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Rocky Subtidal Communities in Massachusetts Bay: Lovell Island - Nahant Transect

A final report on the 1991 - 1992 Sampling period

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ROCKY SUBTIDAL COMMUNITIES IN MASSACHUSETTS BAY:

LOVELL'S ISLAND TO NAHANT TRANSECT

A FINAL REPORT ON THE
1991 - 1992 SAMPLING PERIOD

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I. INTRODUCTION

Rocky substrates in Massachusetts Bay include gravel, pebbles, cobble, boulder and bedrock shelves which support characteristically rich invetebrate and algal communities. These hard bottom areas are sites where certain fish congregate to feed and where lobsters and crabs find refuge and reach high population densities. Cobble areas are particularly important as recruitment sites for lobsters and nursery areas for juveniles. Rocky habitats, however, are extremely difficult to sample from the surface and have thus received less attention than have soft substrate habitats at comparable depths, especially in relation to pollutants and environmental perturbation (but see DesRosiers *et al.* 1986).

Rocky substrate community studies conducted within the Boston Harbor and Broad Sound areas include those of Harris (1976), Menge (1976, 1979) and Lubchenco and Menge (1978). Harris collected bottom samples using SCUBA diving teams and airlift equipment to scrape and retain organisms from rock surfaces. Samples were taken four times per year at stations off Winthrop and surrounding the Boston Harbor Light during 1979-1983, at depths of 15 to 40 m. This sampling program showed a well-developed cold water community of encrusting invertebrates with some seasonality of the faunal composition. The intertidal studies by Menge and Lubchenco were carried out at the Brewster Islands in the mouth of the harbor, and at sites on Nahant as well as along the Maine coast. These studies included two to four years of monthly intertidal sampling, 1972-1976, (nondestructive), with some subtidal studies as well as a wide range of experiments aimed at understanding the role of predators controlling the distribution of intertidal plants and animals. Subtidal rocky habitats in Broad Sound have been sampled sporadically for outfall siting studies as well (M.D.C. 1979, Metcalf & Eddy 1984, M.W.R.A. 1988).

Studies of rocky shore habitats in this region have been few and scattered. Lamb and Zimmerman (1964) surveyed the benthic algae of the Cape Anne region. Lubchenco (1978) and Menge (1976, 1979) monitored the middle and low intertidal zone at Nahant and conducted experiments on competition and predation during 1971-1976. Edwards *et al* (1982) studied the importance of subtidal fish predation on the intertidal zone and Wethey (1983) quantified the population dynamics of high intertidal barnacles over several years. Sebens (1982, 1983, 1985, 1986) examined competitive interactions and effects of predators on subtidal rock surfaces at Nahant from 1977 to the present. Sebens and coworkers are currently monitoring subtidal rocky habitats (6-20 m depth) on two sides of East Point, Nahant and at Halfway Rock east of Marblehead. These subtidal studies, using SCUBA divers, airlift collections, and quantitative photography show that such communities of long-lived invertebrates and encrusting algae are relatively stable although somewhat seasonal in species composition, but can change radically when sea urchin populations expand.

Horizontal and sloping subtidal rock surfaces within northern Massachusetts Bay are covered by pavements of crustose coralline algae, or by beds of small kelp and red algae. Similar habitats have been studied along the coast of Nova Scotia where sea urchins appear to control the type of plant community present (Mann and Breen 1972, Breen and Mann 1976, Mann 1977, Wharton and Mann 1981). Observations within Massachusetts Bay indicate a similar importance of sea urchin herds, whose movements from year to year influence the distribution of subtidal kelp and algal beds as well as invertebrate assemblages (Sebens 1985, Briscoe and Sebens 1988). Predation on urchins by lobsters, crabs, and fish may limit the distribution and abundance of urchins (Mann and Breen 1972, Breen and Mann 1976). In our previous report (Sebens and Witman 1990), we noted the absence of urchins in the two sites closest to the Deer Island outfalls, as well as the lack of crustose coralline algae. Heavy sedimentation of organic material is a likely cause of this site difference.

Rocky subtidal habitats of Massachusetts Bay, and their susceptibility to pollutants, are not well understood. Although certain areas have been sampled for limited periods of time, there had been no systematic effort to monitor rocky substrates at present, and such habitats are often neglected in environmental impact studies associated with particular shoreline developments. Given the existing situation, it would have been impossible to determine whether observed changes in rocky shore communities were the result of human perturbation or were within the natural spatial and temporal variability of such communities. We examined shallow rocky subtidal communities along a transect beginning at Boston Harbor and running northeast toward Nahant starting in 1987. These communities were revisited twice annually. Photographic samples of marked quadrats containing animals and plants on rock surfaces were conducted for quantitative measurement of abundance. Transect studies by divers were used to assess fish, crab and lobster abundance and activity. Samples of surficial sediments were provided to the New England Aquarium for analysis of heavy metal accumulation and to M.W.R.A. for analysis of *Clostridium* spore densities. These two measures give some indication of the exposure of these communities to pollutant loads.

The study by Sebens and Witman (1990) was the first attempt to study rocky subtidal habitats along a gradient from polluted to relatively unpolluted conditions, with concurrent measurement of pollutant loading (1987-1990 sampling dates). The goal of these studies was to quantify the abundance of sessile invertebrate and algal species on subtidal rock surfaces and to assess the relative abundance of active and passive suspension feeders in the community samples. Also, we examined changes along this gradient in the number of phytoplankton/bacteria feeders versus zooplanktivores. We hypothesize that the food resource closer to the outfall site will favor the former over the latter.

This study is a continuation of our efforts to monitor change in shallow (10 -14 m depth) rocky subtidal communities at sites arranged along a transect running roughly southwest - northeast from the vicinity of the Deer Island sewage outfall to Nahant, Massachusetts. Six sites were selected for long term study (Table 1) after initial diving reconnaissance. Two sites, Lovell's Island and "Can 5" , are located in the immediate vicinity of the sewage plume (less than one mile to two miles away). The Deer Island and Winthrop sites were selected to be representative of intermediate sewage impact conditions because they were located two to three miles away from the outfall. The impact of the Deer Island sewage plume was thought to be minimal at the Flip Rock and Shags Rock sites, because they are located five to six miles northeast of the outfall, just off Nahant.

This report describes seasonal patterns of distribution and abundance of sessile and mobile invertebrates, crustose algae, sediment cover and demersal fish along the Lovell's Island - Nahant transect from Summer 1991 to Spring 1992.

II. METHODS

Benthic surveys were conducted by SCUBA diving and with a Remotely Operated Vehicle (ROV) during four seasons; summer (August 7, 1991), fall (November 11, 1991), late winter (March 30 and April 7, 1992), and late spring (May 13, June 8 and June 23, 1992). The standard protocol for photographic sampling consisted of divers photographing hard bottom habitats with a camera framer (quadrupod) covering 0.05 m^2 quadrat area. A Nikonos V underwater camera with a 35 mm lens and closeup lens was mounted on the quadrupod to maintain accurate distance and strobe illumination. During each season, divers took 36 photographs in a haphazard fashion (1.0 m or more apart along a 25 m transect line) at all sites except Lovell's Island which was too polluted for safe SCUBA diving (per Northeastern University Diving Safety Board). Whenever possible, sampling was stratified by substrate type with 12 photographs taken on horizontal solid rock (boulders or bedrock), 12 on vertical rock surfaces, and 12 on horizontal cobble. Two of the sites (Lovell's Island and Can 5) had very little solid rock, and were dominated by cobble substrata. At these sites, less than 12 photographs were taken on horizontal or vertical rock. Bottom photographs at Lovell's Island were taken with the same camera and quadrupod, lowering it from a boat and using a trip-lever to fire it each time. This method of remote sampling at Lovell's Island was difficult, however, and was not possible to repeat during the Winter and Spring sampling periods.

Transparencies (35 mm) were analyzed using the random dot technique, projecting the image on a rear-projection screen and overlaying it with a pattern of 200 randomly placed 3 mm circles. The organism under each dot was identified to species where possible, and to predetermined category otherwise. Organisms to approximately 3 mm diameter are easily identified by this method, but there are several types of encrusting material that cannot be as accurately identified. These are combinations of organisms and accumulated sediment, sometimes bound into tubes (amphipods, terebellid worms, etc.) and often just stuck to the rock surface. If the sediment layer was thin enough to see other organisms through it, it was termed 'thin sediment' and ignored. Only the organism below was counted. If the sediment was thick enough to obscure the objects below, but lacked any other distinguishing features, it was termed ' thick sediment' and was counted as a category. If the sediment was bound into tubes, it was termed 'tube complex' and if it was collected around the dead or living bases of erect hydroids and bryozoans, it was termed 'hydroid-bryozoan complex'. Several species and groups occur as a 'canopy' above the primary substratum, including erect hydroids, bryozoans, anemone tentacles, and certain algae. Canopy organisms were quantified separately from those on primary substratum (200 dots on non-canopy organisms were counted). In addition to the percent cover estimate, every mobile organism (seastars, nudibranchs, chitons, and others) in each photograph was counted and tallied. These samples give estimates of population density for the 'small mobile fauna'.

Band transects were conducted to census large mobile fauna such as crabs, lobsters, and demersal fish because they were not adequately censused by quadrat photography. The procedure consisted of laying out two 25 m long transect lines of small link chain along the bottom by divers swimming several meters off the bottom. Once the chain was laid out, one diver would be positioned on each side of the chain and would hold a 1 m long line sideways then swim along the transect noting all mobile fauna found in each 5 m segment. Macrobenthic organisms greater than 3 cm length or diameter (excluding seastars and urchins) were counted. The total sample thus consisted of four 1m by 25 m (or 25 m^2) transects that were used to calculate mean densities of the large mobile fauna.

At Lovell's Island, the ROV (Phantom 300) with 8 mm Panasonic video camera was used to "swim" the transect in an equivalent manner. The vehicle was run out in a predetermined direction until its full 60 m cable was extended, then it was piloted to the bottom and rotated until it was facing back along its own cable. Often currents made this process difficult, and tangles in the cable reduced its length. The ROV then cruised back along its cable (which was marked every meter), until it reached the point where the cable left the bottom. This process was repeated four or more times. Because the ROV frequently left the cable and had to be reoriented, good transects generally consisted of 4-10 m length, by 50 cm width . The average width of the transect was determined by measuring the cable width in the center of the image every meter along the cable, and relating this back to the real cable width, thus determining real field of view width on the monitor. When the ROV was moving along the cable at about 30-50 cm off the bottom, the image quality was excellent and even small (about 2 cm) crabs could be identified. Since we could not quantify 'small' mobile fauna from stop-frame images, all mobile fauna (including seastars, urchins, etc.)

visible along the transects were counted. Back in the lab, the video images were analyzed for percent cover of macrofauna and sediment cover by "freeze framing" the image at approximate half meter intervals along the video cable. This was performed by placing a clear acetate sheet with ten random dots on it over the video monitor, and identifying the organism or substrate under each dot. The procedure was repeated on 20 images until a total of 200 random dots were censused per ROV transect. Five to seven ROV transects at Lovell's Island were analyzed during each season.

Arcsin square root transformations were performed on all the percent cover data. Mobile fauna densities resulting from the band transects were square root transformed to account for Poisson distributed data (many quadrats with zero density; Sokal and Rohlf 1981). The data presented in the tables and figures were back - transformed. For clarity of presentation, only the mean values were plotted in the Figures 1 - 6. All standard deviations are presented with means and sample sizes in tables 3 to 30.

During each sampling period, surficial sediments were collected for metals and *Clostridium* spore analysis. Cobbles and dead mussel shells were placed in plastic bags underwater by divers and brought to the surface with their load of surface sediment intact. The sediment was washed off the rocks in the laboratory by brushing the rock surface in the same water sample they came up in, then pouring the whole sample of water and sediment into a graduated cylinder and letting it settle for 30 minutes or more after which the water was poured off down to the 'flocculent' layer of fine sediment. Heavy sand was left behind in the plastic bag. Sediments were stored in whirl-pak bags, and frozen in three parts, one for metals, one for *Clostridium*, and one to keep for future analysis. The summer and fall samples were delivered to the New England Aquarium for metals analysis, and the samples for *Clostridium* analysis are still frozen awaiting M.W.R.A funding for those measurements. Previous *Clostridium* levels are reported in Sebens and Witman (1990), and metals analysis in Sullivan (1989, 1990). The results of the 1991 metals analysis were provided in a separate report to the M.W.R.A. in January 1992 (Appendix I of this report).

III. RESULTS

A. Percent Cover

Rocky bottom habitats along the transect were blanketed by a veneer of sediment approximately 5 mm or greater in thickness, which obscured some of the encrusting invertebrates. Maximum coverage of sediment occurred during the winter sampling period with 52 to 71 % of the three substrate types (cobble, horizontal and vertical rock) at Deer Island covered by sediment (Fig. 1 and Tables 17 - 19). Cobble substrata at Can 5 were also characterized by high sediment cover during the winter. Although the highest average sediment cover occurred on vertical rock surfaces in two of the four seasons, sediment cover was highly variable with no consistent trend of sedimentation by substrate type. There was a distinct pattern of decreasing sediment cover with distance from Can 5, one of the sites adjacent to the Deer Island outfall, during the winter sampling period (Fig. 1).

The most abundant encrusting organism in the rocky subtidal communities sampled was *Lithothamnion glaciale*, a crustose coralline alga typified by a thallus covered with protuberances. *Lithothamnion* was nearly absent from the sites adjacent to or at intermediate distances from the Deer Island outfall, with the exception of Deer Island during the spring sampling period (Fig. 2). This may have been due to high sediment cover inhibiting light transmission required for photosynthesis of coralline algae, or to negative effects of sedimentation on *Lithothamnion* recruitment. There was a dramatic increase in the average percent cover of *Lithothamnion* with distance from Can 5 in all seasons, especially on horizontal rock surfaces (Fig. 2). Indeed, high cover of crustose coralline algae was the most distinctive feature of the sites farthest away (Flip Rock and Shags Rock) from the outfall (Fig. 2). Another species of coralline algae, *Phymatolithon rugulosum*, was more abundant than *L. glaciale* on vertical rock walls during the spring at Shags Rock (Table 26).

The two most conspicuous assemblages of sessile invertebrates were dominated by a complex of hydroids and bryozoans (Fig. 3) and mussels, *Mytilus edulis* (Table 10). Cobbles and horizontal rock at Deer Island, and cobbles and vertical surfaces at the Can 5 site had particularly high coverage of the hydroid / bryozoan complex. While there was no clear seasonality in the abundance of the hydroid / bryozoan complex, there was a distinct spatial pattern of lower abundance at the outer two sites (Flip Rock and Shags Rock, Fig. 3). The site nearest the outfall at Deer Island (Lovell's Island) continued to be dominated by mussel beds, which were present since the 1990 survey, but were completely absent earlier. For example, the average percent cover of *Mytilus edulis* (with some sediment cover) as discerned from the ROV transects was 72.5 percent cover in summer, 55.1 percent cover in fall, 61.8 percent cover in winter and 50.4 percent cover in spring. The mussel beds at Lovell's Island supported an abundant population of sea stars, *Asterias vulgaris*, a mussel predator, with mean densities ranging from 47.8 individuals per 25 m^2 in Fall to 1.75 individuals per 25 m^2 in spring (Table 31). Large barnacles, *Balanus balanus*, were approximately two-fold more abundant at the intermediate to outer sites, than those near the outfall (Fig. 4). The highest cover of barnacles occurred on vertical rock surfaces in winter and spring.

B. Abundance of Mobile Fauna

Lobsters, *Homarus americanus*, were the most abundant mobile invertebrate censused in the band transects, attaining maximum densities of 7.5 individuals per 25.0 m^2 in the spring at Deer Island (Fig. 5, Table 27). There was a consistent temporal pattern of low lobster abundance in the winter and maximum abundance during the spring and summer at four of the six sites (Fig. 5, Tables 6, 13, 20, 27, and 31). The absence of lobsters at the Can 5 site may be related to the low spatial complexity of the cobble bottom habitat there, which lacks lobster shelters.

The Jonah crab, *Cancer borealis*, appeared to share aspects of the same seasonality as *H. americanus* (Fig. 5) since the lowest mean densities of *C. borealis* also occurred in winter. *C. borealis* densities tended to be higher in the fall than in the spring at Winthrop, Flip and Shags Rock sites. *Cancer irroratus*, the rock crab, was also scarce in the winter (Fig. 5). No spatial pattern of *C. irroratus* abundance was evident.

Grazers dominated the small mobile fauna category, with up to 1.8 urchins, *Strongylocentrotus droebachiensis*, per 0.05 m^2 on cobble substrata at Deer Island in spring (Fig. 6). The low abundance of urchins in the fall may reflect the influence of the "Halloween Northeaster" which struck the study area several weeks prior to the fall survey in November 1991, dislodging urchins from K. Sebens' monitored rock walls at Shags Rock. *S. droebachiensis* abundance increased with distance from the Can 5 site during fall and winter, but not during the spring sampling period (Fig. 6) when they were also common at Deer Island. Other important grazers were the limpet, *Acmaea testudinalis*, which were particularly abundant on horizontal substrata at Winthrop and Shags Rock (Tables 15 and 29 respectively). The number of species classified as small mobile fauna was highest at the sites farthest from the outfall, as in the 1987-1990 study.

The demersal fish fauna comprised winter flounder, *Pseudopleuronectes americanus*, several species of sculpins (*Myoxocephalus aenaeus, M. octodecemspinosus, M.scorpius*), the rock eel, *Pholis gunnellus*, cunner, *Tautogolabrus adspersus*, and the shanny, *Ulvaria subbifurcata*. Fish were generally not abundant at any of the sites, with average densities not greater than one individual per 25 m^2. The smaller bodied fish, sculpins and rock eels, tended to be more ubiquitously distributed than winter flounder (Tables 13, 20 and 27).

IV. CONCLUSIONS

The 1991-1992 sampling period did not show major differences in site characteristics compared to the 1987-1990 period, except that the subtidal mussel beds that had developed at Lovell's Island in 1990 persisted into 1992. The mussel beds cover areas formerly comprising cobbles covered by sediments, similar to the Can 5 site. These mussel beds at Lovell's Island support large populations of predators including sea stars, crabs, and lobsters compared to the Can 5 site. Since Lovell's Island is closest to the present outfall, and receives the highest pollutant load, it is likely to be the most impacted biologically. The benthos is certainly different from that at all other sites, dominated by opportunistic species (mussels) that settle and grow rapidly but are constantly preyed on as well. Mussels are suspension feeders whose growth rates might be expected to increase with added loads of organic detritus and phytoplankton in the water column. It is thus possible that proximity to the outfall allows the mussels to recruit and grow fast enough to avoid being completely consumed by the local predators. Subtidal mussel beds have been observed off Nahant, but they are temporary phenomena that are removed each year by numerous predators in the subtidal zone.

Can 5, another site that is heavily impacted by the outfall, has shown a consistent pattern throughout the study of low numbers and diversity of benthic species, heavy surficial sedimentation, and low numbers of mobile predators. This site appears to suffer from the heavy sedimentation, but has not developed the mussel beds now characteristic of Lovell's Island. Both Can 5 and Lovell's have low numbers of sea urchins, which are common at all other rocky sites in the study. This pattern was observed in previous years as well. It is possible the urchins are negatively affected by the effluent or sedimentation, that sedimentation limits recruitment, or that the absence of crustose coralline algae retards larval settlement. Sea urchins graze coralline algal surfaces, and juvenile urchins are common on the rough surfaces of some species. The relative lack of bedrock and large boulders at these two sites cannot account for the differences seen since, where boulders do occur, they also lack the common species found at Deer Island and sites farther from the outfall.

The Deer Island and Winthrop sites are intermediate in pollutant load, and in amount of sediment observed on rock surfaces. They contain all the species common at the sites farthest from the outfall, but both sites have a lower abundance of crustose coralline algae, and a higher abundance of hydroid/bryozoan 'complex'. This consists of ephemeral hydroid and bryozoan species with sediment collected around their bases. Sea urchins were uncommon at Deer Island except in spring 1992 when cobble areas showed a very high density. Lobsters and crabs had equal or higher abundances here than in areas further from the outfall. In general, these two intermediate sites share characteristics with the less impacted sites, even though Deer Island is closer to the outfall than is Can 5. Our observations indicate the effluent plume travels seaward toward Lovell's Island and Can 5, not landward toward the Deer Island site.

The two sites farthest from the outfall, Flip Rock and the Shag Rocks, are very similar, and have not changed characteristics over the five years of the study. These sites have more bedrock, but we chose sampling areas at the base of bedrock outcrops where there was a plain of cobble and boulders similar to those at all other sites. Thick sediment was usually less abundant at these two sites, crustose coralline algae was very common, and hydroid-bryozoan complex was least common. The high densities of sea urchins keep the rock surfaces at these two sites cleaned of algae and invertebrates, including the hydroid-bryozoan complex. Barnacles were also uncommon at these sites compared to the others. This may also be due to urchin grazing since urchins are omnivores that consume small barnacles, mussels and other invertebrates in addition to algae. The abundance of lobsters and crabs at these sites was generally high, although it was exceeded at times by the densities at Lovell's Island.

This year's sampling agrees well with our findings of 1987-1990. It appears that sediment from the sewage outfalls impacts sites nearest the outfalls, and there is a general diminution of rock-dwelling macrobenthic organisms at those sites. There is also a lack of crustose algae, and of sea urchins. The Lovell's Island site, closest to the outfall, has shown the greatest instability, changing from a cobble/sediment plain to an extensive area of mussel beds, sometimes with substantial kelp cover. It is very likely that this instability is a direct result of proximity to the outfall, favoring a few tolerant species able to dominate the substratum until removed by predators.

Future Reporting, Data Analysis and Synthesis

We now have data from five years of sampling along this transect, and we expect the study to continue for several years into the future. Major changes in water quality are expected, first following sludge abatement in December 1991, then following activation of the offshore outfall in summer 1995. The first event should result in a major reduction of organic-rich surficial sedimentation on rock surfaces at the Lovell's Island and Can 5 sites. This should allow more suspension feeding invertebrates to occupy these rock surfaces, as well as crustose coralline algae, and may make the sites more suitable for sea urchins. Movement of the effluent outfall offshore should improve conditions further, lessening the total nutrient input for Broad Sound, with the possible result that phytoplankton blooms and associated sedimentation of organic material will be reduced. Water clarity should improve, and benthic algal growth may be stimulated. The dense mussel beds now characteristic of the Lovell's Island site will probably not remain given a much lower food input for the mussels, and less stressful conditions for mussel predators. Overall, we expect the two sites most impacted by the current outfall to become more like the four sites farther away.

Study Design. Our current hard-bottom monitoring study compares sites along a gradient of pollutant loading. The sites were chosen for similarity of depth and bottom type from charts, rather than by diving at many sites and picking those we wanted. Therefore, they appear to be a relatively unbiased group of sites for which comparisons can be made. The sites are not identical, however, and it is always possible that site differences observed are due to something other than proximity to the outfall. All conclusions are based on comparison and correlation, and therefore suffer the criticisms of all such monitoring studies. We are inferring causation based on observed pattern, but cannot test for it experimentally. Nonetheless, we can test for differences before and after outfall abatement and relocation. This is, in effect, an (unreplicated) 'experiment'. Other physical attributes of the site, such as water flow patterns and differing amounts of cobble/boulder and bedrock, will remain the same.

Data analysis, Synthesis and Interpretation. At any point in this study, we can compare changes over time at the sites we are monitoring. One suggestion is to choose a set of 'indicator organisms' which are common enough at any of the sites to be useful for comparison. Analysis of variance can be used to test for differences between sites at any one time period, then to test for differences at a given site over time. This would be done independently for each common organism (lobsters, crab species, each common sessile species or group). This type of analysis will determine the pattern before and after abatement, and any trends over time.

Alternatively, all data from each site can be used to compare sites and sampling dates using a multivariate technique that examines similarily of data sets. This will tell us which sites are most similar at any given time, or over the whole study, and which dates are most similar for one site. If all pre-abatement samples group together, for a site near the outfall, and all after do so as well, this is a strong indication that the community as a whole has changed. I suggest using both techniques since they have different strengths and goals. However, the current sampling and analysis effort being undertaken each year is already much more extensive than could be done with the present level of funding for this study. Four samples per year (1991-1992), have been reduced to two samples (1992-1993) so that all sampling and data analysis can be completed in a reasonable period of time. A major statistical comparison of the full temporal data set would be a large project on its own and would necessitate a separate contract.

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Table 1. Location of research sites in Massachusetts Bay. The Lovell's Island site is closest to the Deer Island outfall and the Shags Rock site is farthest from the outfall. However, the Lovell's and Deer Island sites are directly in the path of the effluent and sludge plume. H=high, M=moderate, L=low

SITE	Sewage Impact	Latitude / Longitude
Lovell's Island	H	42 20. 32 x 70 55. 89
Deer Island	M	42 22. 09 x 70 56. 16
Can 5	H	42 21.18 x 70 54. 49
Winthrop	M	42 23. 07 x 70 55. 49
Flip Rock	L	42 24. 14 x 70 55. 52
Shags Rock	L	42 24. 69 x 70 54. 23

Table 2. Species and categories identified in photographs and transects in Lovell's Island to Nahant surveys.

Scientific Name or Category	Description
Acmaea testudinalis	limpet (gastropod mollusk), only species present in this region, grazes algae
Aeolidia papillosa	nudibranch mollusk, predator on sea anemones
Algae (Red, Green, Brown)	erect foliose or filamentous algae, s=substratum, c=canopy
Anemone	unidentified anemone, usually juvenile *Metridium senile*
Anomia spp.	bivalve mollusk (jingle shell) attached by one shell, two species not dist. in photographs
Aplidium constellatum	colonial ascidian, white translucent, most common species
Asterias vulgaris	common sea star (starfish), predator on most invertebrates
Asterias forbesi	second most common sea star, predator on mussels primarily
Balanus balanus	barnacle, the only common subtidal species
Bryozoans	bryozoans, encrusting or erect, species not det. in photographs
Buccinum undatum	gastropod mollusk, predator on mussels and other invertebrates
Cancer irroratus	common Rock Crab, pointed sides of carapace, predator on mussels and other invertebrates
Cancer borealis	Jonah Crab, rounded sides of carapace, predator on mussels and other invertebrates
Carcinus maenas	Green Crab, a predator on mussels and barnacles
Complex	bound sediment with worm and amphipod tubes (tube) or bound to bases of hydroids and bryozoans (hydroid-bryo)

Crepidula fornicata	gastropod mollusk, slipper shell
Dendrodoa carnea	solitary ascidian, orange red, common
Didemnum albidum	colonial ascidian, bright white, thin and uncommon
Gravel	small pebbles and gravel between larger cobbles, usually less than 3 cm diameter and without encrusting species. Measured as percent cover in photos of cobble areas, but not part of total percent cover <u>on</u> cobbles.
Halichondria panicea	sponge, yellow or greenish, very common
Halisarca spp.	sponge, yellow, two species not dist. in photographs
Hemitripterus americanus	fish, sea raven, a predator on smaller fish
Henricia spp.	smooth armed sea star, orange, purple and other colors. a complex of species of which *H. sanguineolenta* is most common.
Homarus americanus	American Lobster, a predator on mussels, crabs and other invertebrates
Hyas spp.	decorator crabs, at least two species locally
Hydroids	all hydroid species, c=canopy, s=substratum
Ischnochiton spp.	a group of small chitons, including several species of the genus plus small *Tonicella marmorea*.
Isodictya spp.	sponge, orange erect, two species not dist. in photographs
Limanda ferruginea	fish, yellowtail flounder, predator on benthic invertebrates
Lithothamnion glaciale	crustose coralline alga, pink, bumpy surface. Also spelled *Lithothamnium*, may include *L. lemoinae* as well

Metridium senile	sea anemone, c = canopy, s=substratum
Molgula spp.	solitary ascidians, yellow-brown, *M. citrina* most common *M. manhattensis* larger, *Molgula sp.*, orange, not dist. from *D. carnea* in photographs
Modiolus modiolus	horse mussel, brown with hairy periostracum
Myoxocephalus aeneaus	fish, a small sculpin (grubby), predator on small mobile invertebrates, primarily crustaceans
Myoxocephalus octodecemspinusus	fish, sculpin (longhorn), predator on fish and invertebrates
Myoxocephalus scorpius	fish, sculpin (shorthorn), predator on fish and invertebrates
Myxicola infundibulum	tube dwelling pollychaete worm, secretes mucus collar
Mud	mud found between cobbles in photographs. Measured as percent cover in photos of cobble areas, but not part of total percent cover <u>on</u> cobbles.
Orange sponge	encrusting sponge, unidentified species
Pagurus spp.	hermit crabs, counted in transects if large (3 cm or greater)
Peysonnelia sp.	crustose red alga, non-calcified, formerly known as 'red crust' or *Waernis*an. sp. (proposed), very thin, maroon or red/brown
Pholis gunnelus	fish, gunnel or rock eel, very elongate species that preys on small invertebrates
Phymatolithon rugulosum	crustose coralline alga, pink, smooth or pitted surface
Placopecten magellanicus	large sea scallop
Pseudopleuronectes americanus	fish, winter flounder, a predator on infaunal and epifaunal invertebrates

Psolus fabriciius	attached sea cucumer (holothurian), orange-red
Rock (Bare Space)	recently cleared rock surface, may have a film of algae or bacteria but this cannot be seen in photographs
Sediment	thin sediment is loose on rock surface, can see org. through it thick sediment can be bound to surface, cannot see org. through
Spirorbis borealis	Serpulid polychaete, white calcified spiral tubes, actually a complex of several species not dist. in photographs
Strongylocentrotus droebachiensis	the only sea urchin at these sites, green to off-white, a major herbivore on algae and predator on many invertebrates
Tautogolabrus adspersus	fish, Cunner (a wrasse), predator on mussels and other small invertebrates
Ulvaria subbifurcata	fish, shanny, an elongate species that preys on small invertebrates
Urosalpinx sp.	gastropod mollusk, oyster drill, uncommon predator on bivalve mollusks

Fig. 1. Mean percent cover of thick sediment on different substrata.

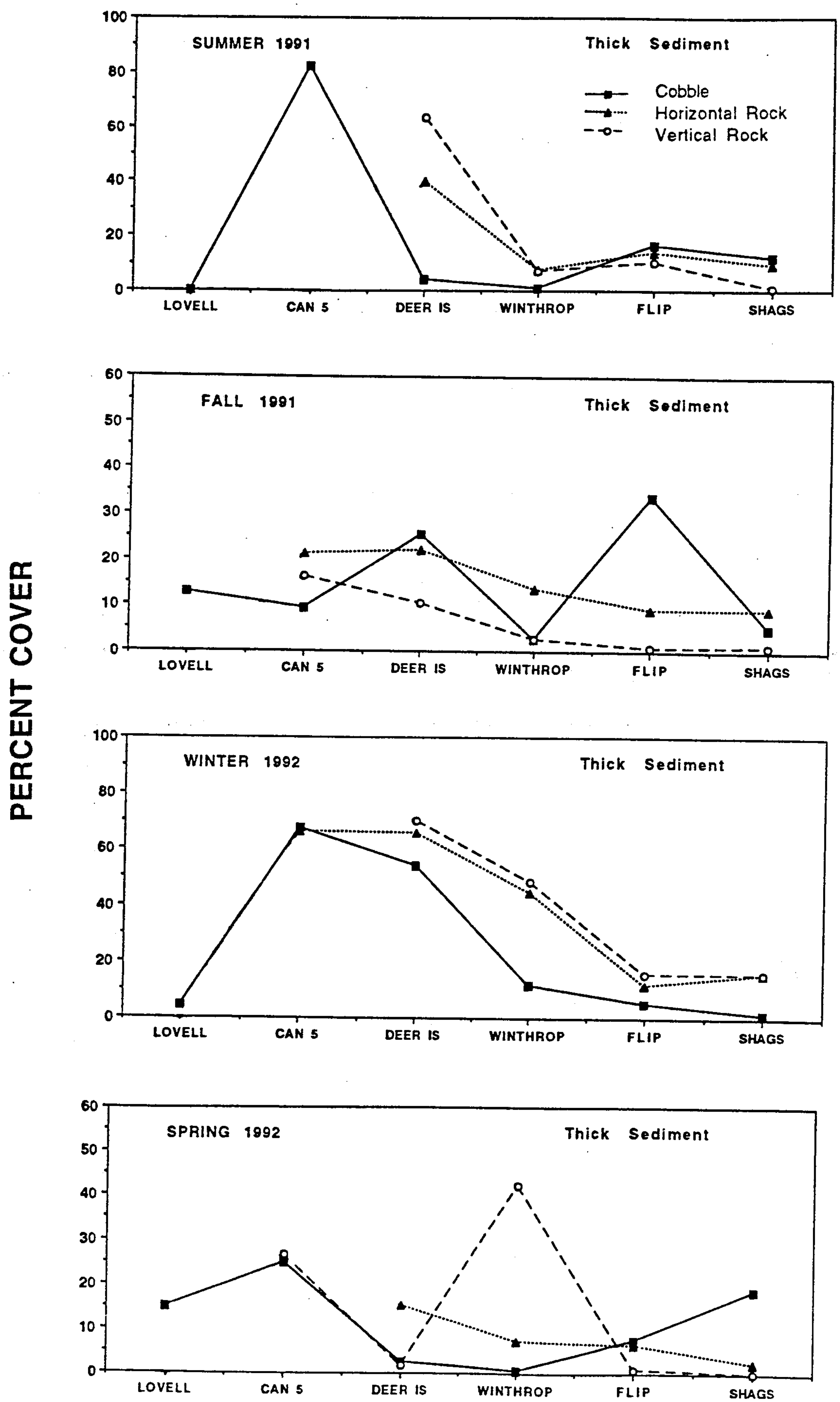

Fig. 2. Mean percent cover of coralline algae, *Lithothamnion sp.*

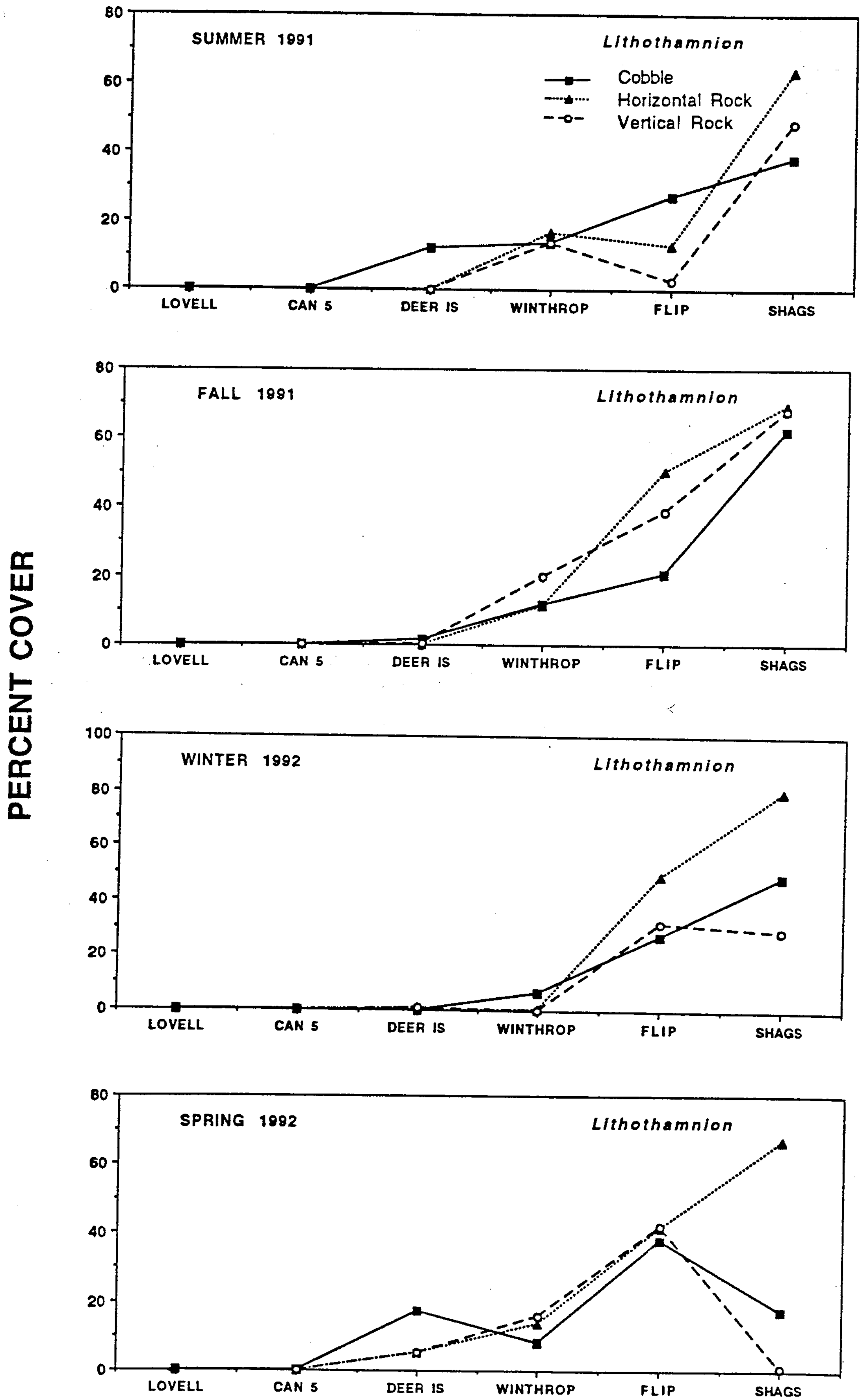

Fig. 3. Mean percent cover of hydroid - bryozoan complex.

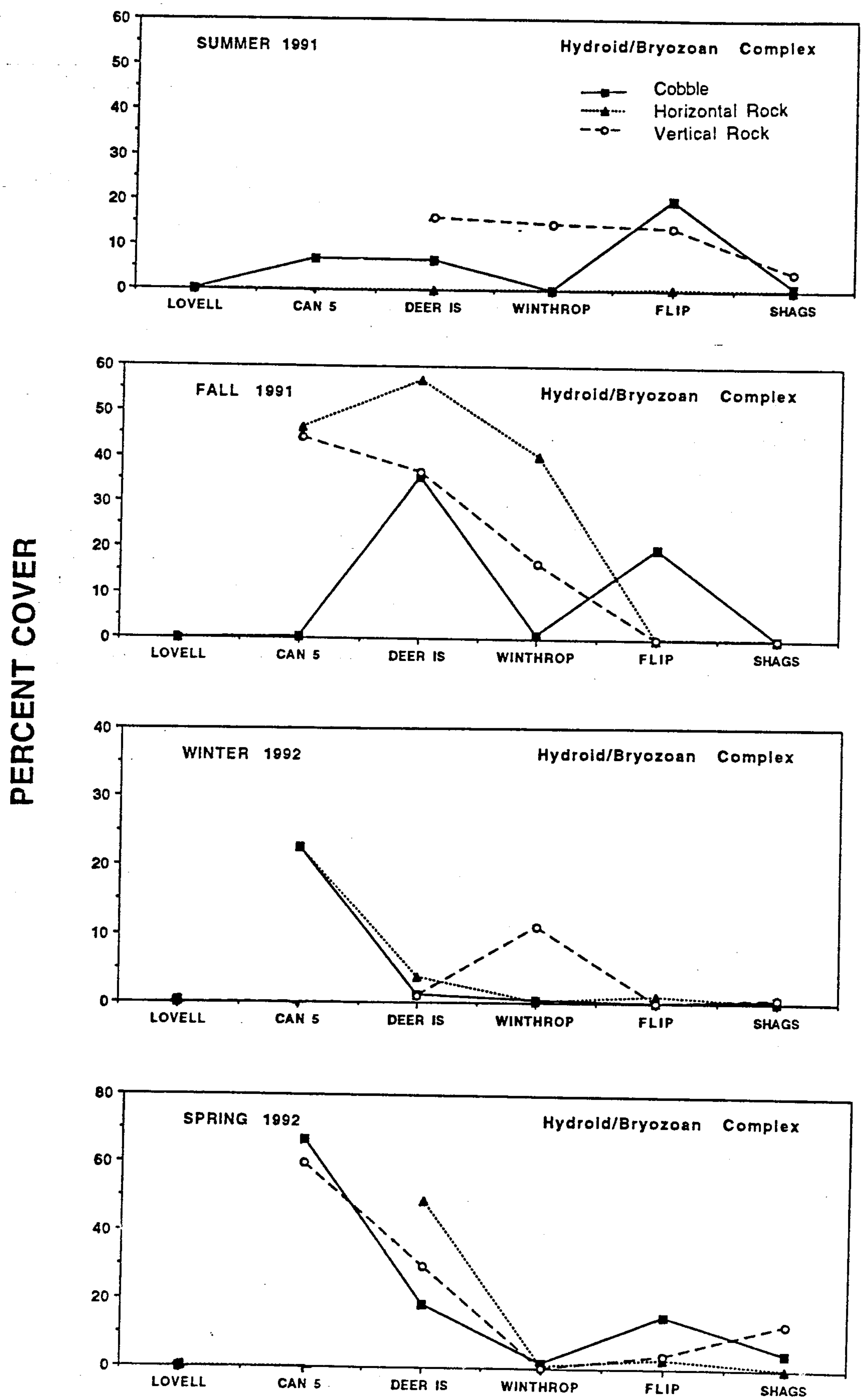

Fig. 4. Mean percent cover of barnacles, *Balanus balanus*.

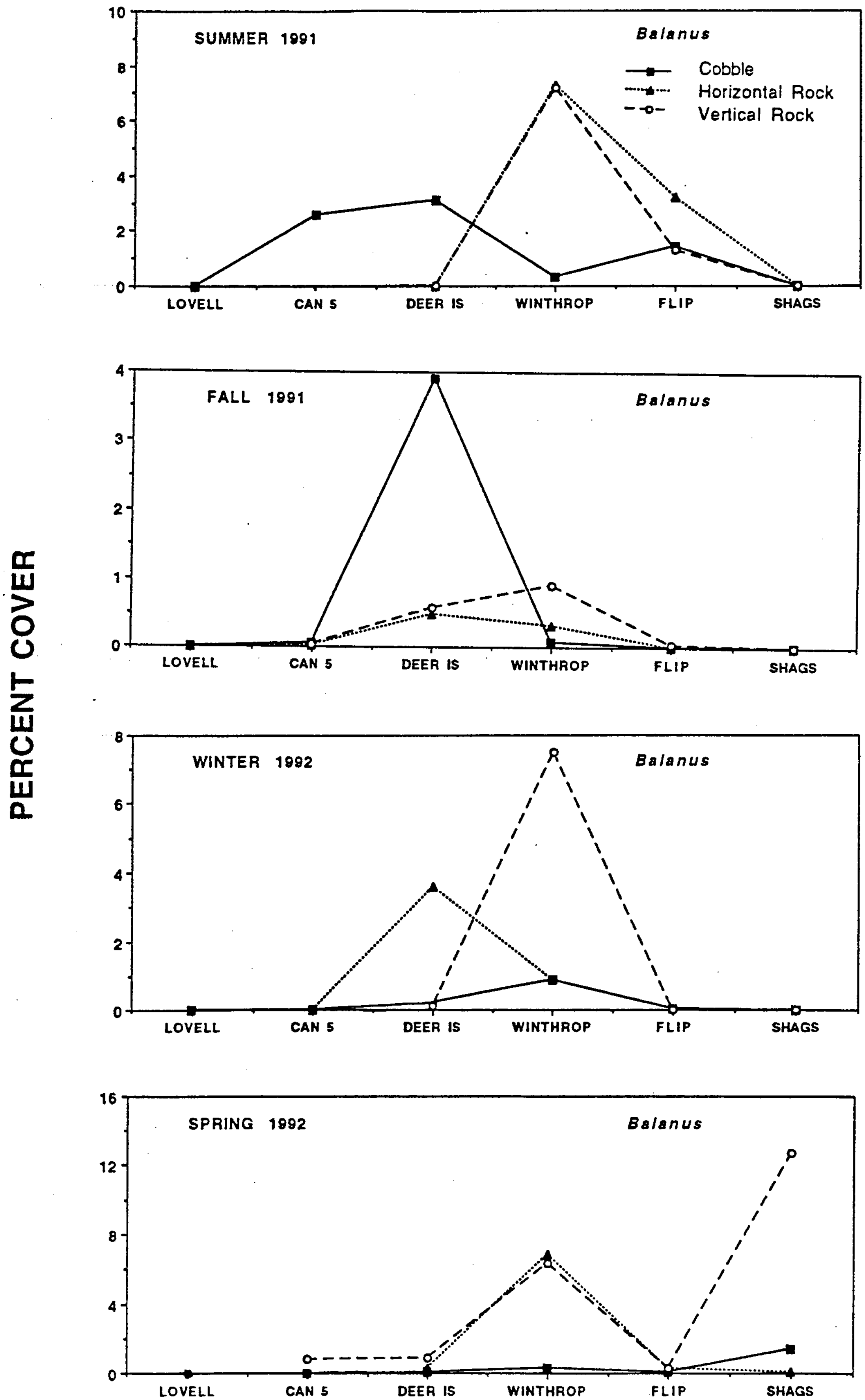

Fig. 5. Mean density of decapod crustaceans.

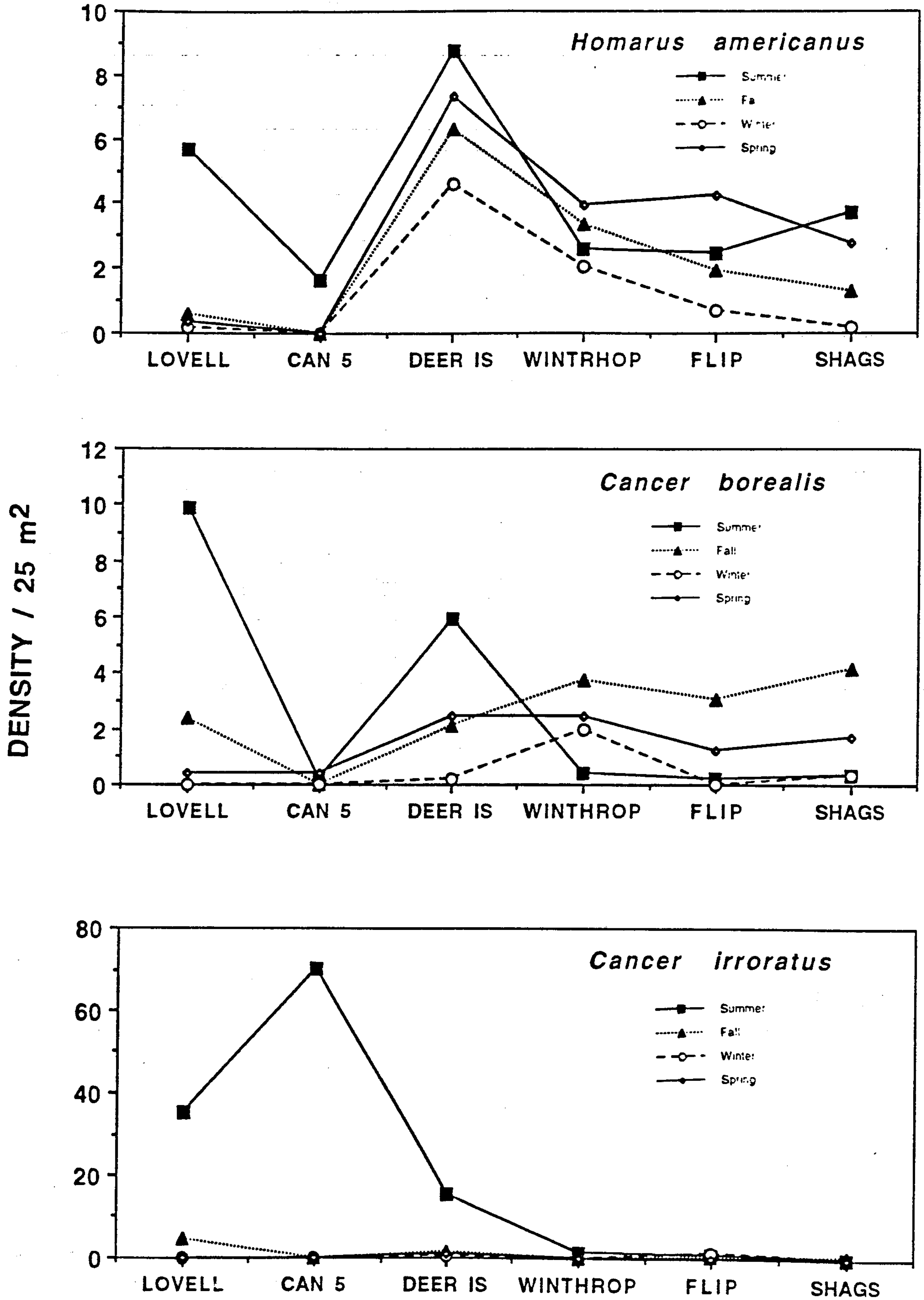

Fig. 6. Mean density of sea urchins, *S. droebachiensis*, on different substrata.

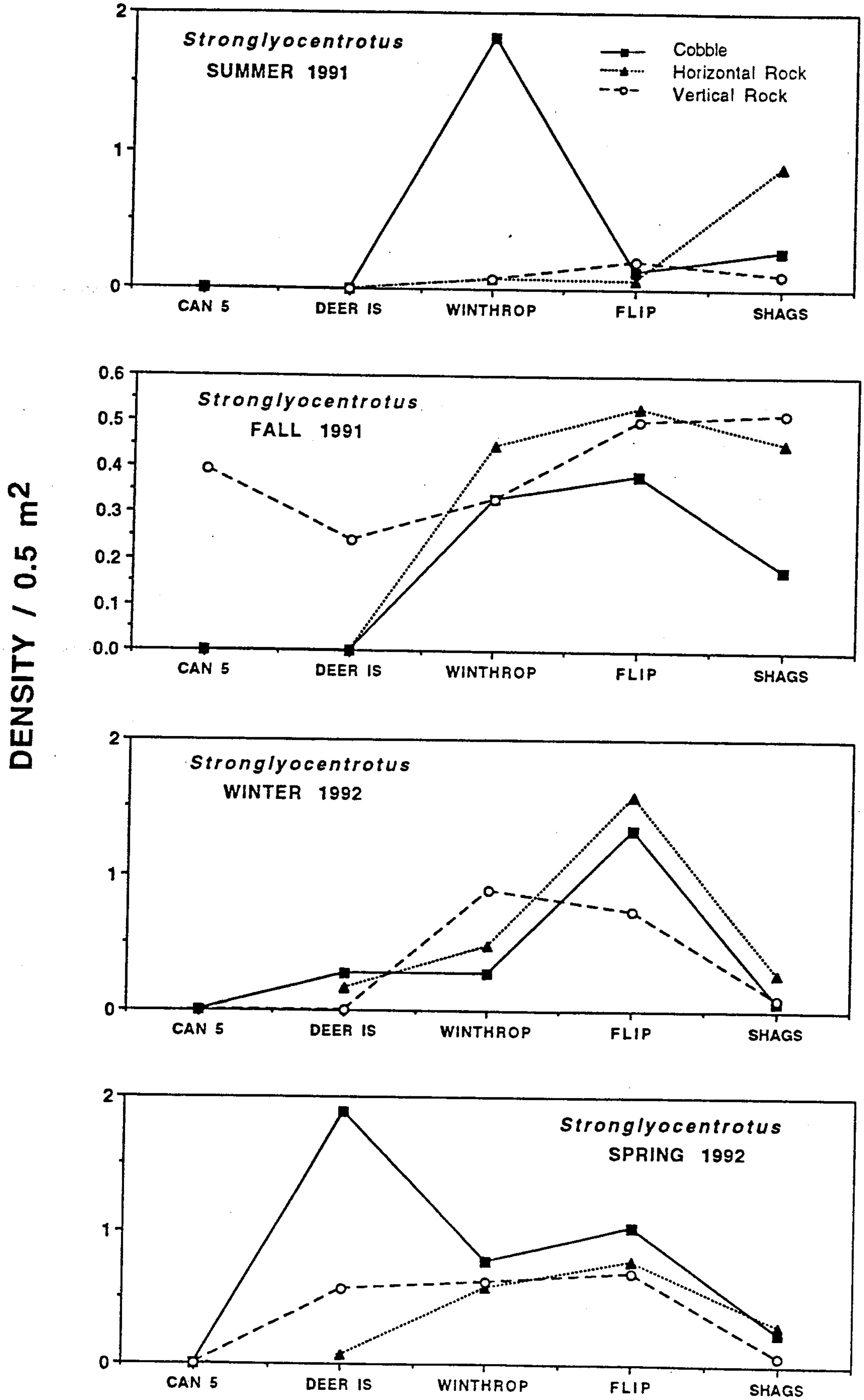

Table 3. Percent cover on cobble substrata, summer 1991.

		Hydroids-s	Hydroids-c	Balanus	Dendrodoa	Halichondria	Halisarca	Encr Bryo
CAN 5	B.T. mean	0.000	0.000	0.026	0.000	0.000	0.000	0.003
	B.T. (mean-sd)	0.000	0.000	0.007	0.000	0.000	0.000	0.003
	B.T. (mean+sd)	0.000	0.000	0.058	0.000	0.000	0.000	0.027
	N	33	33	33	33	33	33	33
DEER ISLAND	B.T. mean	0.000	0.000	0.031	0.001	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.004	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.082	0.007	0.000	0.000	0.000
	N	2	2	2	2	2	2	2
FLIP	B.T. mean	0.000	0.000	0.014	0.001	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.001	0.001	0.000	0.000	0.000
	B.T. (mean +sd)	0.001	0.000	0.074	0.007	0.000	0.000	0.000
	N	13	13	13	13	13	13	13
LOVELL	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	7	7	7	7	7	7	7
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.003	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	< 0	< 0	< 0
	B.T. (mean+sd)	0.000	0.001	0.000	0.001	0.047	0.009	0.002
	N	12	12	12	12	12	12	12
WINTHROP	B.T. mean	0.000	0.000	0.003	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.002	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.024	0.000	0.000	0.000	0.000
	N	11	11	11	11	11	11	11

		Erect Bryo-s	Erect bryo-c	Tube Complex	Thick sediment	Hyd/Bryo complex	Peyssonnelia
CAN 5	B.T. mean	0.000	0.000	0.000	0.819	0.068	0.011
	B.T. (mean-sd)	0.000	0.000	0.000	0.683	0.008	0.000
	B.T. (mean+sd)	0.000	0.000	0.002	0.923	0.180	0.036
	N	33	33	33	33	33	33
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.040	0.066	0.083
	B.T. (mean-sd)	0.000	0.000	0.000	0.018	0.065	0.072
	B.T. (mean+sd)	0.000	0.000	0.000	0.069	0.067	0.094
	N	2	2	2	2	2	2
FLIP	B.T. mean	0.000	0.000	0.000	0.165	0.200	0.041
	B.T. (mean-sd)	< 0	0.000	0.000	0.012	0.059	0.004
	B.T. (mean +sd	0.002	0.001	0.000	0.442	0.396	0.111
	N	13	13	13	13	13	13
LOVELL	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000	0.000
	N	7	7	7	7	7	7
SHAGS	B.T. mean	0.000	0.000	0.000	0.122	0.008	0.001
	B.T. (mean-sd)	0.000	0.000	0.000	0.014	0.000	0.001
	B.T. (mean+sd)	0.000	0.000	0.000	0.314	0.040	0.008
	N	12	12	12	12	12	12
WINTHROP	B.T. mean	0.000	0.000	0.000	0.008	0.000	0.024
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	0.001
	B.T. (mean+sd)	0.000	0.000	0.000	0.033	0.000	0.115
	N	11	11	11	11	11	11

		Lithothamnion	Phymatolithon	Bare space	Spirorbis	Mussels	Red algae-s	Red algae-c
CAN 5	B.T. mean	0.000	0.000	0.018	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.001	0.074	0.001	0.000	0.000	0.000
	N	33	33	33	33	33	33	33
DEER ISLAND	B.T. mean	0.120	0.108	0.520	0.001	0.000	0.000	0.013
	B.T. (mean-sd)	0.105	0.058	0.379	0.000	0.000	0.000	0.002
	B.T. (mean+sd)	0.134	0.169	0.659	0.007	0.000	0.000	0.072
	N	2	2	2	2	2	2	2
FLIP	B.T. mean	0.272	0.013	0.029	0.001	0.018	0.028	0.000
	B.T. (mean-sd)	0.064	0.000	0.005	0.000	0.003	0.000	0.000
	B.T. (mean +sd	0.556	0.051	0.073	0.005	0.100	0.100	0.000
	N	13	13	13	13	13	13	13
LOVELL	B.T. mean	0.000	0.000	0.000	0.000	1.000	0.006	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	1.000	< 0	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	1.000	0.074	0.000
	N	7	7	7	7	7	7	7
SHAGS	B.T. mean	0.381	0.276	0.047	0.000	0.006	0.000	0.000
	B.T. (mean-sd)	0.234	0.093	0.001	0.000	0.002	0.000	0.000
	B.T. (mean+sd)	0.539	0.511	0.156	0.002	0.037	0.000	0.000
	N	12	12	12	12	12	12	12
WINTHROP	B.T. mean	0.135	0.047	0.121	0.000	0.457	0.000	0.003
	B.T. (mean-sd)	0.001	0.000	0.005	0.000	0.026	0.000	0.001
	B.T. (mean+sd)	0.440	0.164	0.353	0.002	0.940	0.000	0.016
	N	11	11	11	11	11	11	11

		Brown algae-s	Brown algae-c	Anomia	Gravel	Mud
CAN 5	B.T. mean	0.000	0.000	0.000	0.206	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.121	0.000
	B.T. (mean+sd)	0.000	0.000	0.001	0.306	0.000
	N	33	33	33	33	33
DEER ISLAND	B.T. mean	0.000	0.001	0.015	0.079	0.000
	B.T. (mean-sd)	0.000	0.000	0.002	0.028	0.000
	B.T. (mean+sd)	0.000	0.007	0.038	0.154	0.000
	N	2	2	2	2	2
FLIP	B.T. mean	0.000	0.008	0.000	0.084	0.000
	B.T. (mean-sd)	0.000	< 0	0.000	0.019	0.000
	B.T. (mean +sd	0.000	0.082	0.003	0.190	0.000
	N	13	13	13	13	13
LOVELL	B.T. mean	0.000	0.015	0.000	0.000	0.043
	B.T. (mean-sd)	0.000	0.010	0.000	0.000	0.006
	B.T. (mean+sd)	0.000	0.116	0.000	0.000	0.113
	N	7	7	7	7	7
SHAGS	B.T. mean	0.000	0.000	0.000	0.178	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.081	0.000
	B.T. (mean+sd)	0.000	0.000	0.001	0.303	0.000
	N	12	12	12	12	12
WINTHROP	B.T. mean	0.000	0.003	0.001	0.295	0.000
	B.T. (mean-sd)	0.000	< 0	0.001	0.165	0.000
	B.T. (mean+sd)	0.001	0.033	0.007	0.443	0.000
	N	11	11	11	11	11

Table 4. Percent cover on horizontal substrata, summer 1991.

		Hydroids-s	Balanus	Aplidium	Dendrodoa	Isodictya	Tube Complex
DEER ISLAND	B.T. mean	0.000	0.000	0.037	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.006	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.203	0.000	0.000	0.000
	N	2	2	2	2	2	2
FLIP	B .T. mean	0.000	0.032	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.006	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.001	0.181	0.000	0.001	0.000	0.000
	N	12	12	12	12	12	12
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.002	0.000
	B.T. (mean +sd)	0.000	0.000	0.000	0.000	0.008	0.001
	N	12	12	12	12	12	12
WINTHROP	B.T. mean	0.000	0.073	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.011	< 0	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.366	0.003	0.000	0.000	0.000
	N	10	10	10	10	10	10

		Thick sediment	Hyd/Bryo complex	Peyssonnelia	Lithothamnion	Phymatolithon
DEER ISLAND	B.T. mean	0.397	0.000	0.000	0.000	0.045
	B.T. (mean-sd)	0.147	0.000	0.000	0.000	0.008
	B.T. (mean+sd)	0.681	0.000	0.000	0.000	0.243
	N	2	2	2	2	2
FLIP	B .T. mean	0.136	0.002	0.203	0.128	0.001
	B.T. (mean-sd)	0.010	< 0	0.026	0.032	0.000
	B.T. (mean+sd)	0.373	0.019	0.488	0.275	0.008
	N	12	12	12	12	12
SHAGS	B.T. mean	0.094	0.001	0.001	0.634	0.179
	B.T. (mean-sd)	0.000	0.001	0.001	0.294	0.036
	B.T. (mean +sd)	0.357	0.008	0.006	0.912	0.398
	N	12	12	12	12	12
WINTHROP	B.T. mean	0.075	0.000	0.194	0.164	0.046
	B.T. (mean-sd)	0.015	0.000	0.017	0.033	0.002
	B.T. (mean+sd)	0.393	0.000	0.495	0.367	0.142
	N	10	10	10	10	10

		Bare space	Spirorbis	Mussels	Red algae-s	Red algae-c	Anomia
DEER ISLAND	B.T. mean	0.022	0.000	0.000	0.270	0.807	0.000
	B.T. (mean-sd)	0.004	0.000	0.000	0.050	0.781	0.000
	B.T. (mean+sd)	0.123	0.000	0.000	0.938	0.832	0.000
	N	2	2	2	2	2	2
FLIP	B .T. mean	0.134	0.000	0.029	0.007	0.000	0.002
	B.T. (mean-sd)	0.035	0.000	0.056	< 0	0.000	0.000
	B.T. (mean+sd)	0.282	0.002	0.302	0.066	0.001	0.011
	N	12	12	12	12	12	12
SHAGS	B.T. mean	0.008	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean +sd)	0.024	0.000	0.000	0.000	0.000	0.000
	N	12	12	12	12	12	12
WINTHROP	B.T. mean	0.110	0.002	0.000	0.001	0.021	0.013
	B.T. (mean-sd)	0.005	0.000	< 0	< 0	0.004	0.000
	B.T. (mean+sd)	0.322	0.007	0.004	0.010	0.117	0.050
	N	10	10	10	10	10	10

Table 5. Percent cover on vertical substrata, summer 1991.

		Metridium-s	Metridium-c	Hydroids-s	Hydroids-c	Balanus	Aplidium	Didemnum
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.027	0.021
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000	0.092	0.073
	N	3	3	3	3	3	3	3
FLIP	B.T. mean	0.000	0.000	0.010	0.000	0.013	0.062	0.000
	B.T. (mean-sd)	0.000	< 0	0.001	0.000	0.005	0.001	< 0
	B.T. (mean+sd)	0.001	0.004	0.057	0.000	0.086	0.259	0.007
	N	12	12	12	12	12	12	12
SHAGS	B.T. mean	0.006	0.000	0.000	0.000	0.000	0.002	0.000
	B.T. (mean-sd)	0.015	0.000	< 0	0.000	0.000	< 0	0.000
	B.T. (mean+sd)	0.075	0.000	0.003	0.001	0.002	0.034	0.001
	N	12	12	12	12	12	12	12
WINTHROP	B.T. mean	0.000	0.000	0.000	0.000	0.072	0.011	0.013
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.005	0.000	0.001
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.209	0.052	0.061
	N	11	11	11	11	11	11	11

		Dendrodoa	Molgula	Halichondria	Halisarca	Isodyctia	Encr Bryo	Erect Bryo-s
DEER ISLAND	B.T. mean	0.016	0.001	0.000	0.000	0.000	0.002	0.000
	B.T. (mean-sd)	0.013	0.000	0.000	0.000	0.000	0.001	0.000
	B.T. (mean+sd)	0.020	0.004	0.000	0.000	0.000	0.015	0.000
	N	3	3	3	3	3	3	3
FLIP	B.T. mean	0.002	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.009	0.001	0.003	0.000	0.000	0.000	0.000
	N	12	12	12	12	12	12	12
SHAGS	B.T. mean	0.000	0.000	0.000	0.007	0.000	0.002	0.001
	B.T. (mean-sd)	< 0	0.000	0.000	0.007	< 0	0.002	0.000
	B.T. (mean+sd)	0.005	0.001	0.001	0.061	0.010	0.017	0.005
	N	12	12	12	12	12	12	12
WINTHROP	B.T. mean	0.003	0.000	0.000	0.001	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	< 0	0.000	< 0	0.000	0.000	< 0
	B.T. (mean+sd)	0.010	0.003	0.000	0.010	0.000	0.003	0.003
	N	11	11	11	11	11	11	11

		Tube Complex	Thick sediment	Hyd/Bryo complex	Peyssonnelia	Lithothamnion
DEER ISLAND	B.T. mean	0.000	0.635	0.159	0.036	0.000
	B.T. (mean-sd)	0.000	0.241	0.044	0.020	0.000
	B.T. (mean+sd)	0.000	0.944	0.326	0.251	0.000
	N	3	3	3	3	3
FLIP	B.T. mean	0.000	0.104	0.139	0.200	0.025
	B.T. (mean-sd)	0.000	0.005	0.006	0.000	0.003
	B.T. (mean+sd)	0.004	0.308	0.405	0.630	0.066
	N	12	12	12	12	12
SHAGS	B.T. mean	0.000	0.011	0.039	0.014	0.484
	B.T. (mean-sd)	0.000	< 0	0.006	0.002	0.253
	B.T. (mean+sd)	0.000	0.107	0.211	0.077	0.719
	N	12	12	12	12	12
WINTHROP	B.T. mean	0.000	0.073	0.147	0.140	0.135
	B.T. (mean-sd)	0.000	0.000	0.006	0.033	0.017
	B.T. (mean+sd)	0.001	0.292	0.421	0.304	0.339
	N	11	11	11	11	11

		Phymatolithon	Bare space	Spirorbis	Mussels	Red algae-s	Red algae-c	Brown algae-s
DEER ISLAND	B.T. mean	0.000	0.000	0.004	0.000	0.000	0.416	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	0.103	0.000
	B.T. (mean+sd	0.000	0.000	0.015	0.000	0.000	0.775	0.000
	N	3	3	3	3	3	3	3
FLIP	B.T. mean	0.002	0.043	0.002	0.000	0.011	0.040	0.000
	B.T. (mean-sd)	< 0	0.002	0.000	0.000	0.002	0.005	< 0
	B.T. (mean+sd	0.027	0.134	0.007	0.001	0.066	0.208	0.004
	N	12	12	12	12	12	12	12
SHAGS	B.T. mean	0.180	0.010	0.001	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.061	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd	0.344	0.040	0.007	0.000	0.000	0.000	0.000
	N	12	12	12	12	12	12	12
WINTHROP	B.T. mean	0.055	0.015	0.002	0.001	0.001	0.004	0.000
	B.T. (mean-sd)	0.001	0.000	0.000	0.001	0.001	0.003	0.000
	B.T. (mean+sd	0.230	0.068	0.007	0.007	0.007	0.033	0.000
	N	11	11	11	11	11	11	11

		Brown algae-c	Anemone??	Anomia	Psolus
DEER ISLAND	B.T. mean	0.000	0.000	0.001	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000
	B.T. (mean+sd	0.000	0.000	0.004	0.000
	N	3	3	3	3
FLIP	B.T. mean	0.012	0.000	0.000	0.000
	B.T. (mean-sd)	0.002	< 0	0.000	0.000
	B.T. (mean+sd	0.066	0.002	0.000	0.000
	N	12	12	12	12
SHAGS	B.T. mean	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	< 0
	B.T. (mean+sd	0.000	0.001	0.001	0.002
	N	12	12	12	12
WINTHROP	B.T. mean	0.001	0.000	0.009	0.000
	B.T. (mean-sd)	0.001	0.000	0.000	0.000
	B.T. (mean+sd	0.008	0.000	0.029	0.000
	N	11	11	11	11

Table 6. Abundance of large mobile fauna, summer 1991.

		Cancer borealis	C. irroratus	Carcinus maenas	Hemitripterus americanus
CAN 5	B.T. mean (#/25m2)	0.200	70.329	0.200	0.000
	B.T. (mean-sd)	-0.166	38.943	-0.166	0.000
	B.T. (mean+sd)	0.700	110.837	0.700	0.000
DEER IS	B.T. mean (#/25m2)	5.911	15.417	0.000	0.200
	B.T. (mean-sd)	2.208	4.052	0.000	-0.166
	B.T. (mean+sd)	11.185	33.670	0.000	0.700
FLIP ROCK	B.T. mean (#/25m2)	0.200	0.771	0.000	0.000
	B.T. (mean-sd)	-0.166	-0.169	0.000	0.000
	B.T. (mean+sd)	0.700	2.322	0.000	0.000
SHAGS	B.T. mean (#/25m2)	0.357	0.000	0.000	0.433
	B.T. (mean-sd)	-0.261	0.000	0.000	-0.055
	B.T. (mean+sd)	1.357	0.000	0.000	1.100
WINTHROP	B.T. mean (#/25m2)	0.433	1.512	0.000	0.000
	B.T. (mean-sd)	-0.055	0.231	0.000	0.000
	B.T. (mean+sd)	1.100	3.428	0.000	0.000

		Homarus americanus	juv. H. americanus	Pseudopleuronectes americanus
CAN 5	B.T. mean (#/25m2)	1.645	1.559	0.000
	B.T. (mean-sd)	0.103	0.367	0.000
	B.T. (mean+sd)	4.134	3.260	0.000
DEER IS	B.T. mean (#/25m2)	8.730	0.000	0.433
	B.T. (mean-sd)	4.362	0.000	-0.055
	B.T. (mean+sd)	14.485	0.000	1.100
FLIP ROCK	B.T. mean (#/25M2)	2.463	0.000	0.613
	B.T. (mean-sd)	-0.015	0.000	-0.106
	B.T. (mean+sd)	7.040	0.000	1.697
SHAGS	B.T. mean (#/25m2)	3.744	0.000	0.000
	B.T. (mean-sd)	1.680	0.000	0.000
	B.T. (mean+sd)	6.491	0.000	0.000
WINTHROP	B.T. mean (#/25m2)	2.605	0.433	0.000
	B.T. (mean-sd)	1.249	-0.055	0.000
	B.T. (mean+sd)	4.347	1.100	0.000

		Myoxocephalus aenaeus	M. octodecemspinosus	Ulvaria subbifurcata
CAN 5	B.T. mean (#/25m2)	0.771	0.200	0.200
	B.T. (mean-sd)	-0.169	-0.166	-0.166
	B.T. (mean+sd)	2.322	0.700	0.700
DEER IS	B.T. mean (#/25m2)	0.200	0.000	0.357
	B.T. (mean-sd)	-0.166	0.000	-0.261
	B.T. (mean+sd)	0.700	0.000	1.357
FLIP ROCK	B.T. mean (#/25M2)	0.000	0.000	0.200
	B.T. (mean-sd)	0.000	0.000	-0.166
	B.T. (mean+sd)	0.000	0.000	0.700
SHAGS	B.T. mean (#/25m2)	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000
WINTHROP	B.T. mean (#/25m2)	0.000	0.000	0.357
	B.T. (mean-sd)	0.000	0.000	-0.261
	B.T. (mean+sd)	0.000	0.000	1.357

		Tautogolabrus adspersus	juv. T. adspersus	Pagurus	Placopecten
CAN 5	B.T. mean (#/25m2)	0.000	0.357	0.200	0.200
	B.T. (mean-sd)	0.000	-0.261	-0.166	-0.166
	B.T. (mean+sd)	0.000	1.357	0.700	0.700
DEER IS	B.T. mean (#/25m2)	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000
FLIP ROCK	B.T. mean (#/25M2)	0.000	36.045	0.000	0.000
	B.T. (mean-sd)	0.000	17.446	0.000	0.000
	B.T. (mean+sd)	0.000	61.191	0.000	0.000
SHAGS	B.T. mean (#/25m2)	0.433	12.277	0.000	0.000
	B.T. (mean-sd)	-0.055	8.676	0.000	0.000
	B.T. (mean+sd)	1.100	16.473	0.000	0.000
WINTHROP	B.T. mean (#/25m2)	0.000	1.965	0.000	0.000
	B.T. (mean-sd)	0.000	0.410	0.000	0.000
	B.T. (mean+sd)	0.000	4.280	0.000	0.000

Table 7. Abundance of small mobile fauna on cobble substrata, summer 1991.

		Acmaea	Asterias forbesi	A. vulgaris	Cancer irroratus	Henricia	Ischnochiton
CAN 5	B.T. mean	0.000	0.117	0.226	0.211	0.022	0.000
	B.T.(mean-sd)	0.000	-0.144	-0.274	-0.150	-0.100	0.000
	B.T. (mean+sd)	0.000	0.449	1.010	0.699	0.161	0.000
	N	33	33	33	33	33	33
FLIP ROCK	B.T. mean	0.250	0.000	0.000	0.000	0.119	0.000
	B.T. (mean-sd)	-0.180	0.000	0.000	0.000	-0.149	0.000
	B.T. (mean+sd)	0.862	0.000	0.000	0.000	0.463	0.000
	N	13	13	13	13	13	13
LOVELL ISLAND	B.T. mean	0.000	0.000	0.000	0.231	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	-0.137	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.727	0.000	0.000
	N	7	7	7	7	7	7
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.063	0.200
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	-0.139	-0.137
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.309	0.646
	N	12	12	12	12	12	12
WINTHROP	B.T. mean	0.276	0.000	0.000	0.000	0.069	0.410
	B.T. (mean-sd)	-0.176	0.000	0.000	0.000	-0.142	-0.177
	B.T. (mean+sd)	0.921	0.000	0.000	0.000	0.329	1.295
	N	11	11	11	11	11	11

		Myxicola	Stronglyocentrotus	Urosalpinx	Fish
CAN 5	B.T. mean	0.061	0.000	0.000	0.000
	B.T.(mean-sd)	-0.170	0.000	0.000	0.000
	B.T. (mean+sd)	0.353	0.000	0.000	0.000
	N	33	33	33	33
FLIP ROCK	B.T. mean	0.000	0.129	0.000	0.000
	B.T. (mean-sd)	0.000	-0.150	0.000	0.000
	B.T. (mean+sd)	0.000	0.490	0.000	0.000
	N	13	13	13	13
LOVELL ISLAND	B.T. mean	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000
	N	7	7	7	7
SHAGS	B.T. mean	0.000	0.274	0.000	0.000
	B.T. (mean-sd)	0.000	-0.110	0.000	0.000
	B.T. (mean+sd)	0.000	0.787	0.000	0.000
	N	12	12	12	12
WINTHROP	B.T. mean	0.000	1.821	0.069	0.069
	B.T. (mean-sd)	0.000	-0.103	-0.142	-0.142
	B.T. (mean+sd)	0.000	5.339	0.329	0.329
	N	11	11	11	11

Table 8. Abundance of small mobile fauna on horizontal substrata, summer 1991.

		Acmaea	Aeolidia	Asterias forbesi	A. vulgaris	Henricia	Ischnochiton
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.000	0.433	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	-0.140	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	1.274	0.000
	N	2	2	2	2	2	2
FLIP ROCK	B.T. mean	0.250	0.000	0.690	0.269	0.000	0.000
	B.T. (mean-sd)	-0.180	0.000	-0.477	-0.274	0.000	0.000
	B.T. (mean+sd)	0.862	0.000	3.625	1.134	0.000	0.000
	N	12	12	12	12	12	12
SHAGS	B.T. mean	0.200	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	-0.137	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.646	0.000	0.000	0.000	0.000	0.000
	N	12	12	12	12	12	12
WINTHROP	B.T. mean	0.471	0.076	0.000	0.000	0.131	0.576
	B.T. (mean-sd)	-0.132	-0.146	0.000	0.000	-0.232	-0.057
	B.T. (mean+sd)	1.360	0.351	0.000	0.000	0.647	1.484
	N	10	10	10	10	10	10

		Stronglyocentrotus
DEER ISLAND	B.T. mean	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	2
FLIP ROCK	B.T. mean	0.063
	B.T. (mean-sd)	-0.139
	B.T. (mean+sd)	0.309
	N	12
SHAGS	B.T. mean	0.888
	B.T. (mean-sd)	-0.108
	B.T. (mean+sd)	2.492
	N	12
WINTHROP	B.T. mean	0.076
	B.T. (mean-sd)	-0.146
	B.T. (mean+sd)	0.351
	N	10

Table 9. Abundance of small mobile fauna on vertical rock substrata, summer 1991.

		Asterias forbesi	A. vulgaris	juv. Asterias	Henricia	Ischnochiton
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.871	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.035	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	2.094	0.000
	N	3	3	3	3	3
FLIP ROCK	B.T. mean	0.978	0.624	0.218	0.177	0.000
	B.T. (mean-sd)	-0.226	-0.161	-0.258	-0.206	0.000
	B.T. (mean+sd)	3.139	1.866	0.945	0.720	0.000
	N	12	12	12	12	12
SHAGS	B.T. mean	0.000	0.000	0.200	0.254	0.250
	B.T. (mean-sd)	0.000	0.000	-0.137	-0.301	-0.180
	B.T. (mean+sd)	0.000	0.000	0.646	1.164	0.862
	N	12	12	12	12	12
WINTHROP	B.T. mean	0.000	0.000	0.000	0.361	0.592
	B.T. (mean-sd)	0.000	0.000	0.000	-0.132	-0.201
	B.T. (mean+sd)	0.000	0.000	0.000	1.060	1.882
	N	11	11	11	11	11

		Stronglyocentrotus	Fish
DEER ISLAND	B.T. mean	0.000	0.274
	B.T. (mean-sd)	0.000	-0.163
	B.T. (mean+sd)	0.000	0.889
	N	3	3
FLIP ROCK	B.T. mean	0.200	0.000
	B.T. (mean-sd)	-0.137	0.000
	B.T. (mean+sd)	0.646	0.000
	N	12	12
SHAGS	B.T. mean	0.108	0.000
	B.T. (mean-sd)	-0.222	0.000
	B.T. (mean+sd)	0.566	0.000
	N	12	12
WINTHROP	B.T. mean	0.069	0.000
	B.T. (mean-sd)	-0.142	0.000
	B.T. (mean+sd)	0.329	0.000
	N	11	11

Table 10. Percent cover on cobble substrata, fall 1991.

		Anomia	Aplidium	Balanus	Bare space	Brown algae-c
CAN 5	B.T. mean	0.000	0.000	0.001	0.741	0.000
	B.T. (mean-sd)	0.000	0.000	< 0	0.492	0.000
	B.T. (mean+sd)	0.000	0.000	0.004	0.926	0.000
	N	10	10	10	10	10
DEER ISLAND	B.T. mean	0.002	0.000	0.004	0.178	0.000
	B.T. (mean-sd)	< 0	0.000	0.000	0.100	< 0
	B.T. (mean+sd)	0.007	0.000	0.013	0.272	0.007
	N	12	12	12	12	12
FLIP ROCK	B.T. mean	0.015	0.000	0.000	0.019	0.000
	B.T. (mean-sd)	< 0	0.000	< 0	< 0	0.000
	B.T. (mean+sd)	0.048	0.000	0.001	0.066	0.000
	N	10	10	10	10	10
LOVELL'S	B.T. mean	0.000	0.000	0.000	0.107	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	< 0	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.518	0.000
	N	10	10	10	10	10
SHAGS	B.T. mean	0.000	0.000	0.000	0.098	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.021	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.222	0.000
	N	12	12	12	12	12
WINTHROP	B.T. mean	0.000	0.002	0.001	0.057	0.004
	B.T. (mean-sd)	< 0	< 0	< 0	0.057	< 0
	B.T. (mean+sd)	0.000	0.000	0.001	0.196	0.002
	N	11	11	11	11	11

		Erect Bryo-s	Halisarca	Hyd/Bryo complex	Isodictya	Lithothamnion
CAN 5	B.T. mean	0.000	0.000	0.003	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	< 0	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.051	0.000	0.000
	N	10	10	10	10	10
DEER ISLAND	B.T. mean	0.000	0.000	0.356	0.000	0.014
	B.T. (mean-sd)	0.000	0.000	0.194	< 0	< 0
	B.T. (mean+sd)	0.000	0.000	0.537	0.001	0.070
	N	12	12	12	12	12
FLIP ROCK	B.T. mean	0.000	0.000	0.198	0.000	0.207
	B.T. (mean-sd)	< 0	0.000	0.092	0.000	0.053
	B.T. (mean+sd)	0.003	0.000	0.333	0.000	0.427
	N	10	10	10	10	10
LOVELL'S	B.T. mean	0.000	0.000	0.007	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	< 0	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.042	0.000	0.000
	N	10	10	10	10	10
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.619
	B.T. (mean-sd)	0.000	< 0	< 0	0.000	0.460
	B.T. (mean+sd)	0.000	0.003	0.003	0.000	0.766
	N	12	12	12	12	12
WINTHROP	B.T. mean	0.000	0.000	0.009	0.000	0.119
	B.T. (mean-sd)	0.000	0.000	0.009	0.000	0.120
	B.T. (mean+sd)	0.000	0.000	0.100	0.000	0.238
	N	11	11	11	11	11

		Metridium-s	Modiolus	Mytilus w/sediment	Orange Sponge	Phymatolithon
CAN 5	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000
	N	10	10	10	10	10
DEER ISLAND	B.T. mean	0.000	0.019	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	< 0	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.135	0.000	0.000	0.000
	N	12	12	12	12	12
FLIP ROCK	B.T. mean	0.001	0.010	0.000	0.000	0.002
	B.T. (mean-sd)	< 0	< 0	0.000	0.000	< 0
	B.T. (mean+sd)	0.012	0.060	0.000	0.000	0.026
	N	10	10	10	10	10
LOVELL'S	B.T. mean	0.000	0.000	0.551	0.004	0.000
	B.T. (mean-sd)	0.000	0.000	0.109	< 0	0.000
	B.T. (mean+sd)	0.000	0.000	0.946	0.062	0.000
	N	10	10	10	10	10
SHAGS	B.T. mean	0.000	0.001	0.000	0.000	0.149
	B.T. (mean-sd)	0.000	< 0	0.000	0.000	0.053
	B.T. (mean+sd)	0.000	0.029	0.000	0.000	0.283
	N	12	12	12	12	12
WINTHROP	B.T. mean	0.000	0.029	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.029	0.000	0.000	< 0
	B.T. (mean+sd)	0.000	0.136	0.000	0.000	0.023
	N	11	11	11	11	11

		Red algae-c	Red algae-s	Spirorbis	Thick sediment	Tube Complex
CAN 5	B.T. mean	0.000	0.000	0.000	0.093	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.031	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.183	0.000
	N	10	10	10	10	10
DEER ISLAND	B.T. mean	0.007	0.001	0.000	0.254	0.000
	B.T. (mean-sd)	< 0	< 0	0.000	0.135	0.000
	B.T. (mean+sd)	0.043	0.004	0.000	0.397	0.000
	N	12	12	12	12	12
FLIP ROCK	B.T. mean	0.000	0.005	0.002	0.337	0.000
	B.T. (mean-sd)	0.000	< 0	< 0	0.163	< 0
	B.T. (mean+sd)	0.000	0.030	0.008	0.538	0.004
	N	10	10	10	10	10
LOVELL'S	B.T. mean	0.000	0.000	0.000	0.129	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	< 0	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.478	0.000
	N	10	10	10	10	10
SHAGS	B.T. mean	0.000	0.000	0.000	0.050	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.016	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.100	0.000
	N	12	12	12	12	12
WINTHROP	B.T. mean	0.001	0.000	0.000	0.026	0.000
	B.T. (mean-sd)	< 0	< 0	< 0	0.026	0.000
	B.T. (mean+sd)	0.024	0.002	0.001	0.073	0.000
	N	11	11	11	11	11

		Peyssonnella	Gravel	Mud
CAN 5	B.T. mean	0.123	0.537	0.000
	B.T. (mean-sd)	0.046	0.368	0.000
	B.T. (mean+sd)	0.231	0.702	0.000
	N	10	10	10
DEER ISLAND	B.T. mean	0.055	0.354	0.000
	B.T. (mean-sd)	0.010	0.266	0.000
	B.T. (mean+sd)	0.134	0.449	0.000
	N	12	12	12
FLIP ROCK	B.T. mean	0.057	0.123	0.000
	B.T. (mean-sd)	0.008	0.035	0.000
	B.T. (mean+sd)	0.147	0.253	0.000
	N	10	10	10
LOVELL'S	B.T. mean	0.000	0.000	0.247
	B.T. (mean-sd)	< 0	0.000	0.037
	B.T. (mean+sd)	0.003	0.000	0.561
	N	10	10	10
SHAGS	B.T. mean	0.017	0.248	0.000
	B.T. (mean-sd)	0.004	0.143	0.000
	B.T. (mean+sd)	0.038	0.370	0.000
	N	12	12	12
WINTHROP	B.T. mean	0.025	0.173	0.000
	B.T. (mean-sd)	0.025	0.063	0.000
	B.T. (mean+sd)	0.079	0.324	0.000
	N	11	11	11

Table 11. Percent cover on horizontal rock substrata, fall 1991.

		Metridium-s	Hydroids-s	Hydroids-c	Balanus	Aplidium
CAN 5	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	< 0	< 0	< 0	0.000
	B.T. (mean+sd)	0.000	0.003	0.005	0.002	0.000
	N	10	10	10	10	10
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.005	0.009
	B.T. (mean-sd)	0.000	0.000	0.000	0.002	< 0
	B.T. (mean+sd)	0.000	0.000	0.000	0.009	0.034
	N	11	11	11	11	11
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	< 0	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.003	0.000	0.000	0.000	0.000
	N	13	13	13	13	13
SHAGS	B.T. mean	0.005	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	< 0	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.084	0.000	0.000	0.000	0.000
	N	11	11	11	11	11
WINTHROP	B.T. mean	0.000	0.000	0.000	0.003	0.025
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	< 0
	B.T. (mean+sd)	0.000	0.000	0.000	0.009	0.081
	N	13	13	13	13	13

		Didemnum	Dendrodoa	Halisarca	Isodictya	Tube Complex
CAN 5	B.T. mean	0.000	0.000	0.001	0.001	0.000
	B.T. (mean-sd)	0.000	0.000	< 0	< 0	0.000
	B.T. (mean+sd)	0.000	0.000	0.021	0.013	0.000
	N	10	10	10	10	10
DEER ISLAND	B.T. mean	0.000	0.005	0.000	0.000	0.000
	B.T. (mean-sd)	< 0	0.002	0.000	0.000	0.000
	B.T. (mean+sd)	0.003	0.009	0.000	0.000	0.000
	N	11	11	11	11	11
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	< 0	0.000	0.000	< 0
	B.T. (mean+sd)	0.000	0.001	0.000	0.000	0.003
	N	13	13	13	13	13
SHAGS	B.T. mean	0.000	0.000	0.001	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	< 0	0.000	< 0
	B.T. (mean+sd)	0.000	0.000	0.014	0.000	0.002
	N	11	11	11	11	11
WINTHROP	B.T. mean	0.000	0.007	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	< 0	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.021	0.000	0.000	0.000
	N	13	13	13	13	13

		Thick sediment	Hyd/Bryo complex	Peyssonnelia	Lithothamnion	Phymatolithon
CAN 5	B.T. mean	0.213	0.465	0.006	0.000	0.000
	B.T. (mean-sd)	0.055	0.105	< 0	0.000	0.000
	B.T. (mean+sd)	0.439	0.848	0.025	0.000	0.000
	N	10	10	10	10	10
DEER ISLAND	B.T. mean	0.221	0.569	0.073	0.000	0.000
	B.T. (mean-sd)	0.100	0.434	0.014	< 0	0.000
	B.T. (mean+sd)	0.373	0.698	0.173	0.003	0.000
	N	11	11	11	11	11
FLIP ROCK	B.T. mean	0.090	0.000	0.088	0.504	0.102
	B.T. (mean-sd)	< 0	0.000	0.021	0.237	0.016
	B.T. (mean+sd)	0.271	0.000	0.194	0.770	0.249
	N	13	13	13	13	13
SHAGS	B.T. mean	0.091	0.000	0.001	0.695	0.117
	B.T. (mean-sd)	< 0	0.000	< 0	0.498	< 0
	B.T. (mean+sd)	0.210	0.000	0.008	0.860	0.264
	N	11	11	11	11	11
WINTHROP	B.T. mean	0.135	0.401	0.084	0.113	0.000
	B.T. (mean-sd)	0.060	0.224	0.015	0.050	< 0
	B.T. (mean+sd)	0.234	0.591	0.203	0.197	0.002
	N	13	13	13	13	13

		Bare space	Spirorbis	Modiolus	Red algae-s	Red algae-c
CAN 5	B.T. mean	0.126	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	< 0	0.000	0.000	0.000	< 0
	B.T. (mean+sd)	0.402	0.000	0.000	0.000	0.001
	N	10	10	10	10	10
DEER ISLAND	B.T. mean	0.042	0.000	0.008	0.004	0.062
	B.T. (mean-sd)	0.013	< 0	< 0	0.001	< 0
	B.T. (mean+sd)	0.086	0.001	0.045	0.010	0.178
	N	11	11	11	11	11
FLIP ROCK	B.T. mean	0.076	0.009	0.000	0.000	0.000
	B.T. (mean-sd)	< 0	< 0	0.000	0.000	0.000
	B.T. (mean+sd)	0.201	0.026	0.000	0.000	0.000
	N	13	13	13	13	13
SHAGS	B.T. mean	0.009	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	< 0	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.030	0.000	0.000	0.000	0.000
	N	11	11	11	11	11
WINTHROP	B.T. mean	0.083	0.000	0.000	0.003	0.097
	B.T. (mean-sd)	< 0	< 0	0.000	< 0	< 0
	B.T. (mean+sd)	0.257	0.001	0.000	0.011	0.340
	N	13	13	13	13	13

		Green algae- c	Brown algae-s	Brown algae-c	Anomia	Orange Sponge
CAN 5	B.T. mean	0.003	0.000	0.000	0.000	0.008
	B.T. (mean-sd)	< 0	0.000	0.000	0.000	< 0
	B.T. (mean+sd)	0.054	0.000	0.000	0.000	0.083
	N	10	10	10	10	10
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.001	0.000
	B.T. (mean-sd)	< 0	0.000	0.000	< 0	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.005	0.000
	N	11	11	11	11	11
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.002	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	< 0	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.014	0.000
	N	13	13	13	13	13
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	< 0	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.003	0.000
	N	11	11	11	11	11
WINTHROP	B.T. mean	0.000	0.000	0.001	0.025	0.000
	B.T. (mean-sd)	0.000	< 0	< 0	0.006	0.000
	B.T. (mean+sd)	0.000	0.002	0.020	0.055	0.000
	N	13	13	13	13	13

Table 12. Percent cover on vertical rock substrata, fall 1991.

		Metridium-s	Hydroids-s	Hydroids-c	Balanus	Aplidium
CAN 5	B.T. mean	0.000	0.002	0.001	0.000	0.033
	B.T. (mean-sd)	< 0	< 0	< 0	0.000	< 0
	B.T. (mean+sd)	0.004	0.015	0.007	0.000	0.186
	N	8	8	8	8	8
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.006	0.010
	B.T. (mean-sd)	< 0	0.000	0.000	< 0	< 0
	B.T. (mean+sd)	0.001	0.000	0.000	0.018	0.040
	N	11	11	11	11	11
FLIP ROCK	B .T. mean	0.049	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	< 0	< 0	0.000	< 0	< 0
	B.T. (mean+sd)	0.319	0.005	0.000	0.005	0.004
	N	13	13	13	13	13
SHAGS	B.T. mean	0.004	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	< 0	0.000	0.000	< 0	0.000
	B.T. (mean+sd)	0.060	0.000	0.000	0.001	0.000
	N	11	11	11	11	11
WINTHROP	B.T. mean	0.000	0.000	0.000	0.009	0.013
	B.T. (mean-sd)	< 0	0.000	0.000	< 0	< 0
	B.T. (mean+sd)	0.001	0.000	0.000	0.027	0.052
	N	10	10	10	10	10

		Didemnum	Dendrodoa	Halichondria	Halisarca	Encrusting Bryo
CAN 5	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000
	N	8	8	8	8	8
DEER ISLAND	B.T. mean	0.002	0.005	0.000	0.000	0.000
	B.T. (mean-sd)	< 0	< 0	< 0	0.000	0.000
	B.T. (mean+sd)	0.019	0.012	0.001	0.000	0.000
	N	11	11	11	11	11
FLIP ROCK	B .T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	< 0	< 0	0.000	< 0
	B.T. (mean+sd)	0.000	0.001	0.007	0.000	0.001
	N	13	13	13	13	13
SHAGS	B.T. mean	0.000	0.000	0.004	0.001	0.001
	B.T. (mean-sd)	0.000	< 0	< 0	< 0	< 0
	B.T. (mean+sd)	0.000	0.002	0.036	0.022	0.007
	N	11	11	11	11	11
WINTHROP	B.T. mean	0.012	0.010	0.000	0.008	0.000
	B.T. (mean-sd)	< 0	0.001	0.000	< 0	< 0
	B.T. (mean+sd)	0.044	0.028	0.000	0.132	0.002
	N	10	10	10	10	10

		Erect Bryo-s	Tube Complex	Thick sediment	Hyd/Bryo complex	Peyssonnelia
CAN 5	B.T. mean	0.000	0.000	0.161	0.443	0.001
	B.T. (mean-sd)	< 0	0.000	< 0	0.156	< 0
	B.T. (mean+sd)	0.002	0.000	0.470	0.753	0.007
	N	8	8	8	8	8
DEER ISLAND	B.T. mean	0.000	0.000	0.104	0.366	0.154
	B.T. (mean-sd)	0.000	0.000	0.034	0.169	0.044
	B.T. (mean+sd)	0.000	0.000	0.207	0.591	0.313
	N	11	11	11	11	11
FLIP ROCK	B .T. mean	0.001	0.000	0.008	0.000	0.169
	B.T. (mean-sd)	< 0	0.000	< 0	0.000	0.021
	B.T. (mean+sd)	0.008	0.000	0.024	0.000	0.417
	N	13	13	13	13	13
SHAGS	B.T. mean	0.000	0.000	0.010	0.001	0.006
	B.T. (mean-sd)	< 0	0.000	0.004	< 0	< 0
	B.T. (mean+sd)	0.001	0.000	0.018	0.007	0.018
	N	11	11	11	11	11
WINTHROP	B.T. mean	0.000	0.000	0.027	0.164	0.258
	B.T. (mean-sd)	< 0	< 0	< 0	0.062	0.077
	B.T. (mean+sd)	0.002	0.001	0.083	0.303	0.499
	N	10	10	10	10	10

		Lithothamnion	Phymatolithon	Bare space	Spirorbis	Mussels
CAN 5	B.T. mean	0.000	0.000	0.161	0.000	0.005
	B.T. (mean-sd)	< 0	0.000	< 0	< 0	< 0
	B.T. (mean+sd)	0.001	0.000	0.452	0.001	0.034
	N	8	8	8	8	8
DEER ISLAND	B.T. mean	0.004	0.000	0.114	0.000	0.042
	B.T. (mean-sd)	< 0	0.000	0.045	< 0	< 0
	B.T. (mean+sd)	0.018	0.000	0.210	0.001	0.236
	N	11	11	11	11	11
FLIP ROCK	B .T. mean	0.384	0.082	0.067	0.012	0.000
	B.T. (mean-sd)	0.148	< 0	0.013	0.002	0.000
	B.T. (mean+sd)	0.654	0.287	0.158	0.030	0.000
	N	13	13	13	13	13
SHAGS	B.T. mean	0.678	0.201	0.013	0.003	0.000
	B.T. (mean-sd)	0.528	0.090	0.006	0.000	0.000
	B.T. (mean+sd)	0.811	0.342	0.024	0.007	0.000
	N	11	11	11	11	11
WINTHROP	B.T. mean	0.199	0.001	0.090	0.000	0.000
	B.T. (mean-sd)	0.062	< 0	0.025	< 0	< 0
	B.T. (mean+sd)	0.389	0.007	0.190	0.003	0.002
	N	10	10	10	10	10

		Red algae-s	Red algae-c	Brown algae-c	Anomia
CAN 5	B.T. mean	0.000	0.000	0.004	0.000
	B.T. (mean-sd)	0.000	0.000	< 0	0.000
	B.T. (mean+sd)	0.000	0.000	0.064	0.000
	N	8	8	8	8
DEER ISLAND	B.T. mean	0.000	0.000	0.003	0.029
	B.T. (mean-sd)	0.000	0.000	< 0	< 0
	B.T. (mean+sd)	0.000	0.000	0.061	0.090
	N	11	11	11	11
FLIP ROCK	B .T. mean	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	< 0
	B.T. (mean+sd)	0.000	0.000	0.000	0.001
	N	13	13	13	13
SHAGS	B.T. mean	0.000	0.000	0.000	0.002
	B.T. (mean-sd)	0.000	0.000	0.000	< 0
	B.T. (mean+sd)	0.000	0.000	0.000	0.015
	N	11	11	11	11
WINTHROP	B.T. mean	0.002	0.013	0.001	0.018
	B.T. (mean-sd)	0.000	< 0	< 0	0.001
	B.T. (mean+sd)	0.006	0.064	0.010	0.055
	N	10	10	10	10

Table 13. Abundance of large mobile fauna, fall 1991.

		Cancer borealis	C. irroratus	Carcinus maenas	Homarus	Juv. H. americanus
CAN 5	B.T. mean (#/25m2)	0.000	0.200	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	-0.166	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.700	0.000	0.000	0.000
	N	4	4	4	4	4
DEER ISLAND	B.T. mean (#/25m2)	2.093	1.468	0.000	6.316	0.357
	B.T. (mean-sd)	0.831	0.933	0.000	2.924	-0.261
	B.T. (mean+sd)	3.774	2.088	0.000	10.866	1.357
	N	4	4	4	4	4
FLIP ROCK	B.T. mean (#/25m2)	3.094	0.433	0.000	1.948	0.625
	B.T. (mean-sd)	1.570	-0.055	0.000	1.190	-0.375
	B.T. (mean+sd)	5.034	1.100	0.000	2.845	2.625
	N	4	4	4	4	4
SHAGS	B.T. Mean (#/25m2)	4.141	0.496	0.000	1.312	0.613
	B.T. (mean-sd)	2.641	-0.327	0.000	0.214	-0.106
	B.T. (mean+sd)	5.932	1.996	0.000	2.912	1.697
	N	4	4	4	4	4
WINTHROP	B.T. mean (#/25m2)	3.765	0.200	1.161	3.373	1.122
	B.T. (mean-sd)	1.765	-0.166	-0.119	1.925	0.240
	B.T. (mean+sd)	6.392	0.700	3.345	5.160	2.345
	N	4	4	4	4	4

		Myoxocephalus aenaeus	*M. octodecemspinosus*	*M. scorpius*	*Pagurus*	*Pholis gunnellus*
CAN 5	B.T. mean (#/25m2)	0.000	0.000	0.000	0.771	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	-0.169	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	2.322	0.000
	N	4	4	4	4	4
DEER ISLAND	B.T. mean (#/25m2)	0.000	0.200	0.000	0.433	0.000
	B.T. (mean-sd)	0.000	-0.166	0.000	-0.055	0.000
	B.T. (mean+sd)	0.000	0.700	0.000	1.100	0.000
	N	4	4	4	4	4
FLIP ROCK	B.T. mean (#/25m2)	0.200	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	-0.166	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.700	0.000	0.000	0.000	0.000
	N	4	4	4	4	4
SHAGS	B.T. Mean (#/25m2)	0.433	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	-0.055	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	1.100	0.000	0.000	0.000	0.000
	N	4	4	4	4	4
WINTHROP	B.T. mean (#/25m2)	0.200	0.000	0.200	0.000	0.200
	B.T. (mean-sd)	-0.166	0.000	-0.166	0.000	-0.166
	B.T. (mean+sd)	0.700	0.000	0.700	0.000	0.700
	N	4	4	4	4	4

		Tautogolabrus adspersus	Juv. T. adspersus	Ulvaria subbifurcata
CAN 5	B.T. mean (#/25m2)	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000
	N	4	4	4
DEER ISLAND	B.T. mean (#/25m2)	0.000	0.000	0.433
	B.T. (mean-sd)	0.000	0.000	-0.055
	B.T. (mean+sd)	0.000	0.000	1.100
	N	4	4	4
FLIP ROCK	B.T. mean (#/25m2)	0.200	3.221	0.000
	B.T. (mean-sd)	-0.166	0.327	0.000
	B.T. (mean+sd)	0.700	8.192	0.000
	N	4	4	4
SHAGS	B.T. Mean (#/25m2)	0.200	0.433	0.700
	B.T. (mean-sd)	-0.166	-0.055	0.200
	B.T. (mean+sd)	0.700	1.100	1.334
	N	4	4	4
WINTHROP	B.T. mean (#/25m2)	0.000	6.457	0.200
	B.T. (mean-sd)	0.000	3.548	-0.166
	B.T. (mean+sd)	0.000	10.147	0.700
	N	4	4	4

Table 14. Abundance of small mobile fauna on cobble substrata, fall 1991.

		Acmaea	*Asterias forbesi*	*A. vulgaris*	Juv. *Asterias* spp.	*Henricia*
CAN 5	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000
	N	10	10	10	10	10
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.000	0.129
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	-0.150
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.490
	N	12	12	12	12	12
FLIP ROCK	B.T. mean	0.000	0.076	0.076	0.076	0.306
	B.T. (mean-sd)	0.000	-0.146	-0.146	-0.146	-0.169
	B.T. (mean+sd)	0.000	0.351	0.351	0.351	0.989
	N	10	10	10	10	10
LOVELL'S	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000
	N	10	10	10	10	10
SHAGS	B.T. mean	0.250	0.177	0.063	0.063	0.250
	B.T. (mean-sd)	-0.180	-0.206	-0.139	-0.139	-0.180
	B.T. (mean+sd)	0.862	0.720	0.309	0.309	0.862
	N	12	12	12	12	12
WINTHROP	B.T. mean	0.063	0.000	0.000	0.063	0.000
	B.T. (mean-sd)	-0.139	0.000	0.000	-0.139	0.000
	B.T. (mean+sd)	0.309	0.000	0.000	0.309	0.000
	N	11	11	11	11	11

		<u>Ischnochiton</u>	<u>Stronglyocentrotus</u>
CAN 5	B.T. mean	0.000	0.000
	B.T. (mean-sd)	0.000	0.000
	B.T. (mean+sd)	0.000	0.000
	N	10	10
DEER ISLAND	B.T. mean	0.000	0.000
	B.T. (mean-sd)	0.000	0.000
	B.T. (mean+sd)	0.000	0.000
	N	12	12
FLIP ROCK	B.T. mean	0.000	0.383
	B.T. (mean-sd)	0.000	-0.298
	B.T. (mean+sd)	0.000	1.546
	N	10	10
LOVELL'S	B.T. mean	0.000	0.000
	B.T. (mean-sd)	0.000	0.000
	B.T. (mean+sd)	0.000	0.000
	N	10	10
SHAGS	B.T. mean	0.177	0.177
	B.T. (mean-sd)	-0.206	-0.206
	B.T. (mean+sd)	0.720	0.720
	N	12	12
WINTHROP	B.T. mean	0.000	0.330
	B.T. (mean-sd)	0.000	-0.269
	B.T. (mean+sd)	0.000	1.299
	N	11	11

Table 15. Abundance of small mobile fauna on horizontal rock substrata, fall 1991.

		Acmaea	Asterias forbesi	A. vulgaris	juv. Asterias spp.	Coryphella
CAN 5	B.T. mean	0.000	0.076	0.131	0.000	0.000
	B.T. (mean-sd)	0.000	-0.146	-0.232	0.000	0.000
	B.T. (mean+sd)	0.000	0.351	0.647	0.000	0.000
	N	10	10	10	10	10
DEER ISLAND	B.T. mean	0.000	0.063	0.000	0.108	0.063
	B.T. (mean-sd)	0.000	-0.139	0.000	-0.222	-0.139
	B.T. (mean+sd)	0.000	0.309	0.000	0.566	0.309
	N	11	11	11	11	11
FLIP ROCK	B.T. mean	0.655	0.183	0.119	0.119	0.000
	B.T. (mean-sd)	-0.213	-0.141	-0.149	-0.149	0.000
	B.T. (mean+sd)	2.104	0.610	0.463	0.463	0.000
	N	13	13	13	13	13
SHAGS	B.T. mean	0.195	0.142	0.000	0.069	0.000
	B.T. (mean-sd)	-0.207	-0.150	0.000	-0.142	0.000
	B.T. (mean+sd)	0.768	0.521	0.000	0.329	0.000
	N	11	11	11	11	11
WINTHROP	B.T. mean	1.279	0.395	0.000	0.000	0.000
	B.T. (mean-sd)	0.289	-0.041	0.000	0.000	0.000
	B.T. (mean+sd)	2.664	0.975	0.000	0.000	0.000
	N	13	13	13	13	13

		Henricia	Ischnochiton	Stronglyocentrotus
CAN 5	B.T. mean	0.076	0.000	0.000
	B.T. (mean-sd)	-0.146	0.000	0.000
	B.T. (mean+sd)	0.351	0.000	0.000
	N	10	10	10
DEER ISLAND	B.T. mean	0.286	0.000	0.000
	B.T. (mean-sd)	-0.337	0.000	0.000
	B.T. (mean+sd)	1.376	0.000	0.000
	N	11	11	11
FLIP ROCK	B.T. mean	0.058	0.183	0.531
	B.T. (mean-sd)	-0.136	-0.141	-0.242
	B.T. (mean+sd)	0.293	0.610	1.820
	N	13	13	13
SHAGS	B.T. mean	0.000	0.479	0.454
	B.T. (mean-sd)	0.000	0.017	-0.220
	B.T. (mean+sd)	0.000	1.087	1.529
	N	11	11	11
WINTHROP	B.T. mean	0.000	0.000	0.446
	B.T. (mean-sd)	0.000	0.000	-0.292
	B.T. (mean+sd)	0.000	0.000	1.718
	N	13	13	13

Table 16. Abundance of small mobile fauna on vertical rock substrata, fall 1991.

		Acmaea	Aeolidia	Asterias forbesi	A. vulgaris	Juv. Asterias spp.
CAN 5	B.T. mean	0.000	0.000	0.166	0.276	0.000
	B.T. (mean-sd)	0.000	0.000	-0.243	-0.203	0.000
	B.T. (mean+sd)	0.000	0.000	0.766	0.981	0.000
	N	8	8	8	8	8
DEER ISLAND	B.T. mean	0.000	0.000	0.276	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	-0.176	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.921	0.000	0.000
	N	11	11	11	11	11
FLIP ROCK	B.T. mean	0.163	0.058	0.058	0.058	1.043
	B.T. (mean-sd)	-0.205	-0.136	-0.136	-0.136	0.125
	B.T. (mean+sd)	0.678	0.293	0.293	0.293	2.368
	N	13	13	13	13	13
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.365
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	-0.266
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	1.393
	N	11	11	11	11	11
WINTHROP	B.T. mean	0.000	0.000	0.000	0.000	0.076
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	-0.146
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.351
	N	10	10	10	10	10

		Henricia	Ischnochiton	Ophioderma	Stronglyocentrotus
CAN 5	B.T. mean	0.096	0.000	0.000	0.394
	B.T. (mean-sd)	-0.153	0.000	0.000	-0.142
	B.T. (mean+sd)	0.412	0.000	0.000	1.172
	N	8	8	8	8
DEER ISLAND	B.T. mean	0.873	0.000	0.161	0.240
	B.T. (mean-sd)	-0.035	0.000	-0.287	-0.259
	B.T. (mean+sd)	2.260	0.000	0.854	1.012
	N	11	11	11	11
FLIP ROCK	B.T. mean	0.058	0.000	0.000	0.502
	B.T. (mean-sd)	-0.136	0.000	0.000	-0.078
	B.T. (mean+sd)	0.293	0.000	0.000	1.327
	N	13	13	13	13
SHAGS	B.T. mean	0.195	0.636	0.000	0.518
	B.T. (mean-sd)	-0.207	-0.117	0.000	-0.312
	B.T. (mean+sd)	0.768	1.790	0.000	2.008
	N	11	11	11	11
WINTHROP	B.T. mean	1.121	0.831	0.000	0.330
	B.T. (mean-sd)	0.013	0.018	0.000	-0.274
	B.T. (mean+sd)	2.849	2.019	0.000	1.311
	N	10	10	10	10

Table 17. Percent cover on cobble substrata, winter 1992.

		Hydroids-s	Hydroids-c	Balanus	Aplidium	Dendrodoa	Halichondria
CAN5	B.T. mean	0.000	0.004	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	<0	<0	0.000	<0	<0	0.000
	B.T. (mean+sd)	0.004	0.042	0.000	0.001	0.001	0.000
	N	14	14	14	14	14	14
DEER ISLAND	B.T. mean	0.000	0.000	0.031	0.006	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.001	<0	<0	0.000
	B.T. (mean+sd)	0.000	0.000	0.095	0.043	0.003	0.000
	N	12	12	12	12	12	12
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.001
	B.T. (mean-sd)	<0	0.000	<0	0.000	0.000	<0
	B.T. (mean+sd)	0.004	0.000	0.003	0.000	0.000	0.015
	N	7	7	7	7	7	7
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	<0	<0	0.000	0.000	<0	0.000
	B.T. (mean+sd)	0.008	0.004	0.000	0.000	0.004	0.000
	N	11	11	11	11	11	11
WINTHROP	B.T. mean	0.000	0.000	0.009	0.000	0.001	0.000
	B.T. (mean-sd)	0.000	0.000	<0	0.000	<0	0.000
	B.T. (mean+sd)	0.000	0.000	0.044	0.000	0.005	0.000
	N	9	9	9	9	9	9

		Encr. Bryo.	Erect Bryo.-s	Erect Bryo.-c	Tube complex	Thick sediment
CAN5	B.T. mean	0.000	0.000	0.000	0.061	0.689
	B.T. (mean-sd)	0.000	0.000	0.000	<0	0.502
	B.T. (mean+sd)	0.000	0.000	0.000	0.362	0.848
	N	14	14	14	14	14
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.000	0.523
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.178
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.855
	N	12	12	12	12	12
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.000	0.040
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.006
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.100
	N	7	7	7	7	7
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.001
	B.T. (mean-sd)	0.000	<0	<0	<0	<0
	B.T. (mean+sd)	0.000	0.001	0.001	0.002	0.023
	N	11	11	11	11	11
WINTHROP	B.T. mean	0.000	0.000	0.000	0.000	0.095
	B.T. (mean-sd)	<0	0.000	0.000	0.000	0.020
	B.T. (mean+sd)	0.007	0.000	0.000	0.000	0.215
	N	9	9	9	9	9

		Hyd/Bryo complex	Peyssonnelia	Lithothamnion	Phymatolithon	Rock
CAN5	B.T. mean	0.226	0.003	0.000	0.000	0.040
	B.T. (mean-sd)	0.080	<0	0.000	0.000	0.004
	B.T. (mean+sd)	0.418	0.015	0.000	0.000	0.113
	N	14	14	14	14	14
DEER ISLAND	B.T. mean	0.011	0.108	0.000	0.023	0.114
	B.T. (mean-sd)	<0	0.013	<0	0.000	0.002
	B.T. (mean+sd)	0.053	0.281	0.002	0.077	0.361
	N	12	12	12	12	12
FLIP ROCK	B.T. mean	0.000	0.014	0.255	0.396	0.163
	B.T. (mean-sd)	<0	0.000	0.101	0.211	0.028
	B.T. (mean+sd)	0.005	0.045	0.450	0.599	0.379
	N	7	7	7	7	7
SHAGS	B.T. mean	0.003	0.003	0.488	0.266	0.095
	B.T. (mean-sd)	<0	<0	0.345	0.128	0.016
	B.T. (mean+sd)	0.029	0.013	0.631	0.433	0.229
	N	11	11	11	11	11
WINTHROP	B.T. mean	0.003	0.035	0.052	0.139	0.355
	B.T. (mean-sd)	<0	0.000	0.009	0.015	0.193
	B.T. (mean+sd)	0.027	0.136	0.128	0.356	0.536
	N	9	9	9	9	9

		Spirorbis	Mussels	Red Algae-s	Red Algae-c	Anomia	Coralline-unid.
CAN5	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	<0	0.000	<0	<0	0.000	0.000
	B.T. (mean+sd)	0.001	0.000	0.002	0.001	0.000	0.000
	N	14	14	14	14	14	14
DEER ISLAND	B.T. mean	0.000	0.001	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	<0	<0	0.000	<0	0.000
	B.T. (mean+sd)	0.000	0.026	0.003	0.000	0.003	0.000
	N	12	12	12	12	12	12
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.001
	B.T. (mean-sd)	0.000	<0	0.000	0.000	<0	<0
	B.T. (mean+sd)	0.000	0.001	0.000	0.000	0.003	0.015
	N	7	7	7	7	7	7
SHAGS	B.T. mean	0.000	0.001	0.000	0.000	0.000	0.009
	B.T. (mean-sd)	0.000	<0	0.000	0.000	<0	<0
	B.T. (mean+sd)	0.000	0.005	0.000	0.000	0.001	0.053
	N	11	11	11	11	11	11
WINTHROP	B.T. mean	0.000	0.003	0.000	0.000	0.000	0.115
	B.T. (mean-sd)	0.000	<0	0.000	0.000	0.000	0.006
	B.T. (mean+sd)	0.000	0.018	0.000	0.000	0.000	0.333
	N	9	9	9	9	9	9

		Coralline-dead	Orange Encr. Sponge	Crepidula	Gravel (100)
CAN5	B.T. mean	0.000	0.000	0.000	0.425
	B.T. (mean-sd)	0.000	0.000	0.000	0.292
	B.T. (mean+sd)	0.000	0.000	0.000	0.564
	N	14	14	14	14
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.260
	B.T. (mean-sd)	<0	0.000	0.000	0.143
	B.T. (mean+sd)	0.004	0.000	0.000	0.398
	N	12	12	12	12
FLIP ROCK	B.T. mean	0.002	0.000	0.004	0.116
	B.T. (mean-sd)	<0	0.000	<0	0.068
	B.T. (mean+sd)	0.009	0.000	0.051	0.174
	N	7	7	7	7
SHAGS	B.T. mean	0.029	0.000	0.000	0.205
	B.T. (mean-sd)	0.002	0.000	<0	0.130
	B.T. (mean+sd)	0.086	0.000	0.003	0.291
	N	11	11	11	11
WINTHROP	B.T. mean	0.000	0.000	0.000	0.273
	B.T. (mean-sd)	0.000	<0	0.000	0.147
	B.T. (mean+sd)	0.000	0.006	0.000	0.422
	N	9	9	9	9

Table 18. Percent cover on horizontal rock substrata, winter 1992.

		Hydroids-s	Hydroids-c	Balanus	Aplidium	Didemnum	Dendrodoa
CAN 5	B.T. mean	0.001	0.019	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	<0	<0	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.007	0.106	0.000	0.000	0.000	0.000
	N	2	2	2	2	2	2
DEER ISLAND	B.T. mean	0.000	0.000	0.002	0.009	0.000	0.001
	B.T. (mean-sd)	0.000	0.000	<0	<0	<0	<0
	B.T. (mean+sd)	0.000	0.000	0.018	0.070	0.003	0.005
	N	8	8	8	8	8	8
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000	0.000
	N	5	5	5	5	5	5
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	<0
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000	0.002
	N	10	10	10	10	10	10
WINTHROP	B.T. mean	0.000	0.000	0.164	0.000	0.000	0.001
	B.T. (mean-sd)	0.000	0.000	0.074	0.000	0.000	<0
	B.T. (mean+sd)	0.000	0.000	0.281	0.000	0.000	0.007
	N	6	6	6	6	6	6

		Tube complex	Thick sediment	Hyd/Bryo complex	Peyssonnelia	Lithothamnion
CAN 5	B.T. mean	0.040	0.666	0.226	0.000	0.000
	B.T. (mean-sd)	<0	0.501	0.025	0.000	0.000
	B.T. (mean+sd)	0.218	0.812	0.549	0.000	0.000
	N	2	2	2	2	2
DEER ISLAND	B.T. mean	0.069	0.652	0.037	0.044	0.000
	B.T. (mean-sd)	<0	0.237	0.009	<0	0.000
	B.T. (mean+sd)	0.396	0.960	0.085	0.234	0.000
	N	8	8	8	8	8
FLIP ROCK	B.T. mean	0.000	0.102	0.000	0.004	0.493
	B.T. (mean-sd)	0.000	0.025	0.000	<0	0.382
	B.T. (mean+sd)	0.000	0.222	0.000	0.038	0.604
	N	5	5	5	5	5
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.806
	B.T. (mean-sd)	0.000	0.000	0.000	<0	0.701
	B.T. (mean+sd)	0.000	0.000	0.000	0.004	0.892
	N	10	10	10	10	10
WINTHROP	B.T. mean	0.014	0.440	0.001	0.018	0.000
	B.T. (mean-sd)	<0	0.211	<0	<0	<0
	B.T. (mean+sd)	0.066	0.685	0.011	0.116	0.005
	N	6	6	6	6	6

		Phymatolithon	Rock	Modiolus	Red Algae-s	Red Algae-c	Green Algae-s
CAN 5	B.T. mean	0.000	0.000	0.000	0.001	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	<0	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.007	0.000	0.000
	N	2	2	2	2	2	2
DEER ISLAND	B.T. mean	0.002	0.003	0.000	0.021	0.000	0.000
	B.T. (mean-sd)	<0	<0	<0	0.004	0.000	0.000
	B.T. (mean+sd)	0.009	0.013	0.001	0.051	0.000	0.000
	N	8	8	8	8	8	8
FLIP ROCK	B.T. mean	0.283	0.035	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.168	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.416	0.132	0.000	0.000	0.000	0.000
	N	5	5	5	5	5	5
SHAGS	B.T. mean	0.177	0.003	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.090	0.001	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.284	0.007	0.000	0.000	0.000	0.000
	N	10	10	10	10	10	10
WINTHROP	B.T. mean	0.092	0.003	0.007	0.057	0.001	0.000
	B.T. (mean-sd)	0.000	<0	<0	0.007	<0	<0
	B.T. (mean+sd)	0.326	0.018	0.060	0.149	0.011	0.002
	N	6	6	6	6	6	6

		Green Algae-c	Brown Algae-s	Brown Algae-c	Coralline-dead	Coralline-unid.
CAN 5	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000
	N	2	2	2	2	2
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000
	N	8	8	8	8	8
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.000	0.008
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	<0
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.045
	N	5	5	5	5	5
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000
	N	10	10	10	10	10
WINTHROP	B.T. mean	0.001	0.000	0.002	0.001	0.006
	B.T. (mean-sd)	<0	<0	<0	<0	<0
	B.T. (mean+sd)	0.008	0.003	0.022	0.004	0.071
	N	6	6	6	6	6

		Anomia	Crepidula	Orange Encr. Sponge
CAN 5	B.T. mean	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000
	N	2	2	2
DEER ISLAND	B.T. mean	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	<0
	B.T. (mean+sd)	0.000	0.000	0.006
	N	8	8	8
FLIP ROCK	B.T. mean	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000
	N	5	5	5
SHAGS	B.T. mean	0.004	0.000	0.000
	B.T. (mean-sd)	0.000	<0	0.000
	B.T. (mean+sd)	0.017	0.003	0.000
	N	10	10	10
WINTHROP	B.T. mean	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000
	N	6	6	6

Table 19. Percent cover on vertical rock substrata, winter 1992.

		Metridium-s	Metridium-c	Hydroids-s	Hydroids-c	Balanus	Aplidium
DEER ISLAND	B.T. mean	0.000	0.000	0.001	0.001	0.001	0.000
	B.T. (mean-sd)	0.000	0.000	<0	<0	<0	0.000
	B.T. (mean+sd)	0.000	0.000	0.008	0.012	0.011	0.000
	N	5	5	5	5	5	5
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	<0	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.001	0.000	0.000	0.000	0.000	0.000
	N	7	7	7	7	7	7
SHAGS	B.T. mean	0.006	0.011	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	<0	<0	0.000	0.000	0.000	<0
	B.T. (mean+sd)	0.094	0.170	0.000	0.000	0.000	0.001
	N	9	9	9	9	9	9
WINTHROP	B.T. mean	0.000	0.000	0.000	0.000	0.076	0.001
	B.T. (mean-sd)	0.000	0.000	<0	<0	0.003	<0
	B.T. (mean+sd)	0.000	0.000	0.001	0.001	0.229	0.009
	N	7	7	7	7	7	7

		Dendrodoa	Didemnum	Halisarca	Tube Complex	Thick sediment	Hyd/Bryo complex
DEER ISLAND	B.T. mean	0.003	0.000	0.000	0.000	0.715	0.010
	B.T. (mean-sd)	0.000	0.000	0.000	<0	0.438	0.001
	B.T. (mean+sd)	0.011	0.000	0.000	0.002	0.924	0.029
	N	5	5	5	5	5	5
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.001	0.122	0.010
	B.T. (mean-sd)	<0	0.000	0.000	<0	0.022	<0
	B.T. (mean+sd)	0.003	0.000	0.000	0.008	0.288	0.072
	N	7	7	7	7	7	7
SHAGS	B.T. mean	0.012	0.000	0.007	0.000	0.082	0.006
	B.T. (mean-sd)	0.000	<0	<0	0.000	<0	<0
	B.T. (mean+sd)	0.043	0.004	0.105	0.000	0.358	0.038
	N	9	9	9	9	9	9
WINTHROP	B.T. mean	0.001	0.000	0.000	0.016	0.473	0.109
	B.T. (mean-sd)	<0	0.000	0.000	0.000	0.206	0.006
	B.T. (mean+sd)	0.006	0.000	0.000	0.058	0.748	0.314
	N	7	7	7	7	7	7

		Red Algae-s	Red Algae-c	Green Algae-s	Green Algae-c	Brown Algae-s	Brown Algae-c
DEER ISLAND	B.T. mean	0.015	0.001	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	<0	<0	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.080	0.010	0.000	0.000	0.000	0.000
	N	5	5	5	5	5	5
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000	0.000
	N	7	7	7	7	7	7
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	<0	<0
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.001	0.007
	N	9	9	9	9	9	9
WINTHROP	B.T. mean	0.002	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	<0	0.000	<0	<0	<0	<0
	B.T. (mean+sd)	0.011	0.000	0.001	0.001	0.001	0.001
	N	7	7	7	7	7	7

		Anomia	Coralline-unid.	Orange Encr. Sponge	Crepidula
DEER ISLAND	B.T. mean	0.000	0.002	0.000	0.000
	B.T. (mean-sd)	0.000	<0	0.000	0.000
	B.T. (mean+sd)	0.000	0.023	0.000	0.000
	N	5	5	5	5
FLIP ROCK	B.T. mean	0.004	0.004	0.017	0.000
	B.T. (mean-sd)	0.001	<0	<0	0.000
	B.T. (mean+sd)	0.009	0.035	0.147	0.000
	N	7	7	7	7
SHAGS	B.T. mean	0.006	0.000	0.000	0.000
	B.T. (mean-sd)	<0	0.000	<0	0.000
	B.T. (mean+sd)	0.024	0.000	0.007	0.000
	N	9	9	9	9
WINTHROP	B.T. mean	0.000	0.009	0.000	0.000
	B.T. (mean-sd)	<0	<0	0.000	<0
	B.T. (mean+sd)	0.001	0.112	0.000	0.001
	N	7	7	7	7

Table 20. Abundance of large mobile fauna, winter 1992.

		Buccinum	Cancer borealis	C. Irroratus	Homarus
CAN 5	B.T. mean (#/25m2)	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000
	N	4	4	4	4
DEER ISLAND	B.T. mean (#/25m2)	0.000	0.200	0.357	4.633
	B.T. (mean-sd)	0.000	-0.166	-0.261	1.952
	B.T. (mean+sd)	0.000	0.700	1.357	8.292
	N	4	4	4	4
FLIP ROCK	B.T. mean (#/25m2)	0.000	0.000	1.500	0.700
	B.T. (mean-sd)	0.000	0.000	-0.143	0.200
	B.T. (mean+sd)	0.000	0.000	4.476	1.334
	N	4	4	4	4
SHAGS	B.T. mean (#/25m2)	0.000	0.357	0.000	0.200
	B.T. (mean-sd)	0.000	-0.261	0.000	-0.166
	B.T. (mean+sd)	0.000	1.357	0.000	0.700
	N	4	4	4	4
WINTHROP	B.T. mean (#/25m2)	0.200	1.965	0.000	2.093
	B.T. (mean-sd)	-0.166	0.410	0.000	0.831
	B.T. (mean+sd)	0.700	4.280	0.000	3.774
	N	4	4	4	4

		Juv. H. americanus	Hyas	Myoxocephalus aenaeus	Pagurus
CAN 5	B.T. mean (#/25m2)	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000
	N	4	4	4	4
DEER ISLAND	B.T. mean (#/25m2)	0.200	0.000	0.200	0.200
	B.T. (mean-sd)	-0.166	0.000	-0.166	-0.166
	B.T. (mean+sd)	0.700	0.000	0.700	0.700
	N	4	4	4	4
FLIP ROCK	B.T. mean (#/25m2)	0.200	0.200	0.000	0.000
	B.T. (mean-sd)	-0.166	-0.166	0.000	0.000
	B.T. (mean+sd)	0.700	0.700	0.000	0.000
	N	4	4	4	4
SHAGS	B.T. mean (#/25m2)	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000
	N	4	4	4	4
WINTHROP	B.T. mean (#/25m2)	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000
	N	4	4	4	4

Ulvaria subbifurcata

CAN 5	B.T. mean (#/25m2)	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	4
DEER ISLAND	B.T. mean (#/25m2)	0.200
	B.T. (mean-sd)	-0.166
	B.T. (mean+sd)	0.700
	N	4
FLIP ROCK	B.T. mean (#/25m2)	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	4
SHAGS	B.T. mean (#/25m2)	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	4
WINTHROP	B.T. mean (#/25m2)	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	4

Table 21. Abundance of small mobile fauna on cobble substrata, winter 1992.

		Acmaea	Asterias spp.	juv. Asterias	Henricia	Ischnochiton	Polychaete
CAN 5	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.054
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	-0.133
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000	0.279
	N	14	14	14	14	14	14
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.200	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	-0.137	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.646	0.000	0.000
	N	12	12	12	12	12	12
FLIP ROCK	B.T. mean	0.110	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	-0.157	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.454	0.000	0.000	0.000	0.000	0.000
	N	7	7	7	7	7	7
SHAGS	B.T. mean	0.000	0.433	0.069	0.069	0.000	0.000
	B.T. (mean-sd)	0.000	-0.258	-0.142	-0.142	0.000	0.000
	B.T. (mean+sd)	0.000	1.571	0.329	0.329	0.000	0.000
	N	11	11	11	11	11	11
WINTHROP	B.T. mean	0.000	0.000	0.000	0.000	0.147	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	-0.237	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.700	0.000
	N	9	9	9	9	9	9

		Stronglyocentrotus	juv. Stronglyocentrotus
CAN 5	B.T. mean	0.000	0.000
	B.T. (mean-sd)	0.000	0.000
	B.T. (mean+sd)	0.000	0.000
	N	14	14
DEER ISLAND	B.T. mean	0.274	0.000
	B.T. (mean-sd)	-0.110	0.000
	B.T. (mean+sd)	0.787	0.000
	N	12	12
FLIP ROCK	B.T. mean	1.335	0.192
	B.T. (mean-sd)	0.547	-0.248
	B.T. (mean+sd)	2.341	0.851
	N	7	7
SHAGS	B.T. mean	0.069	0.000
	B.T. (mean-sd)	-0.142	0.000
	B.T. (mean+sd)	0.329	0.000
	N	11	11
WINTHROP	B.T. mean	0.274	0.000
	B.T. (mean-sd)	-0.115	0.000
	B.T. (mean+sd)	0.796	0.000
	N	9	9

Table 22. Abundance of small mobile fauna on horizontal rock substrata, winter 1992.

		Acmaea	Asterias forbesi	Asterias spp.	Henricia	Stronglyocentrotus
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.276	0.166
	B.T. (mean-sd)	0.000	0.000	0.000	-0.203	-0.243
	B.T. (mean+sd)	0.000	0.000	0.000	0.981	0.766
	N	8	8	8	8	8
FLIP ROCK	B.T. mean	0.336	0.000	0.000	0.000	1.583
	B.T. (mean-sd)	-0.102	0.000	0.000	0.000	0.350
	B.T. (mean+sd)	0.934	0.000	0.000	0.000	3.359
	N	5	5	5	5	5
SHAGS	B.T. mean	0.671	0.076	0.157	0.000	0.266
	B.T. (mean-sd)	-0.272	-0.146	-0.149	0.000	-0.260
	B.T. (mean+sd)	2.345	0.351	0.559	0.000	1.090
	N	10	10	10	10	10
WINTHROP	B.T. mean	0.000	0.000	0.000	0.274	0.475
	B.T. (mean-sd)	0.000	0.000	0.000	-0.125	-0.242
	B.T. (mean+sd)	0.000	0.000	0.000	0.816	1.652
	N	6	6	6	6	6

		Juv. Stronglyocentrotus
DEER ISLAND	B.T. mean	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	8
FLIP ROCK	B.T. mean	2.129
	B.T. (mean-sd)	-0.166
	B.T. (mean+sd)	6.602
	N	5
SHAGS	B.T. mean	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	10
WINTHROP	B.T. mean	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	6

Table 23. Abundance of small mobile fauna on vertical rock substrata, winter 1992.

		Acmaea	Asterias spp.	juv. Asterias	Henricia	Ischnochiton	Stronglyocentrotus
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.157	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	-0.165	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.586	0.000	0.000
	N	5	5	5	5	5	5
FLIP ROCK	B.T. mean	0.192	0.000	0.650	0.000	0.000	0.735
	B.T. (mean-sd)	-0.248	0.000	-0.164	0.000	0.000	-0.323
	B.T. (mean+sd)	0.851	0.000	1.947	0.000	0.000	2.744
	N	7	7	7	7	7	7
SHAGS	B.T. mean	0.000	0.147	0.454	0.000	0.000	0.085
	B.T. (mean-sd)	0.000	-0.237	-0.092	0.000	0.000	-0.149
	B.T. (mean+sd)	0.000	0.700	1.228	0.000	0.000	0.378
	N	9	9	9	9	9	9
WINTHROP	B.T. mean	0.000	0.110	0.000	1.247	0.231	0.889
	B.T. (mean-sd)	0.000	-0.157	0.000	0.243	-0.137	0.171
	B.T. (mean+sd)	0.000	0.454	0.000	2.674	0.727	1.866
	N	7	7	7	7	7	7

Juv. Stronglyocentrotus

DEER ISLAND	B.T. mean	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	5
FLIP ROCK	B.T. mean	1.441
	B.T. (mean-sd)	-0.495
	B.T. (mean+sd)	7.681
	N	7
SHAGS	B.T. mean	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	9
WINTHROP	B.T. mean	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	7

		Metridium-s	Hydroids-s	Hydroids-c	*Balanus*	*Aplidium*	*Dendrodoa*
CAN 5	B.T. mean	0.000	0.000	0.001	0.000	0.002	0.000
	B.T. (mean-sd)	0.000	<0	<0	0.000	<0	<0
	B.T. (mean+sd)	0.000	0.002	0.007	0.000	0.013	0.001
	N	13	13	13	13	13	13
DEER ISLAND	B.T. mean	0.000	0.000	0.001	0.001	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	< 0	< 0	< 0	< 0
	B.T. (mean+sd)	0.000	0.000	0.010	0.007	0.001	0.001
	N	12	12	12	12	12	12
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.001	0.000	0.001
	B.T. (mean-sd)	<0	0.000	0.000	<0	0.000	<0
	B.T. (mean+sd)	0.001	0.000	0.000	0.007	0.000	0.005
	N	12	12	12	12	12	12
SHAGS	B.T. mean	0.000	0.000	0.000	0.014	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.001	0.000	<0
	B.T. (mean+sd)	0.000	0.000	0.000	0.044	0.000	0.001
	N	10	10	10	10	10	10
WINTHROP	B.T. mean	0.000	0.000	0.000	0.003	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	<0	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.035	0.000	0.000
	N	11	11	11	11	11	11

		Hyd/Bryo complex	*Peyssonnelia*	*Lithothamnion*	*Phymatolithon*	Rock	*Spirorbis*
CAN 5	B.T. mean	0.660	0.001	0.000	0.000	0.015	0.000
	B.T. (mean-sd)	0.468	<0	0.000	<0	<0	0.000
	B.T. (mean+sd)	0.828	0.007	0.000	0.002	0.092	0.000
	N	13	13	13	13	13	13
DEER ISLAND	B.T. mean	0.183	0.134	0.171	0.095	0.200	0.001
	B.T. (mean-sd)	0.062	0.042	0.092	0.021	0.106	< 0
	B.T. (mean+sd)	0.349	0.267	0.268	0.214	0.316	0.005
	N	12	12	12	12	12	12
FLIP ROCK	B.T. mean	0.151	0.059	0.379	0.136	0.026	0.001
	B.T. (mean-sd)	0.054	0.001	0.186	0.074	0.002	<0
	B.T. (mean+sd)	0.285	0.204	0.594	0.212	0.075	0.005
	N	12	12	12	12	12	12
SHAGS	B.T. mean	0.044	0.000	0.171	0.325	0.058	0.000
	B.T. (mean-sd)	0.001	0.000	0.039	0.200	0.005	0.000
	B.T. (mean+sd)	0.149	0.000	0.370	0.465	0.166	0.000
	N	10	10	10	10	10	10
WINTHROP	B.T. mean	0.015	0.046	0.081	0.034	0.185	0.000
	B.T. (mean-sd)	<0	0.003	0.014	0.000	0.079	<0
	B.T. (mean+sd)	0.100	0.138	0.197	0.129	0.323	0.002
	N	11	11	11	11	11	11

		Mussels	Red algae-s	Red algae-c	Green Algae-s	Brown Algae-s	Brown algae-c
CAN 5	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000	0.000
	N	13	13	13	13	13	13
DEER ISLAND	B.T. mean	0.060	0.000	0.006	0.000	0.000	0.007
	B.T. (mean-sd)	0.006	< 0	< 0	0.000	0.000	< 0
	B.T. (mean+sd)	0.162	0.002	0.030	0.000	0.000	0.056
	N	12	12	12	12	12	12
FLIP ROCK	B.T. mean	0.000	0.021	0.003	0.000	0.000	0.000
	B.T. (mean-sd)	<0	<0	<0	0.000	0.000	0.000
	B.T. (mean+sd)	0.005	0.101	0.016	0.000	0.000	0.000
	N	12	12	12	12	12	12
SHAGS	B.T. mean	0.000	0.000	0.000	0.003	0.000	0.000
	B.T. (mean-sd)	0.000	<0	<0	<0	<0	<0
	B.T. (mean+sd)	0.000	0.004	0.009	0.059	0.001	0.001
	N	10	10	10	10	10	10
WINTHROP	B.T. mean	0.452	0.000	0.000	0.000	0.000	0.032
	B.T. (mean-sd)	0.145	<0	<0	0.000	0.000	<0
	B.T. (mean+sd)	0.781	0.001	0.004	0.000	0.000	0.212
	N	11	11	11	11	11	11

		Coralline	*Anomia*	Coralline-dead	*Crepidula*	Unid. Red Crust	Anemone
CAN 5	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	<0	0.000	<0	0.000	0.000
	B.T. (mean+sd)	0.000	0.001	0.000	0.001	0.000	0.000
	N	13	13	13	13	13	13
DEER ISLAND	B.T. mean	0.002	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	< 0	< 0	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.023	0.004	0.000	0.000	0.000	0.000
	N	12	12	12	12	12	12
FLIP ROCK	B.T. mean	0.007	0.001	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	<0	<0	0.000	0.000	<0	<0
	B.T. (mean+sd)	0.031	0.008	0.000	0.000	0.004	0.001
	N	12	12	12	12	12	12
SHAGS	B.T. mean	0.000	0.000	0.014	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	<0	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.080	0.000	0.000	0.000
	N	10	10	10	10	10	10
WINTHROP	B.T. mean	0.006	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	<0	<0	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.038	0.003	0.000	0.000	0.000	0.000
	N	11	11	11	11	11	11

		Gravel
CAN 5	B.T. mean	0.152
	B.T. (mean-sd)	0.050
	B.T. (mean+sd)	0.296
	N	13
DEER ISLAND	B.T. mean	0.194
	B.T. (mean-sd)	0.082
	B.T. (mean+sd)	0.338
	N	12
FLIP ROCK	B.T. mean	0.139
	B.T. (mean-sd)	0.716
	B.T. (mean+sd)	0.284
	N	12
SHAGS	B.T. mean	0.050
	B.T. (mean-sd)	0.002
	B.T. (mean+sd)	0.156
	N	10
WINTHROP	B.T. mean	0.322
	B.T. (mean-sd)	0.209
	B.T. (mean+sd)	0.447
	N	11

Table 25. Percent cover on horizontal rock substrata, spring 1992.

		Hydroids-s	Hydroids-c	*Balanus*	*Aplidium*	*Didemnum*	*Dendrodoa*
DEER ISLAND	B.T. mean	0.000	0.000	0.003	0.009	0.000	0.005
	B.T. (mean-sd)	< 0	< 0	< 0	< 0	0.000	0.000
	B.T. (mean+sd)	0.001	0.001	0.015	0.055	0.000	0.014
	N	12	12	12	12	12	12
FLIP ROCK	B.T. mean	0.000	0.000	0.003	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	<0	<0	0.000	<0
	B.T. (mean+sd)	0.000	0.000	0.013	0.001	0.000	0.003
	N	11	11	11	11	11	11
SHAGS	B.T. mean	0.000	0.000	0.001	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	<0	0.000	0.000	<0
	B.T. (mean+sd)	0.000	0.000	0.004	0.000	0.000	0.001
	N	14	14	14	14	14	14
WINTHROP	B.T. mean	0.000	0.000	0.068	0.000	0.000	0.001
	B.T. (mean-sd)	<0	<0	<0	<0	<0	<0
	B.T. (mean+sd)	0.003	0.002	0.260	0.001	0.001	0.006
	N	12	12	12	12	12	12

		Molgula	*Halichondria*	*Halisarca*	Erect bryo-c	Tube Complex	Thick sediment
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.153
	B.T. (mean-sd)	0.000	0.000	0.000	< 0	< 0	0.077
	B.T. (mean+sd)	0.000	0.000	0.000	0.001	0.004	0.249
	N	12	12	12	12	12	12
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.064
	B.T. (mean-sd)	0.000	0.000	<0	0.000	<0	0.012
	B.T. (mean+sd)	0.000	0.000	0.006	0.000	0.001	0.153
	N	11	11	11	11	11	11
SHAGS	B.T. mean	0.000	0.000	0.008	0.000	0.000	0.023
	B.T. (mean-sd)	0.000	0.000	<0	0.000	0.000	<0
	B.T. (mean+sd)	0.000	0.000	0.053	0.000	0.000	0.172
	N	14	14	14	14	14	14
WINTHROP	B.T. mean	0.000	0.003	0.000	0.000	0.000	0.071
	B.T. (mean-sd)	<0	<0	0.000	0.000	<0	0.003
	B.T. (mean+sd)	0.001	0.043	0.000	0.000	0.001	0.220
	N	12	12	12	12	12	12

		Hyd/Bryo complex	*Peyssonnelia*	*Lithothamnion*	*Phymatolithon*	Rock
DEER ISLAND	B.T. mean	0.486	0.102	0.050	0.010	0.021
	B.T. (mean-sd)	0.295	0.005	0.002	< 0	< 0
	B.T. (mean+sd)	0.679	0.302	0.156	0.049	0.093
	N	12	12	12	12	12
FLIP ROCK	B.T. mean	0.024	0.118	0.415	0.187	0.026
	B.T. (mean-sd)	<0	0.047	0.204	0.077	0.002
	B.T. (mean+sd)	0.158	0.217	0.644	0.332	0.079
	N	11	11	11	11	11
SHAGS	B.T. mean	0.001	0.013	0.668	0.085	0.053
	B.T. (mean-sd)	<0	0.000	0.439	0.035	0.003
	B.T. (mean+sd)	0.016	0.047	0.862	0.155	0.157
	N	14	14	14	14	14
WINTHROP	B.T. mean	0.006	0.097	0.136	0.053	0.204
	B.T. (mean-sd)	<0	0.006	0.059	0.000	0.020
	B.T. (mean+sd)	0.041	0.275	0.239	0.186	0.512
	N	12	12	12	12	12

		Spirorbis	Mussels	Red algae-s	Red algae-c	Green Algae-s	Brown algae-c
DEER ISLAND	B.T. mean	0.002	0.000	0.001	0.190	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	< 0	0.022	0.000	< 0
	B.T. (mean+sd)	0.006	0.000	0.006	0.468	0.000	0.010
	N	12	12	12	12	12	12
FLIP ROCK	B.T. mean	0.007	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	<0	0.000	<0
	B.T. (mean+sd)	0.023	0.000	0.000	0.001	0.000	0.003
	N	11	11	11	11	11	11
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	<0	0.000	<0	0.000
	B.T. (mean+sd)	0.000	0.000	0.001	0.000	0.011	0.000
	N	14	14	14	14	14	14
WINTHROP	B.T. mean	0.000	0.003	0.013	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	<0	<0	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.056	0.115	0.000	0.000	0.000
	N	12	12	12	12	12	12

		Anomia	Coralline	*Boltenia*	Brown Crust	Coralline-dead	Balanus-dead
DEER ISLAND	B.T. mean	0.003	0.001	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	< 0	< 0	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.014	0.014	0.000	0.000	0.000	0.000
	N	12	12	12	12	12	12
FLIP ROCK	B.T. mean	0.001	0.000	0.000	0.006	0.000	0.000
	B.T. (mean-sd)	<0	0.000	0.000	<0	0.000	0.000
	B.T. (mean+sd)	0.006	0.000	0.000	0.062	0.000	0.000
	N	11	11	11	11	11	11
SHAGS	B.T. mean	0.001	0.003	0.000	0.000	0.003	0.000
	B.T. (mean-sd)	<0	<0	<0	0.000	<0	0.000
	B.T. (mean+sd)	0.004	0.032	0.001	0.000	0.024	0.000
	N	14	14	14	14	14	14
WINTHROP	B.T. mean	0.001	0.000	0.000	0.000	0.000	0.001
	B.T. (mean-sd)	<0	0.000	0.000	0.000	0.000	<0
	B.T. (mean+sd)	0.008	0.000	0.000	0.000	0.000	0.009
	N	12	12	12	12	12	12

		Orange enc. sponge
DEER ISLAND	B.T. mean	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	12
FLIP ROCK	B.T. mean	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	11
SHAGS	B.T. mean	0.000
	B.T. (mean-sd)	0.000
	B.T. (mean+sd)	0.000
	N	14
WINTHROP	B.T. mean	0.000
	B.T. (mean-sd)	<0
	B.T. (mean+sd)	0.003
	N	12

Table 26. Percent cover on vertical rock substrata, spring 1992.

		Metridium-s	***Metridium-c***	Hydroids-s	Hydroids-c	*Balanus*	*Aplidium*
CAN 5	B.T. mean	0.000	0.000	0.005	0.012	0.008	0.001
	B.T. (mean-sd)	0.000	0.000	0.005	<0	<0	<0
	B.T. (mean+sd)	0.000	0.000	0.005	0.058	0.062	0.008
	N	3	3	3	3	3	3
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.001	0.009	0.011
	B.T. (mean-sd)	0.000	0.000	<0	<0	<0	<0
	B.T. (mean+sd)	0.000	0.000	0.002	0.009	0.039	0.054
	N	13	13	13	13	13	13
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.000	0.003	0.003
	B.T. (mean-sd)	0.000	0.000	<0	<0	<0	0.000
	B.T. (mean+sd)	0.000	0.000	0.004	0.001	0.027	0.011
	N	11	11	11	11	11	11
SHAGS	B.T. mean	0.032	0.000	0.001	0.001	0.127	0.019
	B.T. (mean-sd)	<0	<0	<0	<0	0.009	0.002
	B.T. (mean+sd)	0.220	0.002	0.007	0.006	0.353	0.050
	N	11	11	11	11	11	11
WINTHROP	BT Mean	0.000	0.000	0.000	0.000	0.063	0.000
	BT adj mean-sd	0.000	0.000	<0	<0	0.018	<0
	BT mean+sd	0.000	0.000	0.002	0.002	0.131	0.003
	N	9	9	9	9	9	9

		Didemnum	*Dendrodoa*	*Molgula*	*Halichondria*	*Halisarca*	Encr Bryo
CAN 5	B.T. mean	0.000	0.000	0.000	0.070	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.001	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.239	0.000	0.000
	N	3	3	3	3	3	3
DEER ISLAND	B.T. mean	0.002	0.012	0.000	0.000	0.000	0.003
	B.T. (mean-sd)	<0	0.001	0.000	0.000	0.000	<0
	B.T. (mean+sd)	0.009	0.034	0.000	0.000	0.000	0.014
	N	13	13	13	13	13	13
FLIP ROCK	B.T. mean	0.000	0.001	0.000	0.000	0.004	0.000
	B.T. (mean-sd)	0.000	<0	<0	0.000	<0	0.000
	B.T. (mean+sd)	0.000	0.004	0.001	0.000	0.040	0.000
	N	11	11	11	11	11	11
SHAGS	B.T. mean	0.002	0.002	0.001	0.000	0.000	0.000
	B.T. (mean-sd)	<0	0.000	<0	0.000	<0	<0
	B.T. (mean+sd)	0.011	0.008	0.007	0.000	0.004	0.004
	N	11	11	11	11	11	11
WINTHROP	BT Mean	0.000	0.001	0.000	0.000	0.000	0.000
	BT adj mean-sd	<0	<0	0.000	0.000	0.000	0.000
	BT mean+sd	0.002	0.006	0.000	0.000	0.000	0.000
	N	9	9	9	9	9	9

		Erect bryo-c	Tube Complex	Thick sediment	Hyd/Bryo complex	*Peyssonnella*
CAN 5	B.T. mean	0.000	0.000	0.265	0.596	0.000
	B.T. (mean-sd)	0.000	0.000	0.228	0.532	0.000
	B.T. (mean+sd)	0.000	0.000	0.303	0.659	0.000
	N	3	3	3	3	3
DEER ISLAND	B.T. mean	0.000	0.000	0.016	0.296	0.293
	B.T. (mean-sd)	<0	<0	0.001	0.115	0.046
	B.T. (mean+sd)	0.002	0.002	0.046	0.519	0.641
	N	13	13	13	13	13
FLIP ROCK	B.T. mean	0.000	0.000	0.008	0.036	0.056
	B.T. (mean-sd)	0.000	<0	0.000	0.001	<0
	B.T. (mean+sd)	0.000	0.001	0.033	0.120	0.239
	N	11	11	11	11	11
SHAGS	B.T. mean	0.000	0.000	0.125	0.129	0.033
	B.T. (mean-sd)	0.000	0.000	0.011	<0	<0
	B.T. (mean+sd)	0.000	0.000	0.337	0.497	0.133
	N	11	11	11	11	11
WINTHROP	BT Mean	0.000	0.000	0.423	0.001	0.152
	BT adj mean-sd	0.000	0.000	0.167	<0	0.041
	BT mean+sd	0.000	0.000	0.703	0.014	0.316
	N	9	9	9	9	9

		Lithothamnion	*Phymatolithon*	Rock	*Spirorbis*	Mussels	Red algae-s
CAN 5	B.T. mean	0.000	0.000	0.001	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	<0	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.004	0.000	0.000	0.000
	N	3	3	3	3	3	3
DEER ISLAND	B.T. mean	0.050	0.069	0.003	0.007	0.000	0.000
	B.T. (mean-sd)	0.001	<0	<0	0.000	0.000	<0
	B.T. (mean+sd)	0.163	0.289	0.011	0.025	0.000	0.001
	N	13	13	13	13	13	13
FLIP ROCK	B.T. mean	0.419	0.121	0.044	0.003	0.000	0.000
	B.T. (mean-sd)	0.143	0.007	0.006	<0	0.000	<0
	B.T. (mean+sd)	0.727	0.342	0.113	0.014	0.000	0.002
	N	11	11	11	11	11	11
SHAGS	B.T. mean	0.008	0.141	0.004	0.000	0.000	0.000
	B.T. (mean-sd)	<0	0.003	<0	0.000	0.000	<0
	B.T. (mean+sd)	0.056	0.430	0.034	0.000	0.000	0.002
	N	11	11	11	11	11	11
WINTHROP	BT Mean	0.158	0.001	0.025	0.000	0.014	0.001
	BT adj mean-sd	0.020	<0	0.001	0.000	<0	<0
	BT mean+sd	0.391	0.016	0.123	0.000	0.090	0.011
	N	9	9	9	9	9	9

		Red algae-c	Coralline	Anemone	*Hydractinia*	*Anomia*	Coralline-dead
CAN 5	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000	0.000
	N	3	3	3	3	3	3
DEER ISLAND	B.T. mean	0.009	0.000	0.000	0.000	0.008	0.000
	B.T. (mean-sd)	<0	0.000	0.000	0.000	<0	0.000
	B.T. (mean+sd)	0.052	0.000	0.000	0.000	0.034	0.000
	N	13	13	13	13	13	13
FLIP ROCK	B.T. mean	0.000	0.030	0.000	0.003	0.000	0.000
	B.T. (mean-sd)	<0	<0	<0	<0	<0	0.000
	B.T. (mean+sd)	0.002	0.179	0.001	0.055	0.001	0.000
	N	11	11	11	11	11	11
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.005
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	<0
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000	0.026
	N	11	11	11	11	11	11
WINTHROP	BT Mean	0.000	0.000	0.000	0.000	0.000	0.000
	BT adj mean-sd	0.000	0.000	0.000	0.000	0.000	0.000
	BT mean+sd	0.000	0.000	0.000	0.000	0.000	0.000
	N	9	9	9	9	9	9

		Halocynthia	*Boltenia echinata*	White sponge	Yellow organism	Unknown 1-orange
CAN 5	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000
	N	3	3	3	3	3
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	<0	<0	<0	<0
	B.T. (mean+sd)	0.000	0.002	0.003	0.001	0.001
	N	13	13	13	13	13
FLIP ROCK	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000
	N	11	11	11	11	11
SHAGS	B.T. mean	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	<0	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.005	0.000	0.000	0.000	0.000
	N	11	11	11	11	11
WINTHROP	BT Mean	0.000	0.000	0.000	0.000	0.000
	BT adj mean-sd	0.000	0.000	0.000	0.000	0.000
	BT mean+sd	0.000	0.000	0.000	0.000	0.000
	N	9	9	9	9	9

		Unknown 2- orange	Unknown 3-orange
CAN 5	B.T. mean	0.000	0.000
	B.T. (mean-sd)	0.000	0.000
	B.T. (mean+sd)	0.000	0.000
	N	3	3
DEER ISLAND	B.T. mean	0.000	0.000
	B.T. (mean-sd)	0.000	0.000
	B.T. (mean+sd)	0.000	0.000
	N	13	13
FLIP ROCK	B.T. mean	0.000	0.000
	B.T. (mean-sd)	0.000	<0
	B.T. (mean+sd)	0.000	0.007
	N	11	11
SHAGS	B.T. mean	0.000	0.000
	B.T. (mean-sd)	0.000	0.000
	B.T. (mean+sd)	0.000	0.000
	N	11	11
WINTHROP	BT Mean	0.000	0.000
	BT adj mean-sd	<0	0.000
	BT mean+sd	0.007	0.000
	N	9	9

Table 27. Abundance of large mobile fauna, spring 1992.

		Buccinum	Cancer borealis	C. irroratus	Homarus americanus	Juv. H. americanus
CAN 5	B.T. mean (#/25m2)	0.000	0.433	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	-0.055	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	1.100	0.000	0.000	0.000
	N	4	4	4	4	4
DEER ISLAND	B.T. mean (#/25m2)	0.000	2.445	0.980	7.364	0.200
	B.T. (mean-sd)	0.000	1.591	-0.120	5.159	-0.166
	B.T. (mean+sd)	0.000	3.445	2.800	9.932	0.700
	N	4	4	4	4	4
FLIP ROCK	B.T. mean (#/25m2)	2.408	1.241	0.000	4.241	0.000
	B.T. (mean-sd)	0.560	0.036	0.000	3.766	0.000
	B.T. (mean+sd)	5.169	3.137	0.000	4.741	0.000
	N	4	4	4	4	4
SHAGS	B.T. mean (#/25m2)	0.000	1.677	0.200	2.805	0.200
	B.T. (mean-sd)	0.000	0.852	-0.166	1.213	-0.166
	B.T. (mean+sd)	0.000	2.697	0.700	4.917	0.700
	N	4	4	4	4	4
WINTHROP	B.T. mean (#/25m2)	1.000	2.479	0.000	3.944	0.000
	B.T. (mean-sd)	1.000	1.814	0.000	2.642	0.000
	B.T. (mean+sd)	1.000	3.228	0.000	5.470	0.000
	N	2	2	2	2	2

		Myoxocephalus aenaeus	Pholis gunnellus	Pseudopleuronectes americanus
CAN 5	B.T. mean (#/25m2)	0.000	0.200	0.613
	B.T. (mean-sd)	0.000	-0.166	-0.106
	B.T. (mean+sd)	0.000	0.700	1.697
	N	4	4	4
DEER ISLAND	B.T. mean (#/25m2)	0.200	0.000	0.000
	B.T. (mean-sd)	-0.166	0.000	0.000
	B.T. (mean+sd)	0.700	0.000	0.000
	N	4	4	4
FLIP ROCK	B.T. mean (#/25m2)	0.000	0.200	0.000
	B.T. (mean-sd)	0.000	-0.166	0.000
	B.T. (mean+sd)	0.000	0.700	0.000
	N	4	4	4
SHAGS	B.T. mean (#/25m2)	0.200	0.000	0.200
	B.T. (mean-sd)	-0.166	0.000	-0.166
	B.T. (mean+sd)	0.700	0.000	0.700
	N	4	4	4
WINTHROP	B.T. mean (#/25m2)	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000
	N	2	2	2

		Tautogolabrus adspersus	juv. T. adspersus	Ulvaria subbifurcata	skate
CAN 5	B.T. mean (#/25m2)	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000
	N	4	4	4	4
DEER ISLAND	B.T. mean (#/25m2)	0.000	0.357	0.200	0.000
	B.T. (mean-sd)	0.000	-0.261	-0.166	0.000
	B.T. (mean+sd)	0.000	1.357	0.700	0.000
	N	4	4	4	4
FLIP ROCK	B.T. mean (#/25m2)	0.200	0.200	0.000	0.000
	B.T. (mean-sd)	-0.166	-0.166	0.000	0.000
	B.T. (mean+sd)	0.700	0.700	0.000	0.000
	N	4	4	4	4
SHAGS	B.T. mean (#/25m2)	0.000	0.613	0.000	0.200
	B.T. (mean-sd)	0.000	-0.106	0.000	-0.166
	B.T. (mean+sd)	0.000	1.697	0.000	0.700
	N	4	4	4	4
WINTHROP	B.T. mean (#/25m2)	0.433	1.896	0.809	0.000
	B.T. (mean-sd)	-0.140	0.690	-0.223	0.000
	B.T. (mean+sd)	1.274	3.519	2.605	0.000
	N	2	2	2	2

Table 28. Abundance of small mobile fauna on cobble substrata, spring 1992.

		Acmaea	Aeolidia	Asterias vulgaris	Asterias sp.	Juv. Asterias	Buccinum
CAN 5	B.T. mean	0.000	0.000	0.000	0.058	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	-0.136	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.293	0.000	0.000
	N	13	13	13	13	13	13
DEER ISLAND	B.T. mean	0.200	0.063	0.063	0.000	0.000	0.000
	B.T. (mean-sd)	-0.359	-0.410	-0.410	0.000	0.000	0.000
	B.T. (mean+sd)	0.646	0.309	0.309	0.000	0.000	0.000
	N	12	12	12	12	12	12
FLIP ROCK	B.T. mean	0.371	0.000	0.063	0.000	0.063	0.000
	B.T. (mean-sd)	-0.188	0.000	-0.139	0.000	-0.139	0.000
	B.T. (mean+sd)	1.211	0.000	0.309	0.000	0.309	0.000
	N	12	12	12	12	12	12
SHAGS	B.T. mean	0.266	0.000	0.076	0.076	0.000	0.000
	B.T. (mean-sd)	-0.260	0.000	-0.146	-0.146	0.000	0.000
	B.T. (mean+sd)	1.090	0.000	0.351	0.351	0.000	0.000
	N	10	10	10	10	10	10
WINTHROP	B.T. mean	0.069	0.000	0.000	0.000	0.069	0.069
	B.T. (mean-sd)	-0.142	0.000	0.000	0.000	-0.142	-0.142
	B.T. (mean+sd)	0.329	0.000	0.000	0.000	0.329	0.329
	N	11	11	11	11	11	11

		Cancer borealis	Henricia	Ischnochiton	Stronglyocentrotus
CAN 5	B.T. mean	0.000	0.000	0.058	0.000
	B.T. (mean-sd)	0.000	0.000	-0.136	0.000
	B.T. (mean+sd)	0.000	0.000	0.293	0.000
	N	13	13	13	13
DEER ISLAND	B.T. mean	0.000	0.177	0.411	1.889
	B.T. (mean-sd)	0.000	-0.348	-0.274	0.059
	B.T. (mean+sd)	0.000	0.720	1.427	5.825
	N	12	12	12	12
FLIP ROCK	B.T. mean	0.129	0.129	0.274	1.033
	B.T. (mean-sd)	-0.150	-0.150	-0.110	0.234
	B.T. (mean+sd)	0.490	0.490	0.787	2.123
	N	12	12	12	12
SHAGS	B.T. mean	0.000	0.000	0.216	0.244
	B.T. (mean-sd)	0.000	0.000	-0.207	-0.125
	B.T. (mean+sd)	0.000	0.000	0.826	0.738
	N	10	10	10	10
WINTHROP	B.T. mean	0.000	0.119	0.450	0.774
	B.T. (mean-sd)	0.000	-0.226	-0.076	-0.290
	B.T. (mean+sd)	0.000	0.603	1.186	2.735
	N	11	11	11	11

Table 29. Abundance of small mobile fauna on horizontal rock substrata, spring 1992.

		Acmaea	Asterias spp.	Asterias vulgaris	juv. Asterias	Cancer borealis	Henricia
DEER ISLAND	B.T. mean	0.250	0.000	0.000	0.000	0.000	0.200
	B.T. (mean-sd)	-0.180	0.000	0.000	0.000	0.000	-0.137
	B.T. (mean+sd)	0.862	0.000	0.000	0.000	0.000	0.646
	N	12	12	12	12	12	12
FLIP ROCK	B.T. mean	0.713	0.000	0.000	0.142	0.000	0.000
	B.T. (mean-sd)	0.079	0.000	0.000	-0.150	0.000	0.000
	B.T. (mean+sd)	1.578	0.000	0.000	0.521	0.000	0.000
	N	11	11	11	11	11	11
SHAGS	B.T. mean	1.085	0.054	0.054	0.296	0.054	0.054
	B.T. (mean-sd)	-0.348	-0.133	-0.133	-0.097	-0.133	-0.133
	B.T. (mean+sd)	4.027	0.279	0.279	0.821	0.279	0.279
	N	14	14	14	14	14	14
WINTHROP	B.T. mean	0.227	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	-0.237	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.923	0.000	0.000	0.000	0.000	0.000
	N	12	12	12	12	12	12

		Ischnochiton	Stronglyocentrotus	Juv. Stronglyocentrotus
DEER ISLAND	B.T. mean	0.108	0.063	0.000
	B.T. (mean-sd)	-0.222	-0.139	0.000
	B.T. (mean+sd)	0.566	0.309	0.000
	N	12	12	12
FLIP ROCK	B.T. mean	0.361	0.772	0.069
	B.T. (mean-sd)	-0.132	0.046	-0.142
	B.T. (mean+sd)	1.060	1.800	0.329
	N	11	11	11
SHAGS	B.T. mean	0.389	0.296	0.211
	B.T. (mean-sd)	-0.143	-0.097	-0.186
	B.T. (mean+sd)	1.160	0.821	0.768
	N	14	14	14
WINTHROP	B.T. mean	0.867	0.573	0.000
	B.T. (mean-sd)	-0.292	-0.446	0.000
	B.T. (mean+sd)	3.044	2.888	0.000
	N	12	12	12

Table 30. Abundance of small mobile fauna on vertical rock substrata, spring 1992.

		Acmaea	Asterias forbesi	A. vulgaris	juv. Asterias	Henricia	Ishnochiton
CAN 5	B.T. mean	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000	0.000	0.000	0.000
	N	3	3	3	3	3	3
DEER ISLAND	B.T. mean	0.000	0.000	0.000	0.100	0.229	0.557
	B.T. (mean-sd)	0.000	0.000	0.000	-0.217	-0.184	-0.083
	B.T. (mean+sd)	0.000	0.000	0.000	0.534	0.812	1.490
	N	13	13	13	13	13	13
FLIP ROCK	B.T. mean	0.069	0.069	0.119	0.220	0.302	0.544
	B.T. (mean-sd)	-0.142	-0.142	-0.226	-0.132	-0.098	-0.005
	B.T. (mean+sd)	0.329	0.329	0.603	0.688	0.837	1.296
	N	11	11	11	11	11	11
SHAGS	B.T. mean	0.069	0.000	0.000	0.899	0.069	0.334
	B.T. (mean-sd)	-0.142	0.000	0.000	0.023	-0.142	-0.199
	B.T. (mean+sd)	0.329	0.000	0.000	2.197	0.329	1.132
	N	11	11	11	11	11	11
WINTHROP	B.T. mean	0.000	0.000	0.000	0.497	0.978	0.424
	B.T. (mean-sd)	0.000	0.000	0.000	-0.185	-0.160	-0.307
	B.T. (mean+sd)	0.000	0.000	0.000	3.573	1.295	1.011
	N	9	9	9	9	9	9

		Ophioderma	Stronglyocentrotus	Juv. Stronglyocentrotus
CAN 5	B.T. mean	0.000	0.000	0.000
	B.T. (mean-sd)	0.000	0.000	0.000
	B.T. (mean+sd)	0.000	0.000	0.000
	N	3	3	3
DEER ISLAND	B.T. mean	0.000	0.564	0.000
	B.T. (mean-sd)	0.000	-0.270	0.000
	B.T. (mean+sd)	0.000	2.010	0.000
	N	13	13	13
FLIP ROCK	B.T. mean	0.388	0.684	10.320
	B.T. (mean-sd)	-0.048	-0.251	0.259
	B.T. (mean+sd)	0.971	2.314	32.077
	N	11	11	11
SHAGS	B.T. mean	0.000	0.069	0.069
	B.T. (mean-sd)	0.000	-0.142	-0.142
	B.T. (mean+sd)	0.000	0.329	0.329
	N	11	11	11
WINTHROP	B.T. mean	0.000	0.620	0.147
	B.T. (mean-sd)	0.000	-0.241	-0.237
	B.T. (mean+sd)	0.000	1.079	0.497
	N	9	9	9

Table 31. Abundance of large mobile fauna at Lovell's Island.

SUMMER 1991

	C.borealis	C.irroratus	Homarus amer.	Asterias vul.	Henricia	Pseudopleuronectes americanus
mean density per 25 m 2	9.92	35.40	5.70	19.22	0.74	0
std. deviation	5.73	19.70	6.02	19.79	1.26	0

N = 7 ROV transects

FALL 1991

	C.borealis	C.irroratus	Homarus amer.	Asterias vul.	Henricia	Pseudopleuronectes americanus
mean density per 25 m 2	2.36	4.69	0.59	47.80	0.42	0.26
std. deviation	2.80	4.14	1.01	64.20	1.11	0.70

N = 7 ROV transects

WINTER 1992

	C.borealis	C.irroratus	Homarus amer.	Asterias vul.	Henricia	Pseudopleuronectes americanus
mean density per 25 m 2	0.03	0	0.15	0.95	0	0
std. deviation	0.014	0	0.036	0.127	0	0

N = 6 ROV transects

SPRING 1992

	C.borealis	C.irroratus	Homarus amer.	Asterias vul.	Henricia	Pseudopleuronectes americanus
mean density per 25 m 2	0.42	0	0.35	1.75	0	0
std. deviation	0.58	0	0.48	1.46	0	0

N = 5 ROV transects

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METAL ANALYSIS OF MARINE SEDIMENTS

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METAL ANALYSIS OF MARINE SEDIMENTS

INTRODUCTION

Marine sediment samples were collected by divers from Northeastern University (K.P.Sebens) at six sites (Table 1) in Broad Sound and Boston Harbor in May, 1990, and August and November, 1991. Samples (sediment, label and overlying seawater) were frozen in Whirl-pak bags and delivered to the Edgerton Research Laboratory (ERL), New England Aquarium (NEAq) in December 1991.

MATERIALS

All glass and plasticware were soaked overnight in a 4 N HNO_3 acid bath, rinsed several times with distilled water, and stored in plastic bags before use. All reagents were analytical grade. Distilled deionized water (Q-water) was prepared with a Milli-Q (Millipore) water purification system. Standard Reference Material 1646 (estuarine sediment) was obtained from the National Institute of Standard Technology (formerly the National Bureau of Standards (NBS)).

METHODS

Sediment sample size was very limited in most cases, the weights of nine samples were less than 5 grams. All samples contained excessive amounts of overlying seawater. Samples were thawed in January, 1992 to prepare the sediment samples for metal analysis. The enclosed labelling paper was removed and each sample was transferred to a centrifuge tube and spun at 11,000 rpm (14,500 x g) for 10 minutes in a Sorvall RC2-B refrigerated centrifuge. Overlying water was discarded and the step repeated until all of the sample had been removed from the Whirl-pak bag. In some cases, this step had to be repeated many times until all material was processed. The excess seawater was discarded and the pellet retained for metal analysis.

The sediment samples for metal analysis were frozen and lyophilized for 72 hours. Dried sediments were ground to a powder in an acid-washed boron carbide mortar and pestle. Large particles (e.g. shells and rocks) were removed and duplicate sediment aliquots (approximately 2.5 g each) were taken whenever possible from each sample and transferred to 125 mL erlenmeyer flasks containing glass chips. The samples were then relyophilized and weighed to accurately determine the dry weight of each replicate. There was an insufficient amount of sediment collected from NEAq samples #2, #3, #5, #6, #8, #9, #11, #12 and #14 for duplicate analysis (see Table 1 for Northeastern University sample designations).

Metals were heat and acid-extracted from the sediment samples by HNO_3 and HCl (after Sinex et al., 1980). Eighteen mL of concentrated redistilled nitric acid and 2 mL of concentrated hydrochloric acid were added to each flask and the samples were cold-digested overnight. Samples were then refluxed with vigorous boiling for four hours. The samples were allowed to cool, then were filtered through 0.45 um Nucleopore polycarbonate filters into 50.0 mL volumetric flasks. Samples were brought to volume with Q-water. The final solution matrix was 36% HNO_3, 4% HCl and 4 ppt lithium spectrochemical buffer. One procedural blank and one NBS standard reference material 1646 were prepared and analyzed for each ten sediment samples. All sediment metal concentrations are reported as µg/g dry weight sediment. Solution metal concentrations are reported as µg/mL.

The interference of Fe with the measurement of other elements was evaluated. This interference was assessed by running standards containing high levels of Fe (1000, 500, and 100 µg/mL Fe, no other elements in standard solution) and measuring the emission signals for the Cd, Cr, Cu, Mn, Pb and Zn channels.

RESULTS

Excessive concentrations of Fe (up to 1000 µg/mL) do not interfere with the measurement of Cr, Cu and Mn (see Appendix A, Fe standards). Fe does interfere with Cd, Pb and Zn determinations. Linear concentration correction equations, based on the Fe content of each sediment sample (Fe as mg/mL, not µg/mL), are presented in Table 2. These equations were determined by linear regression of the apparent Cd, Pb or Zn concentration (observed ug/mL, in Appendix A) versus the Fe concentration in the standard (1.0, 0.5 and 0.1 mg/mL). The measured Fe concentration in each sample solution (x) was used to determine the apparent concentration contributed by Fe interference for each element (y). The apparent metal concentration was subtracted from the observed metal concentration in solution to obtain the actual elemental concentration in solution (as µg/mL or parts per million).

The results of multielemental analyses for Cr, Cu, Fe and Mn (elements without Fe interference) are shown in Table 3 (raw data in Appendix B). The corrected sample concentrations for Cd, Pb and Zn are shown in Table 4 (data in Appendix C). All values are presented as ug element/g dry sediment. Instrumental detection limits were calculated as three times the standard deviation of the 0.00 ug/mL standard used in instrument calibration. These limits were 0.03 µg/mL for Cd, Cu, Mn and Zn; 0.015 µg/mL for Cr and 0.12 µg/mL for Fe and Pb.

Cd, Cu and Pb were not detected in any of the procedural blanks at concentrations above instrument detection limits. One procedural blank showed detectable levels of Cr, Fe, Mn and Zn. Another blank showed only zinc to be above detection limits. None of the sample concentrations were corrected for elements found in the procedural blanks since the occurrence of detectable contamination was not consistent. Also, even the highest concentrations of contaminating metal were insignificant compared to sample solution concentrations.

Copper and zinc were the only elements detected in the NBS estuarine sediment (SRM 1646) at the certified level (Table 6). The elements which had not been corrected for Fe interference (Cr, Fe, Mn) were all determined to be slightly lower in concentration than the certified values. The concentrations reported for Cr, Cu, Fe and Mn were very similar to the concentrations we reported in 1989 and 1990 in conjunction with sediment samples for Northeastern University (values included in Table 6). The lower recoveries of Cr, Fe and Mn were probably due to the incomplete dissolution of the reference materials and are consistent with the recoveries reported by Krumgalz and Fainshtein (1989) for the identical NBS standard.

Of the elements which had been corrected for Fe interference, Cd and Pb were detected at levels higher than the certified values. Zn values determined for this study were within the error limits of the certified values. Mean Cd and Pb concentrations in this study (1992) were 7.8X and 2.4X the NBS certified values respectively.

Krumgalz and Fainshtein (1989) reported recoveries consistent with the certified values for Cd and Pb using atomic absorption spectroscopic methods. These higher concentrations may possibly be due to non-iron interferences of the emission lines. In previous reports to Northeastern University (1989 and 1990), we had detected Cd at levels well above the certified value. Both Pb and Zn were lower than the certified values in 1989 and higher in 1990. Based on the results for the standard reference material, the measured concentrations of Cd and Pb in the sediment samples are likely to be somewhat high.

Analytical accuracy and precision for these marine sediment samples could be greatly improved with larger sample sizes. Triplicate samples of 3.5 g each (dry weight) would insure that all elements for metal analysis would be sufficiently above the detection limits of the instrument for reliable and repeatable measurements, even after correcting for Fe interference. We recommend that much larger sample sizes be collected in all future studies. The samples should be immediately centrifuged (under metal-free conditions) and the sediment frozen with a minimum amount of overlying seawater.

LITERATURE CITED

Krumgalz, B.S. and G. Fainshtein (1989) Trace metal contents in certified reference sediments determined by nitric acid digestion and atomic absorption spectrometry. Anal. Chim. Acta 218: 335-340.

Sinex, S.A., A.Y. Cantillo and G.R. Helz (1980) Accuracy of acid extraction methods for trace metals in sediments. Anal. Chem. 52: 2342-2346.

Table 1. Sediment sampling sites in Boston Harbor.

NEAq #	SITE	DATE
1	Winthrop (A)	14 Aug 91 7 Aug 91
2	Shags (A)	8 Aug 91
3	Deer Island (A)(C)	7 Aug 91
4	Lovells Island (A)	7 Aug 91
5	Can 5 (A)	7 Aug 91
6	Flip Rock (A)	8 Aug 91
7	Lovells Island (A)	19 Nov 91
8	Deer Island (B)	15 May 90
9	Shag Rocks (A)	20 Nov 91
10	Flip Rk (A)	19 Nov 91
11	Can 5 (A)	19 Nov 91
12	Can 5 (B)	15 May 90
13	Winthrop (A)	19 Nov 91
14	Deer Island (A)	19 Nov 91

Table 2. Fe interference correction equations for Cd, Pb and Zn. x = Fe concentration in solution (mg/mL), y = apparent element concentration in solution (µg/mL).

ELEMENT	CORRECTION EQUATION	r^2
Cd	$y = 0.2777x - 0.0100$	0.9051
Pb	$y = 0.6929x + 0.0827$	0.8174
Zn	$y = 0.2031x + 0.0025$	0.9513

Table 3. Mean elemental concentrations in marine sediments from Boston Harbor and Broad Sound (μg metal/g dry weight). Value in parenthesis = standard deviation. Calculated from results in Appendix B.

NEAq ID	NU ID	Cr	Cu	Fe	Mn
1	Winthrop	181 (4)	82.7 (1.6)	32439 (3741)	425 (22)
2	Shags	105.5	21.7	18048	421
3	Deer Island	141.5	91.4	29560	439
4	Lovells Island	154.4 (14.1)	148.1 (9.6)	31733 (159)	387 (16)
5	Can 5	102.4	97.1	26240	372
6	Flip Rock	154.5	49.5	28912	532
7	Lovells Island	156 (1)	145.9 (2.6)	33051 (2121)	414 (10)
8	Deer Island	44.4	25.4	19639	331
9	Shag Rock	294	42.9	32679	528
10	Flip Rk	206 (11)	128.3 (3.8)	30825 (337)	457 (11)
11	Can 5	121.4	77.1	26231	420
12	Can 5	92.1	67.1	22243	397
13	Winthrop	174.4 (0.4)	55.1 (0.5)	28473 (840)	415 (4)
14	Deer Island	92.8	57.5	24884	359

Table 4. Mean elemental concentrations in sediments from Boston Harbor and Broad Sound (µg metal/g dry weight) after correction for Fe interference. Value in parentheses = standard deviation. Calculated from results in Appendix C.

NEAq ID	NU ID	Cd	Pb	Zn
1	Winthrop	4.35 (1.70)	145.0 (25.9)	190.0 (27.2)
2	Shags	1.42	79.1	115.5
3	Deer Island	7.28	170.1	206.3
4	Lovells Island	2.23 (2.54)	160.7 (9.6)	247.1 (8.8)
5	Can 5	4.64	138.3	174.5
6	Flip Rock	5.18	142.2	183.6
7	Lovells Island	5.02 (2.71)	185.8 (19.1)	241.1 (12.2)
8	Deer Island	1.13	54.7	96.1
9	Shag Rock	2.53	139.7	161.1
10	Flip Rk	4.79 (1.94)	135.9 (19.9)	142.5 (5.9)
11	Can 5	3.31	130.1	186.7
12	Can 5	4.41	121.7	144.6
13	Winthrop	2.21 (3.08)	131.4 (21.1)	141.7 (1.1)
14	Deer Island	4.59	198.0	205.1

Table 5. Elemental content (μg/mL in solution) in procedural blanks (total volume = 50 mL). Underlined values are above instrumental detection limits (see results section).

ELEMENT	BLANK 1	BLANK 2	BLANK 3
Cd	<0.01	<0.009	<0.01
Cr	<0.005	<0.005	<u>0.029</u>
Cu	<0.007	<0.007	0.014
Fe	<0.02	<0.04	<u>5.85</u>
Mn	<0.007	<0.009	<u>0.053</u>
Pb	<0.01	0.04	<0.03
Zn	<u>0.311</u>	0.019	<u>0.056</u>

Table 6. Metal concentrations as µg metal/g dry weight in National Bureau of Standard Estuarine Sediment 1646 - Cd, Pb and Zn corrected for Fe interference. 1989 mean values (n=2) and 1990 values (n=3) were reported to Northeastern University by NEAq in similar studies dated September 13, 1989 and June 29, 1990.

	Cd	Cr	Cu	Fe	Mn	Pb	Zn
NBS Samples	1.10	48.5	17.6	29419	284	64.4	142.5
	4.56	47.8	16.0	26547	259	84.5	126.9
	ND	44.3	15.8	27240	262	55.9	134.6
Mean (1992)	2.83	46.9	16.5	27735	268	68.3	134.7
(SD)	(2.45)	(2.3)	(1.0)	(1499)	(14)	(14.7)	(7.8)
Mean (1990)	1.88	50.9	17.4	28021	281	76.9	163.2
(SD)	(1.58)	(2.4)	(0.7)	(839)	(10)	(14.8)	(15.4)
Mean (1989)	5.28	49.5	17.1	27320	253	ND	128.2
(SD)	(0.64)	(0.8)	(1.3)	(60)	(0)		(1.7)
CERTIFIED NBS	0.36	76	18	33500	375	28.2	138
	(0.07)	(3)	(3)	(1000)	(20)	(1.8)	(6)

Detection Limit of Cd = 0.03 µg/mL in solution (1992)
= 0.06 µg/mL in solution (1990)

Detection Limit of Pb = 0.02 µg/mL in solution (1989)

Appendix A. Standards used to calculate Fe interference in marine sediment samples. Values in table are observed metal concentration in μg element/mL in solution.

ELEMENT	1000μg/mL Fe	500μg/mL Fe	100μg/mL Fe
Cd	0.246	0.120	0.018
	0.34	0.16	0.02
	0.22	0.10	0.019
Cr	0.016	0.008	<0.005
	0.015	<0.006	<0.005
	0.015	<0.007	<0.008
Cu	<0.007	<0.007	<0.007
	<0.005	<0.005	<0.005
	<0.007	<0.007	<0.007
Fe	990	496	113.7
	1022	515	100.7
	890	471	97
Mn	0.026	0.020	0.020
	0.024	0.008	<0.007
	0.022	0.014	<0.008
Pb	0.72	0.42	0.24
	1.00	0.55	0.18
	0.61	0.31	0.04
Zn	0.200	0.091	0.029
	0.231	0.134	0.01
	0.184	0.092	0.027

Appendix B. Elemental concentrations in marine sediment samples from Boston Harbor and Broad Sound (µg metal/g dry weight).

NEAq ID	NU ID	Cr	Cu	Fe	Mn
1	Winthrop Aug 91	184	81.6	29794	409
		178	83.8	35084	440
2	Shags 91	105.5	21.7	18048	421
3	Deer Island 91	141.5	91.4	29560	439
4	Lovells Island 91	144.4	141.3	31620	375
		164.4	154.9	31845	398
5	Can 5 91	102.4	97.1	26240	372
6	Flip Rock 91	154.5	49.5	28912	532
7	Lovells Island Nov 91	157	144	31552	407
		154.9	147.7	34551	421
8	Deer Island	44.4	25.4	19639	331
9	Shag Rocks N 91	294	42.9	32679	528
10	Flip Rk N 91	214	131	31063	465
		198	125.6	30587	449
11	Can 5 N 91	121.4	77.1	26231	420
12	Can 5 (90)	92.1	67.1	22243	397
13	Winthrop N 91	174.1	54.8	27879	412
		174.7	55.5	29067	418
14	Deer Island N/91	92.8	57.5	24884	359

Appendix C. Elemental concentrations in marine sediment samples from Boston Harbor and Broad Sound (μg metal/g dry weight) after correction for Fe interference. ND = not detected.

NEAq ID	NU ID	Cd	Pb	Zn
1	Winthrop	3.15	126.7	170.7
		5.55	163.3	209.2
2	Shags	1.42	79.1	115.5
3	Deer Island	7.28	170.1	206.3
4	Lovells Island	0.43	153.9	253.4
		4.02	167.5	240.9
5	Can 5	4.64	138.3	174.5
6	Flip Rock	5.18	142.2	183.6
7	Lovells Island	3.10	172.3	232.4
		6.94	199.3	249.7
8	Deer Island	1.13	54.7	96.1
9	Shag Rocks	2.53	139.7	161.1
10	Flip Rk	3.42	121.8	146.7
		6.17	150.0	138.3
11	Can 5	3.31	130.1	186.7
12	Can 5	4.41	121.7	144.6
13	Winthrop	ND	116.4	140.9
		4.39	146.3	142.5
14	Deer Island	4.59	198.0	205.1

Detection Limit of Cd = 0.03 μg/mL in solution

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