	28	52	12	160	152
	Lumbrinereis sp	0	0	0	0	0	0	0	0	0	0	4
	Nereis sp	0	0	12	0	0	8	0	0	0	4	12
	Spirorbis sp	0	0	0	0	0	0	0	0	0	0	0
	Terebella sp	0	0	4	0	0	4	4	12	0	4	4
	Unk 1-Phyllodocidae	0	0	0	0	0	0	0	0	0	8	0
	Unk 2 Polychaete	4	0	0	0	0	0	0	0	0	0	0
ARTHROPODA-CRUSTACEANS	Aephipods spp	0	0	40	0	0	0	40	NA	76	64	28
	Gammarus oceanicus	0	0	0	0	4	0	0	0	0	0	0
	Isopods spp	4	0	12	4	0	0	16	44	12	36	128
	Palaemonetes sp	0	0	0	0	12	0	0	0	0	4	0
	Libinia dubia	0	8	0	0	0	0	12	36	0	8	24
	Neopanope sayi	0	0	0	0	0	0	0	0	4	20	16
	Pagurus arcuatus	0	0	0	0	0	0	0	0	0	0	0
	Pagurus longicarpus	0	0	0	0	0	0	0	0	0	0	0
	Pagurus pollicaris	0	0	0	0	0	0	0	0	4	0	0
	Pinnotheres maculatus	0	0	0	0	0	0	0	0	0	0	0
ECHINODERMATA	Asterias forbesi	0	0	0	0	0	0	0	0	4	0	0
	Henricia sanguinolenta	0	0	0	0	8	0	0	0	0	0	0
	Total:	28	12	229	88	112	124	180	NA	188	544	480
	Maximum:	16	8	92	52	72	52	76	NA	76	204	152

Table A4-8. Animals in spring quadrats. Values are individuals/m^2. NA=not appropiate or too nmerous to count.
(cont.) Stations as in Figure 3-7.

		VQD1	VQD2	VQE1	VQE2	VQE3	VQF1	VQF2	VQF3	VQH1	VQH2	FREQ.	TOTAL	MAX
PORIFERA	*Haliclona loosanoffi*	0	0	0	0	0	0	NA	0	0	0	1	NA	NA
	Unk1 amorphous	*	*	0	0	0	0	0	0	0	0	4	0	0
CINDARIA	*Sertularia pumila*	0	0	0	0	0	0	0	4	0	0	1	4	4
	Unk 1 Anemone	0	0	0	0	0	0	0	0	0	0	2	8	4
PLATYHELMINTHES	Unk 1 Flatworm	0	0	0	0	0	8	0	0	0	0	1	8	8
BRYOZOA	Unk 1-Bryozoan	0	0	0	0	0	0	0	0	0	0	3	0	0
MOLLUSCA-BIVALVES	*Anomia simplex*	0	0	0	0	0	0	0	0	0	0	2	32	20
	Astarte undata	0	0	0	0	0	0	0	0	0	0	1	4	4
	Mytilus edulis	0	0	0	0	4	0	0	0	***	***	4	96	92
	Nuculana tenisulcata	0	0	0	4	0	0	0	0	0	0	2	8	4
MOLLUSCA-GASTROPODS	*Acmaea testudinalis*	0	0	0	0	0	0	0	0	0	0	1	12	12
	Anachis sp	156	228	***	0	64	188	108	***	24	0	18	1528	228
	Crepidula convexa	0	0	0	0	0	0	0	0	0	8	3	28	16
	Crepidula fornicata	0	12	0	0	0	0	0	0	16	0	2	28	16
	Crepidula plana	0	0	0	4	0	0	0	0	0	0	2	8	4
	Lacuna sp	***	0	***	8	***	0	0	***	***	***	10	12	8
	Littorina littorea	68	0	0	0	0	4	48	0	20	20	7	176	68
	Mitrella sp	0	0	0	0	0	0	0	0	0	0	1	28	28
	Urosalpinx cinerea	16	20	12	0	0	36	12	16	72	8	10	232	72
POLYCHAETA	*Cirratulus sp*	0	0	0	0	0	0	0	0	0	0	1	8	8
	Eunice sp	0	0	0	0	0	0	0	0	0	0	3	20	12
	Lepidonotus squamatus	172	72	20	12	88	48	16	20	8	4	20	980	172
	Lumbrinereis sp	0	0	0	0	0	0	0	0	0	0	1	4	4
	Nereis sp	0	0	0	0	8	28	0	0	0	0	6	72	28
	Spirorbis sp	0	0	4	0	0	0	0	0	0	0	1	4	4
	Terebella sp	4	0	0	0	0	48	4	4	0	4	11	96	48
	Unk 1 Phyllodocidae	0	0	0	0	0	0	0	0	0	0	1	8	8
	Unk 2 Polychaete	0	4	0	0	0	0	0	0	4	4	4	16	4
ARTHROPODA-CRUSTACEANS	Amphipods spp	16	0	0	0	8	196	76	88	40	48	13	720	196
	Gammarus oceanicus	0	0	0	8	0	0	0	0	8	0	3	20	8
	Isopods spp	92	0	4	0	104	280	120	40	40	76	16	1012	280
	Palaemonetes sp	0	0	0	0	0	0	0	0	0	0	2	16	12
	Libinia dubia	0	4	12	4	4	0	0	0	8	0	10	120	36
	Neopanope sayi	0	0	4	0	0	4	0	8	0	0	6	36	20
	Pagurus arcuatus	0	0	0	0	4	0	0	0	0	0	1	4	4
	Pagurus longicarpus	0	4	0	0	0	0	0	0	0	0	1	4	4
	Pagurus pollicaris	0	0	0	0	0	0	4	0	0	0	2	8	4
	Pinnotheres maculatus	4	0	0	0	0	0	0	4	0	0	2	8	4
ECHINODERMATA	*Asterias forbesi*	0	0	0	0	0	0	0	0	0	0	1	4	4
	Henricia sanguinolenta	0	0	0	0	0	0	0	0	0	0	1	8	8
	Total:	528	344	56	40	284	840	NA	184	240	172			
	Maximum:	172	228	20	12	104	280	NA	88	72	76			

Table A4-C. Animals from summer quadrats . Values are numbers of indviduals/m². ‡=not prctical to count. Stations as in Figure 3-7.

PHYLUM	SPECIES	SQA1	SQA2	SQB1	SQB2	SQC1	SQC2	SQD1	SQD2	SQE1	SQE2
CINDARIA	*Haliclona loosanoffi*	‡									
	Unk 1-Anemone	13		36							
BRYOZOA	Unk 1-Bryozoan				‡						
MOLLUSCA BIVALVES	*Anomia simplex*								1		
	Mytilus edulis	174	146			9816	18385	134	6	14758	18438
MOLLUSCA GASTROPODS	*Acmaea testudinalis*							1			
	Anachis sp	1	65	60	24	67	63			20	63
	Crepidula convexa										
	Crepidula fornicata	4		1							
	Crepidula plana	2									
	Epitonium sp					1					
	Lacuna sp	1		4	5	7852	5490	30	144	156	200
	Littorina littorea			2		8	27	78	3		1
	Nitrella sp	1	5			149	146		112		
	Nassarius trivittatus										
	Unk 1 Nudibranch						1				
	Urosalpinx cinerea	5	26	8	3	50	88	130	18	26	34
POLYCHAETA	*Lepidonotus squamatus*	4	10	10	7		157	8	24	156	5
	Nereis sp	2	4			3		2	1		
	Terebella sp	1	6			1					
	Unk 1- Sabellidae					1		2	95		
	Unk 2-Polychaete			3	2					2	
ARTHROPODA CRUSTACEANS	Barnacles spp	1									
	Amphipods spp			2	2	22	37	25	34	4	
	Isopods spp		1			12	33		12	2	
	Palaemonetes sp		1								
	Carcinus maenas										
	Eurypanope depressus								1		
	Libinia dubia			1	2						
	Neopanope sayi		2	5	1	5	15	8	2	1	
	Pagurus longicarpus										
	Pinnotheres maculatus	1					2	4			
ECHINODERMATA	*Axiognathus squamatus*	1	28		1						
	Henricia sanguinolenta		4	1	1	4			8	2	
CHORDATA	Unk - Ascidians			52	9	5			39		
	Pholis gunnellus										
	FREQ	14	12	13	11	15	12	11	15	10	6
	TOTAL	211	298	185	37	17996	24446	422	502	15127	18741
	MAXIMUM	174	146	60	24	9816	18385	134	144	14758	18438

Table A4-C. Animals from summer quadrats. Values are numbers of individuals/ m². #=not practical
(cont.) or too numerous to count

PHYLUM	SPECIES	SQF1	SQF2	SQG1	SQG2	SQH1	SQH2		FREQ.	TOTAL	MAX.
CINDARIA	*Haliclona loosanoffi*								#	0	0
	Unk 1-Anemone								2	49	36
BRYOZOA	Unk 1-Bryozoan	#	#						#	0	0
MOLLUSCA	*Anomia simplex*								1	1	1
BIVALVES	*Mytilus edulis*			2408	5091	23913	12716		12	1.1E5	23913
MOLLUSCA	*Acmaea testudinalis*								1	1	1
GASTROPODS	*Anachis sp*	78	10			9			11	460	78
	Crepidula convexa			1					1	1	1
	Crepidula fornicata						1		3	8	4
	Crepidula plana								[illegible]	2	2
	Epitonium sp								1	1	1
	Lacuna sp	84	2	9	52	9258	989		15	24276	9258
	Littorina littorea			43	23	7			9	194	78
	Mitrella sp	2	2			260	6		9	683	260
	Nassarius trivittatus					1			1	1	1
	Unk 1 Nudibranch								1	1	1
	Urosalpinx cinerea	58	2	26	3	77	2		16	356	130
POLYCHAETA	*Lepidonotus squamatus*	10	4	1	23	81	16		15	516	157
	Nereis sp	1		1	9	2	2		10	27	9
	Terebella sp		1						4	9	6
	Unk 1-Sabellidae								[illegible]	98	75
	Unk 2-Polychaete		2						4	9	[illegible]
ARTHROPODA	Barnacles spp			1					2	2	1
CRUSTACEANS	Amphipods spp	4	1	4		849	104		12	1088	849
	Isopods spp	7	2			198	1		9	270	198
	Palaemonetes sp								[illegible]	1	1
	Carcinus maenas			6		2			2	8	6
	Eurypanope depressus								1	1	1
	Libinia dubia					3			3	3	3
	Neopanope sayi	2	1	4	1	5	3		14	55	15
	Pagurus longicarpus			3	6				[illegible]	9	8
	Pinnotheres maculatus			7	2	3	2		7	21	7
ECHINODERMATA	*Axiognathus squamatus*	2							4	32	28
	Henricia sanguinolenta	3	2						8	25	8
CHORDATA	Unk - Ascidians	2				19			6	126	52
	Pholis gunnellus					1			1	1	1
	FREQ	12	11	13	9	17	11	0	122		
	TOTAL	253	29	2514	5210	34688	13842	0	192		
	MAXIMUM	84	10	2408	5091	23913	12716	0	16		

Table A4-D. Animals from fall quadrats. Values are individuals/m^2. *=Not reasonable to enumerate.

PHYLUM	SPECIES	FQA1	FQA2	FQA3	FQB1	FQB2	FQC1	FQC2	FQD1	FQD2	FQE1	FQE2	FQF1
PORIFERA	*Haliclona loosanoffi*	0	0	0	0	0	0	0	0	*	0	0	0
	Amorphous type unid	0	0	0	0	0	0	*	0	0	0	0	*
CNIDARIA	*Astrangia danae (colon)*	20	8	0	0	32	0	24	0	0	8	0	*
	Diadumene leucolena	0	0	32	0	0	0	0	0	0	0	0	102
BRYOZOA	Bryozoa unid	16	*	0	*	0	8	8	0	0	0	0	NA
MOLLUSCA BIVALVIA	*Anadora transversa*	0	0	0	0	0	0	4	0	0	0	0	0
	Anomia simplex	0	0	0	0	0	4	0	0	0	8	4	17
	Mytilus edulis	0	0	20	0	0	20	4	0	65	0	0	187
MOLLUCSA GASTROPODA	*Anachis sp*	64	188	328	0	64	24	228	8	2198	96	896	1068
	Cerithiopsis greeni	0	0	0	0	0	0	0	0	0	4	0	17
	Crepidula fornicata	0	4	0	0	0	0	0	4	33	12	0	34
	Crepidula plana	0	0	8	0	0	12	0	0	33	0	0	0
	Lacuna sp	16	4	28	0	28	48	36	0	374	28	12	712
	Littorina littorea	0	0	0	0	0	48	4	32	81	88	84	0
	Mitrella sp	324	160	548	0	72	168	296	8	374	456	360	950
	Notoacmaea testudinalis	0	0	0	0	0	0	0	0	0	0	4	0
	Onchidoris sp	0	0	0	0	0	4	0	0	0	0	0	0
	Urosalpinx cinerea	0	4	104	0	8	36	0	4	716	16	20	2714
POLYCHAETA	*Diopatra cuprea*	0	0	0	0	0	12	0	0	0	0	0	68
	Lepidonotus squamatus	20	12	36	0	4	0	28	4	65	12	48	34
	Nepthys sp	4	0	0	0	0	4	0	0	0	0	0	0
	Nereis sp	0	0	0	0	0	0	0	0	0	0	0	51
	Odontosyllis fulgunanus	0	0	0	0	0	0	0	0	0	0	0	0
	Spirorbus sp	0	*	0	0	0	0	0	0	0	0	0	0
	Terebelidae unid	0	0	0	0	0	0	8	0	65	16	28	17
	Polychaete unid	0	0	0	0	0	12	0	0	0	0	0	17
ARTHROPODA DECAPODS	Amphipods unid	12	0	84	0	20	12	24	0	147	32	116	492
	Caprilla sp	0	0	16	0	0	0	0	0	65	0	8	0
	Erichsonella filliformi	32	0	8	0	68	12	100	12	65	16	0	204
	Idotea baltica	0	4	0	0	4	0	0	0	0	0	0	17
	Idotea phosphorea	0	0	32	0	0	16	16	0	0	4	24	85
	Carcinus maenas	0	0	0	0	0	4	0	0	0	0	0	0
	Libinia dubia	0	0	0	0	0	28	0	0	0	0	0	0
	Libinia emarginata	12	0	8	0	32	0	76	0	49	64	64	17
	Neopanope sayi	16	28	8	0	0	8	4	4	147	28	84	509
	Pagurus longicarpus	12	60	0	0	0	0	0	0	0	52	0	0
	Pelia mutica	4	40	0	0	0	0	28	0	0	0	0	51
	Rhithropanopeus harrisi	0	0	0	0	0	0	0	0	0	0	0	0
ECHINODERMATA	*Arbacia punctulata*	4	0	0	0	0	0	0	0	0	0	0	0
	Asterias forbesa	0	4	4	0	0	0	0	0	65	0	0	0
	Henricia sanguinolenta	4	0	8	0	0	0	0	0	0	4	28	0
	Pentamera pulcherrima	0	0	0	0	0	4	8	0	0	0	0	0
	Axiognathus squamatus	8	0	144	0	8	0	4	0	16	0	0	51
CHORDATA	Ascidia unid	8	16	0	468	16	28	16	0	81	12	172	51
	Pholis gunnellus	0	0	0	0	0	0	0	0	16	0	0	0
	Number of Species:	17	15	17	2	12	21	19	8	20	19	16	26
	Total Individuals:	576	532	1416	468	356	512	916	76	4656	956	1952	NA
	Maximum individ/sp:	324	188	548	468	72	168	296	32	2198	456	896	NA

Table A4-D. Animals from fall quadrats. Values are individuals/m². NA= not reasonable or (cont) too numerous to count.

PHYLUM	SPECIES	FQG1	FQG2	FQH1	FQH2	FREQ	TOTAL	MAX
CNIDARIA	*Haliclona loosanoffi*	0	0	0	0	1	NA	NA
	Amorphous unid	NA	NA	0	0	3	NA	NA
	Astrangia danae (colon)	0	0	0	0	6	NA	NA
	Diadumene leucolena	0	0	0	0	3	216	102
BRYOZOA	Bryozoa unid	0	0	0	0	7	NA	NA
MOLLUSCA BIVALVIA	*Anadora transversa*	0	0	0	0	1	4	4
	Anomia simplex	0	0	0	0	4	33	17
	Mytilus edulis	0	12	1020	1148	8	2476	1148
MOLLUCSA GASTROPODA	*Anachis sp*	150	16	36	116	16	3583	2198
	Cerithiopsis greeni	0	0	0	0	2	21	17
	Crepidula fornicata	0	0	36	12	7	134	36
	Crepidula plana	0	0	20	0	4	73	33
	Lacuna sp	25	0	76	4	14	1801	712
	Littorina littorea	0	0	8	0	7	345	88
	Mitrella sp	75	0	44	12	15	4134	350
	Notoacmaea testudinalis	0	0	0	0	1	4	4
	Onchidoris sp	0	0	0	0	1	4	4
	Urosalpinx cinerea	75	24	4	8	13	3733	2714
POLYCHAETA	*Diopatra cuprea*	0	0	0	0	2	80	68
	Lepidonotus squamatus	0	24	56	108	14	492	108
	Nepthys sp	0	0	0	0	2	8	4
	Nereis sp	0	0	0	0	1	51	51
	Odontosyllis fulgunanus	0	0	4	0	1	4	4
	Spirorbus sp	0	0	0	0	1	NA	NA
	Terebelidae unid	0	8	0	0	7	163	65
	Polychaeta unid	0	0	4	4	4	37	17
ARTHROPODA DECAPODS	Amphipods unid	577	12	104	136	14	1808	577
	Caprilla sp	0	0	16	20	5	125	65
	Erichsonella filliformis	25	12	64	20	14	720	204
	Idotea baltica	0	8	4	4	7	82	41
	Idotea phosphorea	0	0	16	4	8	197	65
	Carcinus maenas	0	0	8	0	2	12	8
	Libinia dubia	0	0	0	0	1	28	28
	Libinia emarginata	0	8	4	0	11	334	76
	Neopanope sayi	0	16	56	84	14	1032	509
	Pagurus longicarpus	0	0	0	0	3	124	60
	Pelia mutica	0	0	0	0	4	123	51
	Rhithropanopeus harrisii	0	0	20	8	2	28	20
ECHINODERMATA	*Arbacia punctulata*	0	0	0	0	1	4	4
	Asterias forbesa	0	0	0	0	3	73	65
	Henricia sanguinolenta	0	0	0	0	3	85	41
	Pentamera pulcherrima	0	0	0	0	2	12	8
	Axiognathus squamatus	0	0	0	0	6	231	144
CHORDATA	Ascidia unid	25	64	0	52	14	1111	468
	Pholis gunnellus	0	0	0	0	1	16	16
	FREQ	8	12	20	16			
	TOTAL	753	204	1600	1740			
	MAXIMUM	577	64	1020	1148			

Table A5-A. Winter dredges. Algal biomass (g dry wt./dredge). Stations as in Fig. 3-4.

Species	WDA1	WDA2	WDA3	WDA4	WDD1	WDD2	WDE1	WDE2
Ahnfeltia plicata								
Antithamnion sp.		.37						
Ascophyllum nodosum								
Bonnemaisonia hamifera								.01
Callithamnion baileyi		.92		.12				
Ceramium baucheria								
Chaetomorpha linum							.47	.13
Chondrus crispus			3.81	1.58		2.61	9.82	26.31
Codium fragile								
Corallina officinalis								
Dasya baillouviana								
Desmarestia aculeata								
Desmarestia viridis								
Ectocarpus sp.		.86						
Fucus distichus								
Fucus vesiculosus					.84			
Gracilaria tikvahiae			.33				1.03	
Grinnelia americana							.12	
Laminaria digitata								
Laminaria saccharina	409.95	244.17	758.53	72.47	192.40	155.29	217.84	225.17
Lomentaria baileyana								
Membranoptera alata			.70				1.52	
Neoagardhiella baileyi		2.90		2.36	4.24	8.52	.40	2.28
Palmaria palmata			20.35		5.15		14.18	1.81
Phycodrys rubens		.28		.92		.26	.12	1.91
Phyllophora pseudoceranoides		2.38		5.62	18.41	9.06	4.03	5.31
Phyllophora truncata	.97		1.26				6.82	
Polyides rotundus	.09							
Polysiphonia elongata								
Polysiphonia harveyi		2.59						
Polysiphonia lanosa								
Polysiphonia nigra								
Polysiphonia nigrescens								
Polysiphonia urceolata								
Rhodomela confervoides				.06				
Ulothrix sp.								
Ulva lactuca	.06	3.26			7.00	3.32	14.32	20.06
Vaucheria sp.								
Zostera marina		.15			25.27	6.62		.65
Total:	411.07	257.88	784.98	83.13	253.31	185.88	270.87	283.64
Number of Species:	4	10	6	7	7	7	12	10
Mean by station:				384.26		219.59		277.26

Table A5-A. (continued). Algal biomass (g dry wt./dredge). Stations as in Fig. 3-4.

Species	WDI1	WDI2	WDI3	WDI4	WDI5	WDJ1	WDJ2	WDK1	WDK2	WDK3
Ahnfeltia plicata					.16					
Antithamnion sp.										
Ascophyllum nodosum			21.84			1.88	1.25			
Bonnemaisonia hamifera										
Callithamnion baileyi										
Ceramium baucheria			.82	.05						
Chaetomorpha linum										
Chondrus crispus	.59			2.64	.65					
Codium fragile										
Corallina officinalis										
Dasya baillouviana					.04					
Desmarestia aculeata										
Desmarestia viridis										
Ectocarpus sp.										
Fucus distichus										
Fucus vesiculosus						.88	.48		.05	
Gracilaria tikvahiae	6.00		.42	28.55	.88					
Grinnelia americana		.10								
Laminaria digitata										
Laminaria saccharina	25.34		85.60	33.43	44.59	24.17	7.49	3.62		
Lomentaria baileyana			.04							
Membranoptera alata										
Neoagardhiella baileyi	.77	1.55				1.13	.31			
Palmaria palmata	3.90	4.29	7.84							
Phycodrys rubens		.24			1.22					
Phyllophora pseudoceranoides	2.82	.61	.25			1.56				.40
Phyllophora truncata		.97				.89				
Polyides rotundus										
Polysiphonia elongata										
Polysiphonia harveyi										
Polysiphonia lanosa										
Polysiphonia nigra										
Polysiphonia nigrescens										
Polysiphonia urceolata										
Rhodomela confervoides					.03					
Ulothrix sp.										
Ulva lactuca	6.88	1.16	2.40	43.70	.68	3.99	4.53	1.29	.02	.03
Vaucheria sp.										
Zostera marina				.42		.32		.16	.12	.27
Total:	46.30	8.92	119.21	108.79	48.25	34.82	14.06	5.07	.19	.70
	7	7	8	6	3	3	5	3	3	3
					66.30		24.44			1.99

Table A5-8. Spring dredge Algal biomass (g dry wt./dredge). Stations as in Fig. 3-5.

Species	VDA1	VDA2	VDA3	VDA4	VDA5	VDB1	VDC1	VDD1	VDD2
Ahnfeltia plicata									
Antithamnion sp.									
Ascophyllum nodosum						4.37			
Bonnemaisonia hamifera	.07	.18					.07	1.10	.16
Callithamnion baileyi									
Ceramium baucheria				.91	1.14				.44
Chaetomorpha linum									
Chondrus crispus	.31			.45	.96	20.16			
Codium fragile						.19			
Corallina officinalis						.61			
Dasya baillouviana									
Desmarestia aculeata	3.08					3.02		5.39	
Desmarestia viridis	.13				.42	45.73			.16
Ectocarpus sp.						6.67	.34		
Fucus distichus						2.91			
Fucus vesiculosus									
Gracilaria tikvahiae			.12			.75			.21
Grinnellia americana									
Laminaria digitata	57.87								
Laminaria saccharina	226.91	78.82	434.44	489.06	71.36	314.85	964.04	203.10	287.46
Lomentaria baileyana									
Membranoptera alata							8.46		
Neoagardhiella baileyi	44.37				.44	25.68	6.74	1.91	
Palmeria palmata		3.84	5.61	.47	.33	10.36		.76	.06
Phycodrys rubens	.50			.30			3.25		
Phyllophora pseudoceranoides	15.23					2.23	4.29	.41	.06
Phyllophora truncata	3.61				.37	3.73		1.34	
Polyides rotundus									
Polysiphonia elongata	.07								
Polysiphonia harveyi									
Polysiphonia lanosa	.13								6.53
Polysiphonia nigra							2.81		
Polysiphonia nigrescens	.39	.94		3.29		1.00		15.11	
Polysiphonia urceolata	.06			.32					
Rhodomela confervoides									
Ulothrix sp.							1.92		
Ulva lactuca	.24			25.24		14.28		47.30	68.86
Vaucheria sp.				.17					.07
Zostera marina						6.44		.33	.51
Total:	352.97	83.93	440.17	520.21	75.22	463.02	992.20	276.75	364.52
Number of Species:	15	4	3	9	7	17	9	10	11
					294.50	463.02	992.20		320.63

Table A5-8 (continued). Algal biomass (g dry wt./dredge). Stations as in Figure 3-5

	VDE1	VDF1	VDH1	VDH2	VDH3	VDI1	VDI2
Ahnfeltia plicata		.85					
Antithamnion sp.							
Ascophyllum nodosum							
Bonnemaisonia hamifera		.08	.15		.77		
Callithamnion baileyi							
Ceramium baucheria		2.40			6.59		.13
Chaetomorpha linum							
Chondrus crispus	1.60	1.02		.06	1.14		3.09
Codium fragile					.03		
Corallina officinalis							
Dasya baillouviana							
Desmarestia aculeata	1.17		4.49	.22	2.01		2.75
Desmarestia viridis							
Ectocarpus sp.							1.05
Fucus distichus							2.56
Fucus vesiculosus							
Gracilaria tikvahiae		.29					4.81
Grinnelia americana							
Laminaria digitata		14.77					
Laminaria saccharina	823.85	283.00	167.85		269.29	15.67	710.30
Lomentaria baileyana							
Membranoptera alata							
Neoagardhiella baileyi	.56	29.94	16.77	.10	331.68		
Palmaria palmata	.51		3.02				.04
Phycodrys rubens					.23		
Phyllophora pseudoceranoides	1.04	1.23	4.33		20.97		1.02
Phyllophora truncata		.86	.35	.56	10.78		2.46
Polyides rotundus					1.25		4.31
Polysiphonia elongata							
Polysiphonia harveyi		.72					
Polysiphonia lanosa	1.38	.05	23.94				
Polysiphonia nigra					13.09		
Polysiphonia nigrescens				.09			
Polysiphonia urceolata		.10					
Rhodomela confervoides							
Ulothrix sp.							
Ulva lactuca	3.94	11.72	.12		36.52	.32	.72
Vaucheria sp.			.14				
Zostera marina		.85	.04	.05	.27	2.58	
Total:	834.05	347.88	221.19	1.08	694.62	18.57	733.27
Number of Species:	8	15	11	6	14	3	12
Station Totals:	834.05	347.88			305.63		375.92

Table A6-A. Animals from winter dredge hauls. Values are number of individuals/haul. NA=not practical to count.

Phylum	Species or Taxon	WDA1	WDA2	WDA3	WDA4	WDD1	WDD2	WDE1	WDE2	WDI1	WDI2	WDI3	WDI4	WDI5
PORIFERA	*Microciona prolifera*													
	Unid 1						3	1	3	NA		1	NA	
	Unid 2	1												
CNIDARIA	*Campanularia sp*							NA						
BRYOZOA	*Crisia sp*			NA			1					NA		
	Bryozoan unid								NA					
MOLLUSCA BIVALVIA	*Astarte undata*										2			
	Mercenaria mercenaria											3	1	3
	Mulinia lateralis													
	Mytilus edulis	4	196	1			3							
	Pitar morrhuana													
MOLLUSCA GASTROPODA	*Acmaea testudinalis*					1							2	
	Anachis sp	8		3		44	18	6	6			12	1	
	Busycon canaliculatum										1	2		
	Crepidula convexa													
	Crepidula fornicata					12	1							8
	Ilyanassa obsoleta												1	
	Lacuna sp					29	13	8	8			2		
	Mitrella sp	8			7	12	4		6	NA		60	34	
	Nassarius trivittatus										1			
	Urosalpinx cinerea					2								
ANNELIDA	*Amphitrite johnstoni*			2			1							
	Diopatra cuprea						1					2	1	
	Lepidonotus squamatus	7		7	4	9	15	5	9	1		9	5	2
	Lumbrineris sp										6			
	Lycastopsis pontica												1	
	Nereis arenaceodonta						2		2					
	Nereis pelagica	1		1										
	Nereis sp			1							1			
	Pista palmata													
	Polydora ligni													2
	Terrebellidae unid													
	Polychaete unid								6			3		2
	Oligochaete unid								2					
ARTHROPODA CRUSTACEA	*Cancer sp*			1		2	3		1	2	1			3
	Carcinus maenas					1							1	
	Crangon septemspinosa						2						3	
	Libinia dubia	2		2	1	3		2						
	Neopanope sayi	4	3	10		7	14	2	3					
	Pagurus longicarpus													
	Pagurus policaris					18					1		1	
	Pagurus sp						1							
	Amphipods unid	0	0	0	0	0	0	0	0	0	0	0	0	0
	Isopods unid	3								1				
ECHINODERMA	*Arbacia punctulata*			2				1						
	Asterias forbesi					2	1		4			2	1	2
	Henricia snaguinolenta			1										
CHORDATA	Ascidian unid											1		
	Syngnathus fuscus													
	Myxocephalus aenus						1							
	Pseudopleuronectes americanus												1	
MISC.	Whelk eggs													
	Egg type I								3					
	Egg type II								15					
	Egg mass unid	NA			1		NA					NA		
NO. SPECIES:		12	4	14	6	15	19	9	15	6	9	14	15	9
TOTAL:		NA	199	NA	13	142	NA	NA	NA	NA	19	NA	55	22
MAXIMUM:		NA	196	NA	7	44	NA	NA	NA	NA	9	NA	34	8
MINIMUM:		NA	0	NA	0	0	NA	NA	NA	NA	0	NA	0	0

Table A6-A. Animals from winter dredge hauls. Values are number of individuals per haul. NA=not
(cont) practical to count.

Phylum	Species or Taxon	WDJ1	WDJ2	WDJ3	WDK1	WDK2	WDK3	WDK4	FREQ	TOTAL	MAX	MIN
PORIFERA	*Microciona prolifera*	NA			3				2	NA	NA	0
	Unid 1	0	0	0	0	0	0	0	8	NA	NA	0
	Unid 2								1	1	1	0
CNIDARIA	*Campanularia sp*								1	NA	NA	0
BRYOZOA	*Crisia sp*								3	NA	NA	0
	Bryozoan unid				NA				2	NA	NA	0
MOLLUSCA BIVALVIA	*Astarte undata*								1	2	2	0
	Mercenaria mercenaria	4			1	11	3	1	8	27	11	0
	Mulinia lateralis	1							1	1	1	0
	Mytilus edulis								4	204	196	0
	Pitar morrhuana	1							1	1	1	0
MOLLUSCA GASTROPODA	*Acmaea testudinalis*								2	3	2	0
	Anachis sp								8	98	44	0
	Busycon canaliculatus							1	3	4	2	0
	Crepidula convexa					17			1	17	17	0
	Crepidula fornicata			1		7	2	4	7	35	12	0
	Ilyanassa obsoleta		1						2	2	1	0
	Lacuna sp							1	6	61	29	0
	Mitrella sp						11	2	10	NA	NA	0
	Nassarius trivittatus						1	1	3	3	1	0
	Urosalpinx cinerea	1							2	3	2	0
ANNELIDA	*Amphitrite johnstoni*								2	3	2	0
	Diopatra cuprea								3	4	2	0
	Lepidonotus squamatus				1				12	74	15	0
	Lumbrineris sp								1	9	9	0
	Lycastopsis pontica								1	1	1	0
	Nereis arenaceodonta								2	4	2	0
	Nereis pelagica								2	2	1	0
	Nereis sp							2	3	7	4	0
	Pista palmata				3				1	3	3	0
	Polydora ligni								1	2	2	0
	Terebellidae unid				1	1		1	3	3	1	0
	Polychaete unid				2				4	16	9	0
	Oligochaete unid								1	2	2	0
ARTHROPODA CRUSTACEA	*Cancer sp*		3	2	2	6		4	12	30	6	0
	Carcinus maenas								2	2	1	0
	Crangon septemspinosa								2	7	5	0
	Libinia dubia								5	10	3	0
	Neopanope sayi				3	2			9	48	14	0
	Pagurus longicarpus		2						1	2	2	0
	Pagurus pollicaris		1		2	1		1	7	25	18	0
	Pagurus sp								1	4	4	0
	Amphipods unid	0	0	0	0	0	0	0	10	NA	NA	0
	Isopods unid				1		1	1	5	7	3	0
ECHINODERMA	*Arbacia punctulata*								2	3	2	0
	Asterias forbesi	7	1	1	2	1	4		12	28	7	0
	Henricia snaguinolenta								1	1	1	0
CHORDATA	Ascidian unid								1	1	1	0
	Syngnathus fuscus						1		1	1	1	0
	Myxocephalus aenus								1	1	1	0
	Pseudopleuronectes americanus								1	1	1	0
MISC.	Whelk eggs				1				1	1	1	0
	Egg type I								1	3	3	0
	Egg type II								1	15	15	0
	Egg mass unid								4	NA	NA	0
NO. SPECIES:		8	7	5	15	10	9	13				
TOTAL:		NA	8	4	NA	46	23	19				
MAXIMUM:		NA	3	2	NA	17	11	4				
MINIMUM:		NA	0	0	NA	0	0	0				

Table A6-8. Animals from spring dredge hauls. Values are total number of individuals per haul. NA=not practical to count. Stations as in Figure 3-5.

PHYLUM	SPECIES	VDA1	VDA4	VDB1	VDC1	VDD2	VDE1	VDF1	VDH1	VDH2	VDH3	VDI1	VDI2	FREQ	TOTAL
PORIFERA	*Microciona prolifera*												1	1	1
	Sp 1 UNID					NA								1	NA
	Sp 2 UNID			3	3									2	6
MOLLUSCA BIVALVIA	*Mercenaria mercenaria*											2	2	2	4
	Mytilus edulis		13				1	1					1	4	16
	Bivalve Unk 1												2	1	
	Bivalve Unk 2	1												1	1
MOLLUSCA GASTROPODA	*Anachis sp*	1		1	1	1	1				1		2	7	8
	Crepidula convexa			1						1				2	2
	Crepidula fornicata			1		1							3	3	5
	Crepidula plana			1										1	1
	Lacuna sp					8			***				3	3	***
	Littorina littorea			4				2						2	6
	Urosalpinx cinerea												1	1	1
ANNELIDA POLYCHAETA	*Lepidonotus squamatus*	1			1	4	1	4	1		6		13	8	31
	Nereis sp					1							1	2	2
	Potamilla reniformis												1	1	1
	Polychaeta unid												1	1	1
	Terebellidae unid												1	1	1
ARTHROPODA CRUSTACEA	*Crangon septemspinosa*					1								1	1
	Libinia dubia			2			1			1	2		2	5	8
	Neopanope sayi			1	1			3					3	4	8
	Pagurus longicarpus			18		3								2	21
	Pagurus pollicaris							1					1	2	2
	Palaemonetes sp			2									2	2	4
	Pinnotheres maculatus				1								1	2	2
	Amphipods unid	1									1		4	3	6
	Isopods unid							1	1		1		2	4	5
ECHINODERMATA	*Asterial forbesi*			1									1	2	2
	Henricia sanguinolenta					1								1	1
NO. OF SPECIES:	30	4	1	11	5	9	4	6	2	2	5	1	21		
	TOTAL INDIVIDUALS:	4	13	33	7	NA	4	12	2	2	11	2	48		